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Adoption Patterns and Characteristics of Faculty Who Integrate Computer Technology for Teaching and Learning in Higher Education

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a dissertation entitled "Adoption Patterns and Characteristics of Faculty Who Integrate Computer Technology for Teaching and Learning in Higher Education" submitted by Dawn Michele Jacobsen in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

The integration of technology for teaching and learning appeals to some faculty in higher education, and not to others. This exploratory investigation builds and extends upon Rogers' (1995) theory of the diffusion of innovations and adopter categories in order to describe current faculty innovativeness, as well as to explore the differences between early adopting faculty and mainstream faculty. A mixed-method research design, using both quantitative and qualitative methodologies, was employed to investigate the difference between those who readily adopt technology for teaching and learning, and those who do not. This study employed a new method for conducting educational and psychological research; an on-line, World Wide Web-based version of the survey instrument was designed and piloted for this investigation. Collecting data using the Internet is a relatively new research methodology. As such, data collected using this procedure was compared to that collected using conventional methods to determine whether equivalent results can be obtained.

Seventy-six faculty from across disciplines at two large North American universities completed a 195-item survey about computer use patterns, self-rated expertise, technology adoption patterns, generalized self-efficacy, changes to classroom environments, incentives and barriers, preferred methods for learning about technology, and methods for integrating technology and evaluating the outcomes. In-depth interviews were conducted with faculty who have adopted technology for teaching and learning. Survey results were used to establish baseline data for future comparisons, to identify trends, issues, and concerns unique to post-secondary instructors, to differentiate between two adopting groups, and as a source of demographic and attitudinal data used in descriptive and exploratory statistical analyses. Qualitative data was analyzed for emergent categories and themes, and was used to explore faculty member's innovation-decision processes.

As expected, some differences were found between early adopters and mainstream faculty for self-rated computer expertise and total adoption of technology for teaching and learning. Some differences were found between faculty who used the web-based and paper-based survey. Recommendations are made for campus-wide technology integration plans based upon findings that early adopter and mainstream faculty prefer different methods for learning about technology, different types of support and training, and report different motivators and impediments to integrating computer technology.

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Dedicated

to

My Parents

Michael Anton Jacobsen

Agnes Fern (Keller) Jacobsen

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INTRODUCTION

Information technology is no longer the novelty it was a number of years ago. No longer the exclusive domain of a small “technological priesthood” (Sabelli, 1998), computers have become an integral part of our daily lives, and in many ways, we cannot seem to function without them. Individuals use computers to book flights as well as to fly them. Computers are used to manage and direct the flow of information and currency by governments, banks, and stock markets. There has been exponential growth of the Internet and personal connectivity in the last decade. The proliferation of increasingly sophisticated technology at home and in the workplace has spawned unprecedented use of machines by men, women, and children (Weil & Rosen, 1997).

Computers are also becoming standard equipment in education, as basic to teaching and learning as libraries, books, and pencils, and as essential to communication as telephones (Brown, Burg, & Dominick, 1998). Information rich institutions of higher education use technology for administrative management, information access and delivery in libraries, research and development, as a medium of communication, and for teaching and learning. However, it should be stressed from the outset that information technology (IT) has no aim in itself (Bull, Dalinga-Hunter, Epelboin, Frackmann, & Jennings, 1994) and is not an end in itself. The changing, increasing or even overwhelming role and importance of information is an underlying and driving force for the development and adoption of IT. It is safe to say that advances in computing technology and the communications infrastructure are significantly changing the potential and use of information on campuses. Those involved in higher education direct their efforts towards collecting, using, processing and delivering information. Research information is the ‘raw material’ and ‘final product’ of research processes. Research findings need to be communicated, and IT supports, influences and changes this dissemination process. Teaching and learning rely on the transfer and processing of information, and IT may facilitate this exchange.

Higher education contributes to new knowledge and provides the ever-changing qualifications required by industry and society. Computer technology is becoming ubiquitous in society, and after years of sustained experimentation, has emerged as an increasingly essential component of the college experience (Green, 1996). Brown, Burg, Dominick (1988) believe that a relevant post-secondary education in the 21st century must give students experience with the computer tools that will be an inevitable part of their work and lives. Universities take seriously their responsibility to include computer knowledge, skills and literacy in some form as part of a student’s education, and therefore have invested large sums of money into acquiring and developing information technology.

Recent estimates indicate that North American colleges and universities invest billions of dollars per year for the acquisition of computer technology (Candiotti & Clark, 1998; Geoghegan, 1994). Formal evidence linking this investment to higher productivity (Schwalbe, 1996) and changes and improvements in the teaching and learning process is accumulating (Kulik & Kulik, 1980, 1987; Ehrmann, 1995), and new research approaches and methodologies are being developed to adequately study the complex issues involved in measuring the effects of educational technology (Bull, et al, 1994; Clark, 1989; Laurillard, 1993; Reigeluth, 1989). A wide range and variety of instructional uses of technology are being presented and discussed at international conferences (for a current review, see Ottmann & Tomek, 1998). Tool applications, such as word processors and spreadsheets, are widely used for writing and research tasks. Increased access to and use of the Internet is making a unique contribution to the teaching and learning process (Shaw, 1994).

Along with the changes to work and leisure that information technology seems to demand of society, current fiscal realities also influence the implementation of technology on campus. As a result of shrinking operating budgets, universities are looking for ways to increase tuition revenues without having to erect more buildings to accommodate students on site. Communications technology is becoming an important part of future strategies to provide distance education services, “anytime, anywhere” access (Daniel, 1997), to an increased number of students. Recently developed technological delivery mechanisms, such as video conferencing and the World Wide Web, seem to offer promising alternatives to same time, same place instruction. Alternative delivery mechanisms also appeal to many of today’s returning students, many of whom are older, employed, and eager for university credentials to aid in current and future careers. These students often have different expectations for their post-secondary education, such as evening, weekend and distance access. Thus, information and communication technologies, like the Internet, appear to provide viable solutions for delivering educational services to a geographically and temporally dispersed student body.

Integrating technology into the teaching-learning transaction has been found to transform the teacher’s role from being the traditional “sage on the stage” to *also* being a “guide on the side”, and student roles can also change from being passive receivers of content to being more active participants and partners in the learning process (Alley, 1996; Repp, 1996; Roblyer, Edwards, & Havriluk, 1997). The transition from teacher-directed to more student-centered instruction has coincided with the shift from predominantly behaviorist to more constructivist approaches to learning. It was originally believed that technology would serve a behaviorist, “teaching-machine” role in the classroom (Skinner, 1954). However, the transition from a mass production, industrial model of the physical laborer, to a model of the knowledge worker in an information age, has been accompanied by a transition in education and psychology from a behaviorist, stimulus-response-feedback model of the learner to a more constructivist, knowledge-building, information-processing model of the learner. Constructivists, like Seymour Papert (1980), envisioned a new role for the computer, that of partner in the active knowledge building and problem solving learning processes of the student. The changing roles of teacher and student do not necessarily rely on IT entirely, however, the integration of computer technology into education, and the proliferation of computers in society, appears to both demand and require changes in the teaching and learning process (Clifford, Friesen, & Jacobsen, 1998). Children of the “net generation” have grown up regarding technology as a part of the natural landscape; to them, digital technology is no more intimidating than a VCR or toaster (Tapscott, 1998). The younger generation has different expectations for education. For many adults, however, their initial encounters with technology can be characterized not by accommodation, but by confrontation, uncertainty, and frustration. “For the first time in history, children are more comfortable, knowledgeable and literate than their parents about an innovation central to society, and parents are unnerved,” says Tapscott (1998, p. 1). Despite the growing wave of technology’s penetration into education, it is clear that there are also a number of educators, the parent generation, who are unnerved.

The Gap Between Early Adopters and Mainstream Faculty

Despite research and testimony that technology is being used by more faculty (Green, 1996), the diffusion of technological innovations for teaching and learning has not been widespread, nor has it become deeply integrated into the curriculum (Geoghegan, 1994). Information technology has not been integrated into the curriculum, whether in terms of widespread use by departments and faculty for teaching, or in terms of the depth at which technology is meaningfully integrated into individual courses and into the curriculum as a whole (Geoghegan, 1994). Estimates suggest that no more than five to ten percent of faculty utilize information technology in their teaching as anything more than a "high tech" substitute for blackboard and chalk, overhead projectors, and photocopied handouts (Geoghegan, 1994; Reeves, 1991). Although there is a growing number of faculty who are very enthusiastic about adopting technology because of the potential of computer tools for their students, there is still a large number of mainstream faculty who seem hesitant or reluctant to adopt technology for their teaching tasks. As such, the evaluation of the success of educational technology still seems to depend largely on how well innovators and early adopters make it work. In order to take advantage of the benefits of information technology in higher education, we need to better understand what differentiates early adopters from mainstream faculty to predict how to encourage further adoption of information technology on campus. In addition to increasing our understanding of the current adoption patterns and characteristics of early adopters and mainstream faculty, we must also explore the relationship between technology integration and fundamental teaching and learning issues.

Expert Teaching and Early Adoption

A university's effectiveness is often judged by its most visible contribution to society: the quality of its teaching. University professors are considered experts in their disciplines, however, most begin their teaching careers with little or no pedagogical knowledge or training. In spite of beginning as untrained novices, the majority of professors somehow learn how to teach, some develop into competent and proficient teachers, and a small number become expert. The successful integration of technology for teaching and learning in higher education requires the development of two types of expertise: pedagogical and technological. It is likely that, with the possible exception of professors for whom computer technology is a primary area of research, most professors start out as relatively untrained novices at integrating technology in their teaching. Through a process of experimentation, modeling, and with other means of training, support and self-development, some professors develop into competent and proficient teachers with technology and a small number become experts at finding innovative ways to use technology with students. Not all professors who adopt technology integrate this innovation in meaningful ways to transform teaching and learning. The mere presence or use of computers in classrooms does not, in itself, change anything. Instead, it is the way that faculty think about teaching and learning, and their beliefs about what teachers and students can do differently with the technology that can fundamentally change education.

Analyzing faculty adoption patterns using Rogers' (1995) diffusion theory, in which almost every individual has the potential to become an adopter of an innovation, is qualitatively different from a consideration of the development of teaching expertise, in which only a very few individuals become experts. In addition to examining whether or not faculty have adopted technology for teaching, a consideration of the development of teaching expertise recognizes that even among adopters there are varying levels of interest, skill, and motivation for integrating technology into teaching and learning. A relevant question to ask is, "among those who adopt technology for teaching and learning, what is different about those who become expert at finding innovative ways to use computers with students?" Modified slightly, this question might be, "what is it that makes an expert an expert?" Of particular interest in the present investigation is the relationship between early adoption of technology and expert teaching. This relationship will be explored using Bereiter and Scardamalia's (1993) research from cognitive psychology on the development of teaching expertise. An understanding of the characteristics of early adopting faculty who are also expert teachers can broaden our understanding of the differences among individuals in this category, and give us insight into what early adopters know and do in order to be successful at integrating technology into their teaching.

A Campus-Wide Vision for Integrating Technology

Instructional technology may support and increase the efficiency of the teaching-learning transaction or even modify educational processes on campus. However, when we consider the integration of technology in higher education, all of the stakeholders, including administration, faculty, students, and support staff, should share a similar vision about its use and the potential benefits. If the vision regards technology as a means to reshape and reform what we mean by teaching and learning, then the potential benefits of using new writing, communication, and research tools can be meaningfully explored. On the other hand, if technology is regarded as an "add-on" to existing teaching and learning methods, or only as a potential money-saving strategy, then the benefits will be harder to realize. Two examples will be used to illustrate the difference between the integration of technology for teaching, and using computers as an "add-on" to instruction.

In the first case, using technology to explore various means for crafting narratives, expositions, poetry, and such, can lead to new ways of considering text. For example, how do writers create text differently using various tools, such as word processors, PowerPoint, hypermedia, and through electronic exchanges using e-mail and the Internet? How do students of differing abilities use these tools, and are there different tools that "release" the writer within? Consider the following example of a grade 6 class using PowerPoint to craft research reports (Clifford, Friesen, & Jacobsen, 1998). Instead of using word processing to create a standard report about bears in the Kananaskis, the students were given the challenge of creating and presenting their research project using PowerPoint. A surprising result was that the students who were the "traditional" high achievers had some difficulty approaching this new medium where the space for text is smaller, and the environment lends itself to the "unpacking" of lengthy text. The students' previous model of creating a lengthy, unbroken stream of text (i.e., an essay or report) did not transfer easily to the screen-by-screen PowerPoint environment. However, the most surprising result was observed with the writers on the other end of the scale, the students who had previously experienced difficulty generating conventional essays or reports. The "struggling writers" readily adapted to the screen-by screen-writing environment provided by PowerPoint, and crafted extensive research reports that included graphics, sound, animation, and color. For these students, PowerPoint provided a flexible environment which they could shape to express their knowledge about bears. In the end, both groups of students benefited from using this new tool; the entire class was exposed to new ways of shaping text and media, and the struggling writers experienced new success in expressing their ideas.

Consider a more typical use of computers in a modern classroom. Instead of using overheads on a projector, the professor uses an expensive workstation and liquid crystal display unit to present text-based PowerPoint slides during a lecture. Students listen and take notes. How is this different from conventional delivery methods? One advantage for the instructor is the ease with which these slides can be edited and modified for a future lecture. However, it is difficult to argue that using PowerPoint slides in this way for a lecture fundamentally changes how students participate in the learning process. Even if the students use PowerPoint to create neater, and perhaps more legible, slides for in-class presentations, it is hard to argue that this use of PowerPoint is fundamentally different from what could be done with an overhead projector. In the grade 6 example, the use of PowerPoint as a multimedia writing and presentation tool provided a malleable environment that enabled some students to express themselves in ways that made better sense to them. Although the differences are a matter of degree, these two examples contrast how the integration of technology can transform a learning task, or merely be used as a variation on conventional teaching and learning methods.

If a university's culture promotes (either implicitly or explicitly, intentionally or unintentionally) the use of technology as an expensive add-on, then the important questions about teaching and learning will remain unasked and unexplored. In this case, the investment in technology could probably be put to better use elsewhere. On the other hand, if administrators and faculty members are willing to fundamentally rethink teaching and learning, and question and explore new approaches to writing, communication, and research, then we may indeed realize some benefits of investing in technology.

Purpose of the Present Investigation

Given the size of investment in instructional technology in higher education, the anticipated increase in demand for distance education in the future, and the demonstrated effectiveness with some educational outcomes, it seems reasonable to investigate why the integration of technology for teaching and learning is so appealing to some faculty, and not to others.

The purpose of the present investigation is to explore the adoption patterns and characteristics of faculty who integrate computer technology for teaching and learning in higher education. The first task will be to examine the differences between faculty who readily adopt technology for their teaching tasks, and those who seem hesitant or reluctant to adopt technology for teaching and learning. Everett Rogers' (1995) adopter categories and innovation-decision process will be used to analyze the difference between early adopters and mainstream faculty, as well as to examine the issues surrounding the integration of technology for teaching and learning in higher education. The second task will be to examine the characteristics of early adopters who are excellent teachers to develop a better understanding of individual cases of adoption of technology for teaching and learning. The relationship between early adoption and excellent teaching will be explored in chapter two. Literature on the cognitive development processes of expert teachers will provide both a rationale and a research framework from which to infer some of the motivational processes of early adopters who integrate technology for teaching and learning in innovative and effective ways. Two assumptions underlying this line of research are: (1) that "attributed expertise" (Sternberg & Frensch, 1992), an individual is an expert if they are regarded as such by others, is a valid indicator of a teacher's knowledge and skill at integrating technology to transform teaching and learning, and (2) the integration of technology for teaching and learning results in desired and valuable learning outcomes.

A rationale for the research methodology is presented in Chapter Three. In brief, both quantitative (selected-response survey items) and qualitative methodologies (open-ended survey response items and semi-structured interviews), have been chosen to pursue this line of research. The choice of a methodological design was based upon the closeness of fit between the research question, prior research, and methods used to collect data. First, survey methods will provide quantitative data that will be used to build and extend upon Rogers' (1995) theory of the diffusion of innovations. Second, open-ended questions and interviews will provide rich qualitative data about the values, beliefs and characteristics of individual adopters and non-adopters of technology, which will complement the survey data. The qualitative data will also be used to explore the relationship between early adoption and excellent teaching. Both survey and interview methods are used to gather information about changes to teaching and learning as a result of integrating technology, the incentives and barriers to integration, and some of the outcomes of using technology. Excerpts from interviews and responses from faculty who have adopted technology for teaching tasks will also be used to examine why the potential of technology is often difficult to achieve in real life (Wilson, 1988).

This study also employs a new method for conducting educational and psychological research; an on-line, World Wide Web-based version of the survey instrument was designed and piloted for this investigation. The phenomena under investigation seemed to both suggest and support an exclusively electronic method of survey participation. However, a paper version of the survey was also used in order to include both adopters and non-adopters of technology in the study. Collecting data using the Internet is a relatively new research methodology. As such, data collected using this procedure was compared to that collected using conventional methods to determine whether equivalent results were obtained.

Significance of the Study

The present investigation grew out of a perceived need to broaden the base of current evidence about adoption patterns on campus and the characteristics of faculty who integrate technology in higher education. The choice to employ a relatively new research methodology for on-line survey research was based upon a desire to explore the feasibility of web-based methods for conducting educational and psychological research.

This dissertation contributes to knowledge in two ways: (1) new evidence is provided about the adoption and integration of technology for teaching and learning in higher education which corroborates Rogers' (1995) theoretical framework, and (2) a new methodology for conducting survey research is piloted and tested, and the results are compared to conventional methods. The outcomes of this investigation will be useful to different academic groups in higher education: (1) those in leadership positions, such as administrators, deans, and department heads, (2) individual faculty members who are interested in the further adoption of technology for teaching and learning on campus, and (3) individual faculty members who are interested in conducting educational or psychological research using the Internet. The following section discusses how the study outcomes will be useful to different stakeholders on campus.

First, the primary audience for the results of this investigation are campus leaders with decision-making power who are interested in finding ways to bridge the gap between early adopters of information technology and mainstream faculty who are yet to use technology to improve teaching and learning. This investigation yields a current description of campus-wide, faculty adoption patterns of information technology for both personal use and for teaching and learning in higher education. These results can be used to inform and educate the post-secondary community about the adoption of technology by academic staff, resulting changes to the teaching and learning process, the incentives and barriers to integrating technology, preferred methods for learning about technology, and methods for evaluating the outcomes of integration. A better understanding of the difference between early adopters and mainstream faculty is needed in order to plan for more widespread adoption of technology for teaching and learning on campus. An outcome of the present research is a series of recommendations for practice, for both individual faculty and institutions, about training, support, and resource needs on campus. The suggestions also identify professional development opportunities and incentives that may encourage mainstream faculty to integrate computer technology into their post-secondary teaching.

A second audience for these results is the individual faculty member who is interested in facilitating efforts to encourage more widespread adoption, as well as faculty members who are new or potential adopters. This study explores the characteristics of earlier adopting faculty who integrate technology in teaching and learning on campus, and explores the relationship between excellent teaching and early adoption. The descriptive accounts of both shared and unique characteristics of early adopting faculty members who integrate technology for teaching and learning provides insight into the complex process of developing the necessary expertise to integrate technology for teaching and learning in higher education, and provide other faculty with a means of drawing parallels and contrasts between the experiences of others and their own practice. This information will be useful to faculty members who are interested in further developing their skills and knowledge about teaching and integrating technology, and may also provide a starting point for faculty who want to begin integrating technology in their classrooms.

Finally, the present investigation describes the methodology used to pilot and test an on-line, web-based interface for survey research. Researchers who are interested in conducting survey research using the Internet will be interested in the comparison between web-based and paper-based methods of participation, and the type of information that can be gathered using this relatively new methodology.

Chapter Outline

Chapter Two is a summary of the relevant research literature on the integration of technology for teaching and learning in higher education. The first topic to be examined in the literature review is the theoretical framework provided by Rogers' (1995) theory of the diffusion of innovations. The second major topic is an examination of the development of teaching expertise, and the potential relationship between early adoption and excellent teaching. The third major topic is an examination of the implications of developing a long-term plan for campus-wide integration of technology that is based on the characteristics of early adopters. Chapter Three describes the methodology, research instruments, and data collection procedures used to conduct this investigation. Chapter Four presents an analysis and interpretation of survey results from the current investigation. Chapter Five presents the results of interviews case-by-case. Finally, Chapter Six discusses the results of this investigation in light of current published literature and trends, makes recommendations for technology integration plans, and identifies the implications for future research in this area.

Chapter Two
LITERATURE REVIEW

The academic literature related to using technology for teaching and learning is large and diverse. This section will review the literature on the adoption patterns and characteristics of faculty who integrate technology. The first topic to be examined is the framework provided by Rogers' (1995) theory of the diffusion of innovations. Focus will be on how adopter categories and the innovation-decision process are conceptualized, and how these concepts can be applied in an investigation of faculty adoption patterns. The second major topic is an examination of the development of teaching expertise, and the potential relationship between early adoption and excellent teaching. Rogers' (1995) theory and a consideration of the development of expertise provide a rationale for the chosen research methodology. The third major topic embodies a review of the literature on the implications of developing long-term plans for campus-wide adoption of technology that are based on the characteristics of early adopters. There is growing recognition of the need to provide a different support infrastructure for mainstream faculty than sufficed for early adopters of technology for teaching and learning. A number of system-wide initiatives have been implemented at various higher education institutions which provide models for encouraging wider diffusion of technology for teaching and learning, and bridging the gap between early adopter success and more mainstream adoption.

What Differentiates Early Adopters From Others?

Descriptions in the literature suggest that faculty who are innovators or early adopters of instructional technology for teaching and learning are intrinsically motivated, self-taught, "lone-wolves" and experimenters (Wertheimer & Zinga, 1997), who are confident and efficacious (Rogers, 1995), comfortable with constant change, attracted to the technology, risk takers (Gilbert, 1995), and excellent teachers whose use of technology appears to be a natural extension of their area of expertise (Hadley & Sheingold, 1993). Individuals in this group have often used technology to "reengineer" (Hammer & Champy, 1993), or transform the teaching-learning transaction, thus changing teacher and student roles (Roblyer, Edwards, & Havriluk, 1997). What differentiates the early adopter of instructional technology from other faculty members?

Diffusion of innovations theory (Rogers, 1995) provides an approach to discussing the differences between early adopters and others. The importance of a theoretical framework is rooted in the cycle of knowledge development: observations lead to theory to classify, explain, and predict observations (Davis & Parker, 1997). The theory leads to questions about the behavior or actions being observed. Theory-based research defines expected outcomes and the variables associated with them, and provides a reason for expecting to find certain results. Research provides evidence for or against the theory-based expectations.

Diffusion of Innovations

A theoretical framework for analyzing of the characteristics of adopters is provided by Everett Rogers' (1995) theory of the diffusion of innovations. A majority of Rogers' (1995) studies have investigated discontinuous innovations, and technological innovations fall into this category. "A technological innovation usually has at least some degree of benefit for its potential adopters. This advantage is not always very clear-cut, at least not to the intended adopters. They are seldom certain that an innovation represents a superior alternative to the previous practice that it might replace" (Rogers, 1995, p. 13). Therefore, there is a good match between Rogers' (1995) theory of the diffusion of innovations and the specific innovation of interest in the present investigation. Rogers' (1995) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). The four main elements are the innovation, communication channels, time, and the social system. The following sections elaborate upon these four elements with a focus on the innovation, the innovation-decision process, and adopter categories.

The Innovation

Rogers (1995) defines an innovation as an idea, practice or object that is perceived as new by the individual, and diffusion as the process by which an innovation makes its way through a social system. The characteristics of innovations, as perceived by individuals, tend to influence their rate of adoption and are associated with the persuasion stage of the innovation-decision process. Rogers (1995) lists five characteristics of innovations. Relative advantage describes the degree to which an innovation is perceived as better than that which it supersedes. Compatibility is the degree to which an innovation is consistent with the existing values, past experience, and needs of the potential adopter. Complexity is the degree to which an innovation is perceived as difficult to understand and use. Trialability is whether an innovation may be experimented with on a limited basis. Observability is the degree to which the results of an innovation are visible to others.

The innovation in the present investigation is instructional technology, and diffusion is the extent to which all faculty on campus have adopted this innovation for teaching and learning. An important conceptual and methodological issue is to determine the boundaries that define a technological innovation (Rogers, 1995). Therefore, instructional technology in this investigation includes 44 types of computer-based software and tools used for teaching and learning, and only implies the hardware on which these run, the peripherals needed for CD-ROM, laserdisk, an so on, and the network infrastructure for communications technology. Thus, presenting information available on the World Wide Web in the classroom using a projector would be considered using instructional technology, as would displaying PowerPoint slides using a projector.

An investigation into the adoption of computer technology must also consider the concepts of *interrelatedness* and *re-invention*. A technology cluster consists of one or more distinguishable elements of technology that are perceived as being closely *interrelated*. Rogers' (1995) asserts that an adopter's experience with one innovation influences that individual's perception of the next innovation in a technology cluster to diffuse through the individual's system. Thus, if an adopter has a negative first experience with one computer application, they may regard all computer applications through this perspective. Rogers' (1995) also describes how diffusion research has evolved from regarding an innovation as an invariant quality to the concept of *re-invention*, defined as "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation (p. 17)". Ram and Jung (1994) discuss the concept of "use innovativeness" in the context of adopting computers. A great deal of computer technology can be described as "model-less"; there are some inherent use characteristics, but there is also a wide margin for "invented" uses (Ram & Jung, 1994). Quantitative research methods are useful for gathering information about current diffusion patterns and rate of adoption of certain technologies on campus, while qualitative methods, such as open-ended questions and interviews are useful for exploring the concepts of interrelatedness and re-invention.

When an innovation has been adopted by most or all of the members in a social system, diffusion has reached the saturation point. Geoghegan (1994) suggests that this saturation point has been reached with early adopters of instructional technology. When new ideas are invented, diffused, and are adopted or rejected, leading to various consequences, social change occurs (Rogers, 1995). This social change can be planned or spontaneous, intended or unintended; for example, a physics department invents a new network interface and protocol for exchanging leading edge information among physicists versus the spontaneous and exponential demand for access to the Internet with the advent of the World Wide Web.

The Innovation-Decision Process

Rogers' (1995) asserts that an individual's decision to adopt an innovation is not an instantaneous act. Rather, it is a process that occurs over time, consisting of a series of actions and decisions. Rogers' model of the innovation-decision process, conceptualized as consisting of five stages, is depicted in Figure 1. The *innovation-decision process* is "the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision" (Rogers, 1995, p. 163).

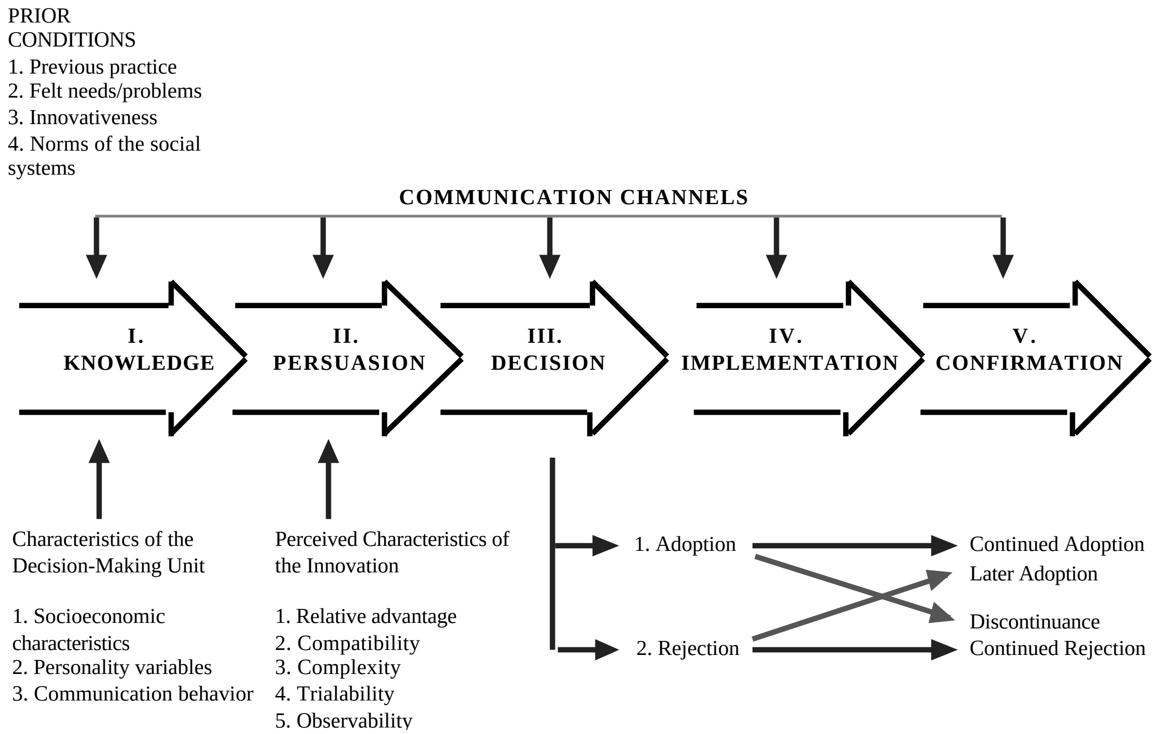

Figure 1. A Model of Stages in the Innovation-Decision Process (Rogers, 1995)

The innovation-decision process is essentially an information-seeking and information processing activity in which the individual is motivated to reduce uncertainly about the relative advantages and disadvantages of an innovation (Rogers, 1995). *Knowledge* occurs when an individual (or other decision-making unit, hereafter referred to as "an individual") is exposed to an innovation's existence and gains some understanding of how it functions. Types of knowledge range from awareness about the innovation, how-to use an innovation properly, and principles-knowledge dealing with the functioning principles underlying how the innovation works. Predispositions such as selective exposure and selective perception may influence an individual's behavior toward communication messages about an innovation and the effects that such messages are likely to have. Hassinger (1959), cited in Rogers (1995), argues that even if individuals are exposed to innovation messages, such exposure will have little effect unless the innovation is perceived as relevant to the individual's needs and as consistent with the individual's attitudes and beliefs.

Persuasion occurs when an individual forms a favorable or unfavorable attitude toward or opinion of the innovation based upon perceived characteristics of the innovation, such as relative advantage, complexity, and so on. Persuasion is also influenced by information sought from near-peers whose subjective opinion of the innovation is most convincing (Rogers, 1995). When someone who is like us shares a positive evaluation of the innovation, we are more motivated to adopt it. *Decision* occurs when an individual engages in activities that lead to a choice to adopt or reject the innovation. Adoption is a decision to make use of an innovation as the best course of action available. Active rejection means considering and trying the innovation out on a limited basis, and deciding not to adopt. Passive rejection, also called non-adoption, consists of never really considering the use of the innovation.

Implementation occurs when an individual puts the innovation into use. Until this stage, the process has been a mental exercise. Implementation involves an overt behavior change as the new idea is actually put into practice. This stage may continue for a lengthy period of time until the innovation finally loses its distinctive and noticeable quality as a new idea. Re-invention, the degree to which an innovation is changed or modified by the user, can also occur in this stage. *Confirmation* occurs when an individual seeks reinforcement of an innovation-decision already made, or reverses a previous decision to adopt or reject the innovation if exposed to conflicting messages about the innovation. Each stage in the innovation-decision process is a potential rejection point. One can gain awareness of an innovation in the knowledge stage, and then simply forget about it. Rejection can occur even after a prior decision to adopt, which is called discontinuance.

Adopter Categories

The time element of the diffusion process allows us to generate diffusion curves and to classify adopters into categories. Because individuals in a social system do not adopt an innovation at the same time, *innovativeness* is the degree to which an individual is relatively earlier or later in adopting new ideas than other members of a social system (Rogers, 1995). For example, word processing is becoming a ubiquitous technology on campuses; faculty who used text editors twenty years ago have a higher degree of innovativeness than faculty who started using word processing yesterday. According to Rogers' (1995) theory, the diffusion of an innovation usually follows a normal, bell-shaped curve when adoption is plotted over time on a frequency basis (Figure 2). If the cumulative number of adopters is plotted, the result is an S-shaped curve. A diffusion curve allows us to compare the innovativeness of an individual or other unit of adoption with other members of a system, usually measured as the number of members in the system to adopt the innovation in a given time period. Many human traits are normally distributed; physical traits such as height or weight; behavioral traits such as intelligence or learning of information. Hence, Rogers (1995) reasons, a variable such as the degree of innovativeness is also expected to be normally distributed; decades of diffusion research on innovativeness from across disciplines has supported this expectation.

Mahajan, Muller, & Srivastava (1990) suggest that Rogers' classification model based on innovativeness offers several advantages for describing the adoption patterns of individuals in a group: (1) it is easy to use, (2) it offers mutually exclusive and exhaustive standardized categories, by which results can be compared, replicated, and generalized across studies, and (3) because the underlying distribution is assumed to be normal, continued acceptance of an innovation can be predicted and linked to the adopter categories.

Rogers (1995) suggests that the adoption of a new idea results from information exchange through interpersonal networks. The first adopter of an innovation discusses it with other members of the system, and each of these adopters pass the new idea along to other peers. The diffusion curve begins to level off after half of the individuals in a social system have adopted, because each new adopter finds it increasingly difficult to tell the new idea to a peer who has not yet adopted, for such non-knowers become increasingly scarce. The segment of the diffusion curve between 10 to 20 percent adoption is "critical mass" or the "heart of the diffusion process" (Rogers, 1995) and represents the transition from the "early adopter" level of innovativeness to the "early majority".

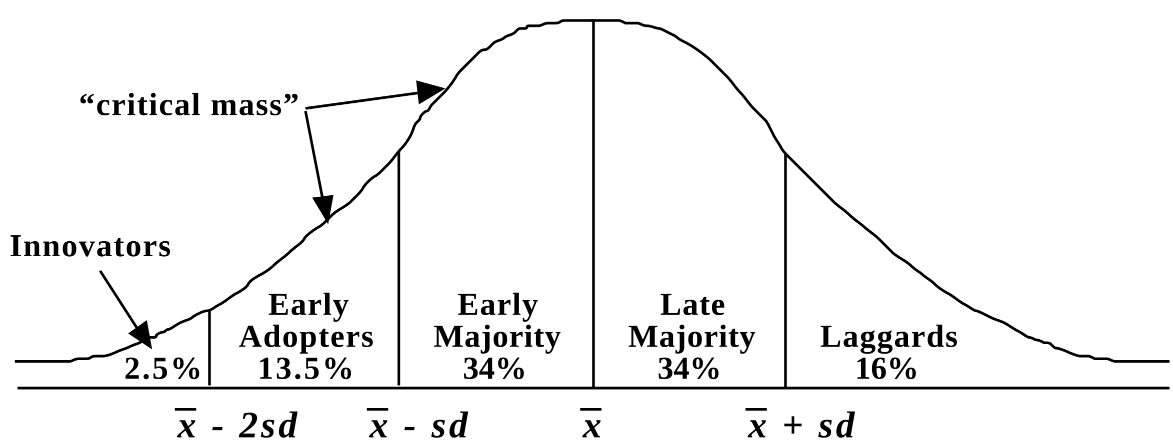

Figure 2. Adopter Categorization on the Basis of Innovativeness (Rogers, 1995)

Having been abstracted from empirical investigations and market research, the five adopter categories Rogers (1995) describes along the continuum of innovativeness (i.e., innovators, early adopters, early majority, late majority, and laggards) are “ideal types” designed to make comparisons possible based on characteristics of the normal distribution and partitioned by the mean and standard deviation. Although the values of the mean and standard deviation differ for each sample of observations, Crocker and Algina (1986) describe three characteristics that all normal distributions share: 1) the mean, mode, and median are always the same value, 2) every normal distribution is symmetric; that is, the right and left halves of the curve are exact mirror images, and 3) approximately 68% of the scores lie in the interval between μ and $\mu \pm 1\sigma_x$. Ideal types are not simply the average of all observations about an adopter category, that is, exceptions can be found, and pronounced breaks do not occur between each of the five categories.

A different diffusion curve can be generated for each type of computer application to compare percentage of diffusion. For example, personal use of word processing is described as almost completely diffused because it has been adopted by a majority (> 90%) of faculty (Geoghegan, 1994), whereas presentation software and email use in classrooms is just beyond “critical mass” at 20 percent adoption (Green, 1996). Levels of college student (33%) and home (40%) computer ownership have passed the early adopter stage, with faculty ownership (50%) diffusing into the late majority (Green, 1996). Research comparing both the adoption of various technologies and the extent to which they are used effectively by university faculty for teaching and learning would generate different diffusion curves. The following summary descriptions provide a useful starting point to differentiate between adopters using Rogers’ (1995) categories.

<u>Innovators (INs)</u>. Characterized as the pioneers, innovators are venturers who identify and explore new frontiers without map or guide. Their interest in new ideas leads them out of local peer networks. Communication patterns and friendships among a clique of INs are common even if they are geographically separated. INs usually have control of substantial financial resources, or enjoy some form of career security, to absorb the possible loss from an unprofitable innovation. They have an ability to understand and apply complex technical knowledge in their field. For example, one might find a majority of computer technology innovators in faculties of engineering and computer science, both because technology is an area of basic research and because there are more resources allocated to the acquisition of technology. INs are able to cope with a high degree of uncertainty about an innovation at the time of adoption, and are willing to accept an occasional setback when a new idea proves unsuccessful. While an innovator may not always be respected or supported in their social system, they play an important promotional role in the diffusion process: that of launching a new idea in the system by importing the innovation from outside the system’s boundaries.

Early Adopters (EAs). Characterized as being a more integrated part of the local social system than innovators, early adopters are "localites" rather than "cosmopolites". EAs have the greatest degree of opinion leadership in most systems, and potential adopters look to them for advice and information about the innovation. The EA is considered the "individual to check with" before using a new idea, and are generally sought by change agents to serve as local evangelists for speeding the diffusion process. A change agent is an individual who influences potential adopters' in a direction deemed desirable by a change agency (Rogers, 1995). Because EAs are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members of a social system. The EA is respected by peers, embodies successful, discrete uses of new ideas, and makes judicious innovation-decisions.

Rogers (1995) describes the EA as the "heart of the diffusion process" because they decrease uncertainty about a new idea by adopting it, and then convey a subjective (i.e., hunch or gut feeling) and or an objective evaluation of the innovation (i.e., empirical investigation of effectiveness) to peers through interpersonal networks. EAs have been found to differ from later adopters across a number of personality variables. EAs have more empathy, less dogmatism, a greater ability to deal with abstractions, greater rationality, greater intelligence, a more favorable attitude toward change, a better ability to cope with uncertainty and risk, a more favorable attitude toward science, less fatalism, and higher aspirations for formal education and occupations than do later adopters.

Mainstream. Taken together, the early majority (EM) and the late majority (LM) represent the "mainstream". The EM adopts new ideas just before 50% of the members of a system. They interact frequently with their peers, but seldom hold positions of leadership in a system. The EMs unique position between the very early and relatively late to adopt makes them an important link in the diffusion process. As one-third of the members in a system, they provide inter-connectedness in the system's interpersonal networks. The EM may deliberate for some time before completely adopting a new idea. Their innovation-decision period is relatively longer than that of the innovator and early adopter. They may follow with deliberate willingness in adopting innovations, but seldom do they lead.

The LM is a skeptical one-third of a social system, and adopts new ideas after the median (i.e., 50th percentile) member of a system. Adoption may be both an economic necessity and as a result of increasing network pressure from peers. Innovations are approached cautiously, the LM do not adopt until most others have done so, and system norms must definitely favor an innovation before they are convinced. Their relatively scarce resources mean that most of the uncertainty about a new idea must be removed before the LM feels that it is safe to adopt.

Laggards (LGs). The last members in a social system to adopt an innovation are referred to as laggards. The point of reference for the LG is the past, that is, decisions are often made in terms of what has been done before, and these individuals interact primarily with others who also have relatively traditional values. LGs tend to be suspicious of innovations and change agents. Their innovation-decision process is relatively lengthy, with adoption and use lagging far behind awareness-knowledge of a new idea. Resistance to innovations on the part of LGs may be entirely rational from the LGs' viewpoint, as their resources and confidence may be limited and they must be sure that a new idea will not fail before they adopt. Often, the LGs' precarious economic position forces the individual to be extremely cautious in adopting innovations, and system-blame may more accurately describe the laggards' situation in many cases.

Information has been collected by researchers in an attempt to characterize individuals at the tail end of the distribution as a specific personality type. Rosen and Maguire (1990) conducted a meta-analysis to examine the personality characteristics of computerphobics, and found that none of the common beliefs characterizing the computerphobic (i.e., they are female rather than male, older rather than younger, and possess other types of anxiety) represent reality. However, with regard to the current discussion of EAs and innovation adoption patterns, it seems likely that computerphobics represent the tail-end of the distribution and are small in number. Rosen and Maguire (1990) state that the computerphobic group is actually quite small (<10%). We might extrapolate this finding to the faculty population to predict that the number of faculty who resist technology because they are computerphobic is probably small.

Rogers' Diffusion Theory: Related Contexts

Researchers have provided evidence for Rogers' theory by examining the diffusion of various innovations. Dickerson and Gentry (1983) found that EAs of home computers displayed similar characteristics to adopters of other innovations: middle-aged, higher income, more education, an opinion leader and information seeker. They found that EAs of home computers have had more experience with a variety of technical products and services than non-adopters. Consistent with Rogers' proposition that the more compatible the innovation is with the adopter's background, the more likely it is to be adopted, the two experiences which best predicted adoption of the home computer are those related to functions (i.e., games, programming) superseded by the home computer. In a study of school counselors, Casey (1995) describes innovators as advanced, self-taught "power users" who are authoring programs using programming languages, and the laggards as "technophobes" who avoid computer technology at all costs. He believes most counselors fall somewhere between these two extremes. Casey's (1995) EAs were more mainstream than the innovators, effective at amplifying promising developments engineered by innovators, and eager leaders who provided workshops and publications for peers while struggling with the slow pace of mainstream acceptance.

Ram and Jung (1994) looked beyond diffusion patterns to investigate adopter characteristics with regards to *use innovativeness* with personal computers. *Use innovativeness* is the degree to which an adopter uses a previously adopted product to solve a novel consumption problem. EAs are found to have higher usage variety than do later adopters, which may be a result of their higher involvement with the innovation. In other words, EAs are likely to be more use innovative and capitalize on the wide variety of uses to which a computer can be put, be more aware of its various features and capabilities, and seek different uses for their computers than do later adopters. EAs, like expert computer users, use more options, features and software on their computers, whereas the early and late majority, like novice users, use fewer options to start with. Ram and Jung (1994) suggest that later adopters are more intimidated with new technology and need different kinds of support than EAs, such as additional training and user-friendly manuals. Another appropriate strategy may be product differentiation through simplification: create a no-frills computer for the later adopters, rather than trying to make them as diversely accomplished as the EAs are with the fully loaded model (Ram & Jung, 1994).

Newbies and Enthusiastic Beginners

There is a growing number of computer-using faculty who are not necessarily highly skilled, or computer literate in the traditional sense, but are very enthusiastic about adopting technology because they see the potential of newer tools, such as e-mail and the World Wide Web, for their students. Many observers agree that communication technologies may be what entices mainstream faculty to adopt other technologies for teaching and learning (Foa, 1993). Once they are intrigued by e-mail and the Web they may start asking questions about other technologies (Gilbert, 1996). These enthusiastic beginners see technology as a methodology for doing neat and exciting things with their students rather than being fascinated with the technology itself.

With the development of graphical interfaces, technology has become somewhat more transparent and user friendly. However, there are still barriers that may constrain use by enthusiastic beginners, and a fairly steep learning curve to climb before integration becomes effortless. User friendliness is a seductive term that does not accurately represent current technology reality. Computers are still not well-designed, fault-free, and easy to use. In fact, software manufacturers seem to be swinging from a "user friendly" simple design with few features but great functionality, to a more complicated, feature-rich design. Donald Norman (1993), a cognitive scientist who researches human-computer design, must be having a field day examining the thousands of new, and often poorly mapped, features and capabilities of current software! For example, Microsoft Word 6.0, a current market share leader, is a powerhouse 16 MB word processor with thousands of features that will probably never be used by the average user. Because of their use innovativeness, EAs might maximize their investment in such a program by utilizing many of its capabilities. However, later adopters may not need a feature-rich program to start with, and may be intimidated by all of the bells and whistles.

Early Adopters of Instructional Technology

Results from a faculty survey conducted 10 years ago (Jacobson & Weller, 1988) indicate that early adopters, with self-reported good-excellent computer skills, had different perceptions about obstacles than did later adopting, mainstream faculty with poor-fair computer skills. While a majority of faculty agreed that lack of funds for hardware and the lack of technical support were obstacles, a larger percentage of mainstream faculty viewed the lack of technical support as more problematic than early adopters. EAs were more self-sufficient with regards to support and wanted more access to hardware resources for experimentation. Although the EAs reported acquiring computer use mainly through self-training and assistance from colleagues, both EAs and mainstream faculty felt that a lack of training was an obstacle to widespread use of computers. Jacobsen and Weller (1988) found that although the reported use of some computer applications was quite low, enthusiasm for adopting additional innovations was quite high across both groups.

These findings suggests three trends: (1) that the use of computers for one purpose may encourage enthusiasm for further computer use, (2) that mainstream faculty may be limited adopters because of the lack of technical support and training, and (3) that colleague supported training is a viable way to encourage diffusion of computer applications and use. There appears to be an opportunity to capitalize on the early adopter’s knowledge and skill base, and somehow share this with mainstream faculty who have concerns about support and training.

Hamilton and Thompson (1992) provide a good summary of certain personality characteristics displayed by EAs in their study of the adoption of an electronic network for educators. A communications network was established to create an electronic link between student and practicing teachers and the education faculty at a college to: decrease the isolation often experienced by student and practicing teachers, to make faculty expertise readily available, and to increase faculty awareness of any problems in the field. EAs in this study shared similar levels of education, social status, and social participation, had a cosmopolitan outlook, accessed information from mass media, belonged to wide interpersonal communication networks, displayed a high degree of innovation information seeking, possessed positive attitudes toward change and risk, and had similar aspirations and neutral attitudes toward fatalism. EAs played an important role in this diffusion process because their adoption was visible to the early majority and influenced their subsequent adoption. Hamilton and Thompson (1992) suggested that network developers should seek out EAs who will enhance the diffusion process.

The following study examined early adopters with respect to teaching methods. Philipp, Flores, and Sowder (1994) studied Kindergarten-to-Grade 12 (K-12) mathematics teachers who were identified as early adopters of innovative teaching methods, and found their characteristics to be similar to those summarized by Rogers (1995). EAs focused on problem solving, conceptual relationships and understanding, and communication in mathematics. These characteristics are similar to the "discrete and successful use of new ideas" described by Rogers (1995). Teachers had a comprehensive knowledge of the mathematics they were teaching, which is consistent with the alleged "higher rationality, higher intelligence" of EAs. These teachers participated in their own professional growth by attending conferences and inservice programs, completing graduate studies, and seeking encouragement and support for their reform from peers and administration, suggesting that these EAs were involved in and contributed to a rich interpersonal network.

Often, the individuals who have integrated technology for teaching and learning have done so in a university climate that has provided little or no external or explicit recognition or incentive for either excellent teaching or technology implementation (Sammons, 1993). There is no professional training requirement for university teachers as far as their teaching is concerned (Laurillard, 1993), faculty members receive little or no formal training on using computers for teaching and learning, and the annual review process often fails to recognize innovative teaching as part of the merit system (Sammons, 1993). Instead, faculty rely on colleague support and self-teaching.

A faculty member may combine teaching and research with technology. However, development time for computer-based teaching materials may extend over years, with little reward for the final product. In fact, many universities have a policy which requires the developer to share or give copyright of software products to the institution (Reeves, 1991). It appears that system-wide changes will be needed in the reward system and training for faculty members in order to encourage broader diffusion of instructional technology within the mainstream.

Excellent Teaching and Early Adoption

Characteristics of exemplary teaching apply directly to the effective use of technology in undergraduate teaching. The integration of technology implies more than adopting computers for teaching and learning tasks. Integration implies a transformative or re-invention process where instructional strategies and outcomes are redefined by technology; the innovative capabilities and possibilities of technology are used to fundamentally change teaching and learning. Therefore, any attempt to understand the integration of technology using Rogers (1995) theoretical framework has to also include a consideration of the individual case, the teacher who has adopted technology and is figuring out ways to transform their classroom environments. Not all professors who adopt technology integrate this innovation in meaningful ways to transform teaching and learning.

Addressing a Gap in Rogers' (1995) Theoretical Framework

One of the potential limitations of considering the integration of technology using only Rogers' (1995) adopter categories lies in their very nature as summaries of global characteristics and time of adoption. While the innovation-decision process and adopter categories are useful for simplifying the complexity of adoption patterns in a social system by describing the central exemplar or summarization of the early adopter and other categories, these "defining characteristics" also understate the uniqueness of the individual member. It is worth remembering that early adopters are, at the same time, unique and variable individuals who may resemble each other much less than they resemble the general subgroup characteristics. For example, one can imagine that EAs possess various and different: levels of ability and skill, beliefs and visions about the value of technology, specific personality traits, levels of risk-taking behavior, motivations to learn about technology (internal, external, environmental, opportunity), development patterns (self-taught, peer teaching, courses), and have implemented computers in different environments, under different conditions (i.e., vendor, department and self support) and with different expectations. Indeed, an interesting question worth further investigation is whether early adoption depends on personality or environment. Although not a goal of the present investigation, it appears that there is a need to develop a model, similar in nature to Sternberg and Horvath's (1995) "Prototypical Model of the Expert Teacher" which allows for variability among experts, against which one can compare EAs of instructional technology to better understand their commonalities and differences.

Global Characteristics Versus Personal Stories

Although early adopter categories are useful to describe general group characteristics and trends, there is a need for more focused and careful description of individuals within this category. Donald Norman (1993) eloquently describes this problem in his distinction between logical facts and the power of personal stories in decision making processes. The problem is that in an attempt to abstract the relevant from the irrelevant, logical analysis oversimplifies to the extreme and only applies to information that can be readily measured; however, what can be measured and what is important are not necessarily related (Norman, 1993). Subjective concepts, like value or beauty, moral good or evil, cannot be measured like number of classroom events or details identified, or types of planning and teaching strategies. These are all subjective concepts, and even though all may agree that morality and values are important, there is no simple way to translate these into a language of logic; no way without badly distorting their content (Norman, 1993).

Personal stories, or profiles, of experts are well suited to capturing exactly those elements or details that formal models, such as theories of diffusion, may leave out. A theoretical framework is an attempt to generalize and summarize the characteristics of adopters, to remove from the analysis subjective emotions and thought. Personal stories, such as the profiles of expert teachers (Sternberg, 1997), capture the subjective emotions, thoughts, and beliefs of the category members. Logic generalizes, stories particularize (Norman, 1993). Logic allows one to form a detached, global judgment; storytelling allows one to take the personal point of view, to understand the particular aspects of expertise and experience embodied by the individual. Stories are not better than logic; logic isn't better than stories (Norman, 1993). It is appropriate to use both in the attempt to characterize early adopters of technology on campus.

In their review of knowledge elicitation techniques for expert system design, Ford and Adams-Webber (1992) present a convincing argument for gathering data from multiple experts both case by case and within a model: "From a constructivist perspective we would expect experts to agree about the vast majority of their knowledge (i.e., widely shared consensual beliefs) and yet have major differences in their largely self-constructed expertise" (p. 131). They suggest that it is often preferable to build separate knowledge bases for each expert rather than attempting to incorporate their expertise into a single data base to avoid a homogenized, "averaged" opinion about an area of expertise. This view is consistent with the individual case studies presented in Sternberg's (1997) book about expert psychology teachers; although there are similarities, each expert is unique.

Rogers' (1995) theory of the diffusion of innovations and adopter categories are appropriate for capturing the global characteristics of early adopters, but a case by case description captures the self-constructed nature of the individual's expertise gained from years of personal experience "consisting of functional but fallible anticipations held with high confidence and uncertain validity" (Ford & Adams-Webber, 1992). Norman's (1993) summary on the value of both logic and storytelling for decision making captures best the process by which the present investigation of adoption patterns and characteristics of faculty who integrate technology in teaching and learning will follow in an attempt to characterize EAs: "First the data and the logical analysis, then the stories in order to let the personal, emotional side (of early adopters) have the last word" (p. 130).

Case Studies of Expert Teachers

Let us consider the contribution of case study research to understanding the characteristics of expert teachers in higher education. Scardamalia and Bereiter (1993) write rich and detailed accounts of experts from various domains, including elementary teaching, and a number of books have been written that profile the individual experiences of expert higher education teachers (Cahn, 1978; Ellis, 1993; Jones, 1995; Sternberg, 1997), with many of the essays written by the expert teachers themselves. Captured in these accounts are the views and stories of individual faculty who have been identified (by various means) as expert teachers. Individual profiles fill in some of the gaps left by definitional models by describing the expert's approach to excellent teaching. For example, Sternberg's (1997) book profiles the views of expert psychology professors who have written textbooks for their course. Many of the expert professors concur that their mission is to "give psychology away", and describe a multitude of complex pedagogic means and strategies to encourage, teach, promote, and require critical thinking. Although each story conveys a rich and unique account of the expert's approach to teaching, there is also remarkable consistency across profiles in what the individual experts regard as important and valued instructional goals. Berliner (1992) has also found this consistency across experts, which suggests commonality, and both he and Sternberg (1997) suggest that expert teachers are the best mentors for beginning teachers.

Perhaps the greatest value of case studies which profile expert post-secondary teachers is to provide role models for junior faculty. The number of experts is small, and the case study may be the most efficient and practically feasible way to share and distribute their expertise with other faculty. Another potential contribution of the personal case study is its value as a textual protocol of the expert's reflection on what it means to be expert. Taken together, these case studies offer a variety of perspectives that give insight into the uniqueness and variability of the individual earlier adopters, as well as the commonalities between them.

Motivation To Become Expert at Integrating Technology

Once a faculty member has adopted technology for teaching, what motivates them to move beyond competent use to further develop their technological and pedagogical expertise? Rogers' (1995) theory is very useful for understanding and prediction the diffusion of an innovation in a social system over time, and his adopter categories provide a logical way to summarize and characterize early adopters and others. Clearly, EAs share characteristics that differentiate them from the majority of mainstream faculty. A consideration of EAs who readily integrate technology for teaching and learning, leads quite naturally to questions about the difference between integrating technology for teaching and learning, and merely using technology as an add-on to instructional strategies.

Rogers (1995) calls for increased understanding of the motivation to adopt an innovation (p. 109), and diffusion research does not adequately address the motivational aspects of becoming expert at integrating an innovation. Bereiter & Scardamalia (1993) provide more insight into the motivation to develop expertise by highlighting three ideas from cognitive psychology: (1) *flow*, which suggests that individuals put effort into the process of expertise because it feels good, (2) *second-order environments*, which, unlike other social environments, provide support for the process of expertise, and (3) the *heroic element* of expertise, which acknowledges that the other explanations do not quite complete the motivational picture.

Flow requires a nice balance between ability and challenge; if challenge exceeds ability, the result is frustration and anxiety, and if ability exceeds challenge the result is boredom. Combined with the effects of learning, repetition of the same activity will eventually cease to produce the pleasurable flow experience, and something must be done to increase the level of challenge to bring it in harmony with the increased level of ability. Thus, there is a progressive element to maintaining flow.

Experts seldom exist in isolation, and instead are linked together by associations or informal networks. The expert subculture embodies ideals and goals which help direct the expert's development, and provide support, cooperation and recognition of success. In a second-order environment, or expert subculture, one of the requirements of adaptation is to participate in the pursuit of ideal goals of the group, and this necessitates progressive problem solving (Bereiter & Scardamalia, 1993). Conditions to which an individual must adapt change progressively as a result of successes of other people in the environment. Each expert's advance in technology, strategy, or contribution to knowledge, sets a new standard which others try to surpass. Individual experts do not merely adapt to constant change. Instead, one adapts to changes that keep raising the ante, by setting a higher standard of performance, by reformulating problems at more complex levels, or by increasing the knowledge that is presupposed (Bereiter & Scardamalia, 1993).

The heroic element of the process of expertise captures the development of individual experts who exist in first-order environments that do not necessarily support or reward the development of expertise. Heroic experts are found delivering mail, at home caring for children, or even teaching in a solitary university or college classroom. These experts reinvest mental resources in their work, elevating it or expanding its scope to take in a broader set of concerns-such as the concerns of their students. These experts exhibit professionalism in its most favorable sense, but often without the benefit of professional identification or a subculture to support them (Bereiter & Scardamalia, 1995). The intrinsic nature of flow may motivate them, but the nature of their work suggests that the benefits of flow may be few and far between. In such cases, pursuing high standards and continuing to advance requires an element of heroism in the sense that arduous efforts that benefit others are disproportionate to what others provide in the way of rewards and supports. The image of the heroic mail carrier braving storm and flood to deliver the mail reinforce the fact that the hero must go it alone; there are few social forces lending support. Athletes and performing artists also convey the heroic image of the expert by virtue of the arduous drill and training that they sustain to bring their performance up to that moment which we ignorantly applaud as a display of natural talent (Bereiter & Scardamalia, 1993). Even with experts who seem to achieve their status without arduous effort, there is an element of heroism. For if expertise involves progressive problem solving, and progressive problem solving entails working at the edge of one's competence, then at least a bit of daring is required; working at the edge risks failure and loss of esteem, but it also provides a certain excitement, which is probably addictive (Bereiter & Scardamalia, 1993).

It may not be the case that "early adoption of instructional technology" and "excellent teaching" are qualities that often exist in the same faculty member. Rob Chandhok, from Carnegie Mellon University, reminds us that "there are plenty of innovators in education that make no use of technology at all" (Gilbert, 1995, p. 33). Universities have to design technology integration plans that focus both on excellent teaching and integrating various technologies to support teaching and learning. Early adopters of technology who are also excellent teachers have much to contribute to this planning process. Kearsley (1996) suggests that excellent teaching should be our first priority, because adopting technology will not improve poor teaching, except temporarily. He argues that in the absence of knowledge about and enthusiasm for the discipline, student participation, explicit expectations, well-defined course structure, and an enjoyable learning environment, technology will not enhance learning to any appreciable degree. If cases are found where early adoption and excellent teaching exist in the same individual, then it is worth profiling this rare expertise for the benefit of other faculty members who wish to develop both their technology and teaching knowledge and skills. The present investigation begins this task by interviewing and profiling the characteristics of a small number of earlier adopters who are also excellent teachers.

Links Between Diffusion Research and the Present Investigation

Rogers (1995) identifies the *pro-innovation bias* as a potential shortcoming of diffusion research. The *pro-innovation bias* is the implication in diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected. The topic of interest in the present investigation is the integration of technology for teaching and learning. As such, a survey has been designed that measures time of adoption of technology for teaching and learning in order to plot the diffusion curves for this innovation. Aspects of the research methodology have also been designed to address a potential pro-innovation bias. For example, both early, later, and non-adopters are participants in this investigation in order to explore the different characteristics of early adopters and mainstream faculty. Also, different subscales have been chosen to gather information about changes to classrooms, incentives, and barriers to integrating technology. This information will help to increase understanding of both the motivators and impediments to adoption, as well as to begin to understand reasons for rejection and discontinuance. The recognition that the integration of technology implies more than just whether or not a faculty member uses computers, leads to a consideration of how and why this innovation is adopted. Motivations for adoption are a difficult issue to investigate (Rogers, 1995). Seldom are direct questions in a survey adequate for uncovering an adopter’s reasons for using an innovation. However, diffusion research that attempts to see an innovation through the eyes of the adopters and non-adopters may result in a better understanding of why the innovation was adopted or rejected, and yield descriptions of what is good and bad about a technology. Hence, in addition to collecting quantitative data about time of adoption and experiences with the innovation, the present investigation includes both restricted-response and open-ended questions that gather qualitative data about the incentives and barriers to integrating technology for teaching and learning, and methods for using and evaluating technological applications. Additionally, interview methods have been chosen in order to gain insight into the innovation-decision processes and motivation of EAs who have also been identified as excellent teachers.

Developing Long-Term Plans for Campus-wide Diffusion

Universities are in a situation where there is widespread adoption of instructional technology by innovators and early adopters, but limited adoption by mainstream faculty. It is apparent from descriptions of EAs and the "early-late majority" mainstream, that these two groups have different characteristics, motivations, and needs. Therefore, campus-wide integration plans cannot be developed on the assumption that mainstream faculty will naturally use computers as readily and easily as the early adopter. In the relatively short period of time that instructional technology has been used on campuses, many hard lessons have been learned and it is up to each and every "learner" to share those lessons (Lessons Learned Home, 1998; Reeves, 1991). This knowledge sharing process can be made more efficient and widespread through institution level commitment and support of IT.

Critical Mass and the Chasm Between Early Adopters and Mainstream

According to Green's (1996) annual Campus Computing Survey, adoption of technology for classroom use rose between 1994 and 1995. E-mail use doubled to 20 percent, use of presentation software was over 25 percent, and the use of multimedia resources and CD-ROM-based materials has risen to just under 10 percent. Green (1996) suggests that the use of information technology is approaching the "critical mass" level, described by Rogers (1995) as the point at which enough individuals have adopted an innovation so that the innovation's further rate of adoption becomes self-sustaining. However, Green (1996) also indicates that of all the issues surrounding the adoption of technology for teaching and learning, individual faculty rated "user support and training" as the most important. Unfortunately, the investment in instructional development (that is, providing assistance to faculty eager to use technology in their classrooms) has remained flat on some campuses over the last six years. Although infrastructure supports innovation, and many campuses have taken steps to replace obsolete equipment and provide access to multimedia capable computers, technical assistance and user support are still the more critical catalysts for adoption and integration of instructional technology (Green, 1996).

Geoghegan (1994) describes what he refers to as a "chasm" between early adopters and the early majority, such that the innovation is never adopted by the mainstream. He contrasts early adopters, who are risk takers, more willing to experiment, generally self-sufficient, and interested in the technology itself, with early majority faculty who are more concerned about the teaching content and learning problems being addressed than the technology used to address it, view ease of use as critical, and want proven applications with low risk of failure. Geoghegan (1994) suggests that critical mass is insufficient by itself to support continued diffusion because of the lack of institutional support for: (1) developing instructional software, (2) plans for further integration of computers into the curriculum, (3) shortages of equipment and facilities, and (4) unrealistic expectations by administration based on innovators' and early adopter's successes.

Early adopters make an innovation visible to the mainstream and decrease uncertainty about the innovation. EAs are more experienced with technology and have higher use innovativeness, thus capitalizing on technology's many features and options. They seek different uses of technology to solve novel problems and contribute to new and better uses of technology. However, by making adoption look relatively easy, they disguise the extensive knowledge and skills that mainstream faculty will need in order to adopt. Geoghegan (1994) believes that without wide-spread institutional support, the successes of EAs will not effectively and efficiently diffuse into the mainstream.

A survey conducted by Spotts and Bowman (1993) at Western Michigan University supports Geoghegan's (1994) view that mainstream faculty have different needs. Factors identified by more than half of the faculty as important in influencing their use of instructional technology were: availability of equipment, promise of improved student learning, funds to purchase materials, compatibility with subject matter, advantages over traditional (existing) methods, increased student interest, ease of use, information on materials in their discipline, compatibility with existing course materials, university training in technology use, time to learn the technology and comfort level with the technology.

An additional factor identified by Ehrmann (1995), "The medium is not the message", may also contribute to the mainstream's hesitance to adopt. Communications media and other technologies are so flexible that they do not dictate methods of teaching and learning. Ram and Jung (1994) also referred to the "model-less" nature of many computer applications. The mainstream needs direction on where to start with flexible technologies that can be integrated in any number of ways. However, administrators often assume that once faculty get access to technology they all will easily, automatically, and quickly change their teaching methods and course materials to take advantage of IT. The chief culprit for this belief is the varied and extensive use by EAs and basing expectations for mainstream faculty adoption on this use innovativeness.

Institutions as a Change Agencies

The literature suggests one clear message: administration has to be convinced to let go of the infrastructure-driven, "if you build it, they will come" approach to technology integration on campus if they want to address the chasm between early adopters and mainstream faculty. Faculty and administration have a deep mutual dependency. The top-down program advocate needs convincing exemplars to justify large investments in technology at a moment when funds are scarce, and the bottom-up project advocate and enthusiastic beginner needs a well-conceived and reliable working environment for successful implementation of innovative concepts (Noblitt, 1997). Change agents in the administration (i.e., the president, deans, and directors of service units), opinion leaders (i.e., early adopters), and mainstream faculty, need to find ways to discuss implementation strategies and develop technology integration plans for campus-wide adoption.

Universities traditionally have flatter organizational structures with loosely coupled organizational units to provide the primary services of higher education (Bull, et al., 1994) compared to the private sector. Initiatives for the innovative use of instructional technology (IT) in teaching and learning tend to come from early adopter individuals and research units. With the reduction in size and price of computing resources and the required investment, decision-making for IT investment more easily fits the traditional organizational structures of higher education with decentralization and local responsibility for decisions.

However, these individual initiatives and efforts, as well as decentralized investments in IT, scattered all over an institution, or scattered all over the institutions within one province or country, are insufficient by themselves to fully develop the potential of instructional technology for teaching and learning (Bull, et al., 1994). Critical mass is just not enough. Early adopters might be committed and enthusiastic in developing new technology-based teaching methods and computer assisted instructional software. However, to make these efforts more widespread and their results used more comprehensively, incentives, training, support and reward structures “from above” are needed to build a strong human infrastructure (Daigle & Jarmon, 1993), as well as providing the technological infrastructure (i.e., networks, hardware and software) to drive integration. IT investments for teaching have to be similar to the state of the art in the world of work, as higher education prepares graduates for the future. These ever-new investments cannot be left to uncoordinated departmental or individual initiatives, as they often exceed respective budgets (Bull, et al., 1994).

Administration needs to recognize that to cause change they will have to address the reward system and commit to system-wide investment in IT in order to address the needs of mainstream faculty; the key to diffusion will be training and support. Without investment in the human infrastructure, nothing of sustainable value will be achieved (Foa, 1993).

An Application of Rogers’ Innovation-Decision Process

Brace and Roberts (1996) describe a campus-wide approach to technology integration based on Rogers’ (1995) innovation-decision process that targets mainstream faculty's needs. Innovations are likely to gain more rapid acceptance if they are perceived as having high relative advantage, or as being better than the idea they supersede (Rogers, 1995). Innovations with a high compatibility with existing values, past experiences and needs of potential adopters also have an advantage.

The campus-wide strategies described by Brace and Roberts (1996) are: (1) to build awareness of the possibilities and advantages of technology, EAs from various disciplines demonstrated how they developed multimedia applications and used them in their courses, and the university sponsored yearly technology conferences and symposia, (2) ready access was provided to up-to-date, stable and reliable technology, as well as providing each faculty member with a personal desktop computer, (3) training was made available through developmental workshops, orientations, and one-on-one sessions, (4) technical support for both hardware and software was provided by service units for acquisition, installation, information and implementation, and (5) funding was provided for release time and summer grants, and recognition was provided through incentives and encouragement. Although no data were provided to evaluate the outcomes and the success of this integration plan, the implications seem clear: instead of relying on "critical mass" and serendipitous diffusion to bridge the "chasm" between EAs and mainstream faculty, those who propose wide-scale adoption of a technology-based curriculum must find a way to combine innovation with a responsible, campus-wide plan for implementation (Noblitt, 1997). Rogers' (1995) innovation-decision process and stages of adoption will be used to frame the following discussion of the contribution that EAs can make to a campus-wide technology integration plan.

(1) Knowledge of an Innovation and (2) Persuasion to Adopt

Visionaries who believe in the value of information and instructional technology are needed on campus. They need to be leaders who can effect real change by somehow increasing *how-to* and *principles-knowledge* among the mainstream. *How-to knowledge* consists of information and skills necessary to use an innovation properly (Rogers, 1995). In the case of complex innovations, such as computer technology, the amount of how-to knowledge needed for proper adoption is much greater than for less complex innovations. An inadequate level of how-to knowledge may lead to rejection and discontinuance because of the frustration likely to be encountered. Principles-knowledge consists of information dealing with the functioning principles underlying how the innovation works (i.e., research on the effects and outcomes of using certain technologies in teaching and learning). It is possible to adopt an innovation without principles-knowledge, but the danger of misusing the new ideas is greater, and discontinuance may result.

A campus-wide culture that promotes adoption of technology can be developed by leaders at each level of the organizational structure. Those at the executive levels are the hardest to convince to take the lead in using technology, perhaps because many belong to the pre-computer generation (Foa, 1993). Characteristics that are beneficial to long-term planning are capturing the vision and enthusiasm for innovation displayed by EAs, and channeling this into system wide initiatives that benefit all faculty. The biggest challenge is cultural: in computing organizations and cliques, the “techies” are at the top of the pecking order and like to tinker with technology, while the “teachies” regard technology as a possible solution to a teaching and learning problem (Gilbert, 1995). What is needed is some way to get the “top-down” folks, the “techies”, and the “teachies” to talk to one another. Starting with the president, and including vice-presidents, deans, and directors of each division, a technology-rich culture can start from changes to communication channels. For example, to promote e-mail use (and take advantage of the campus network) ensure that every faculty member, including the president, has a computer, network access, and thorough training in how to use the email system. Then, instead of using the paper-based, internal “snail-mail” system to distribute news and information, ensure that the president, deans, department heads, and directors put news or information on the system and nowhere else (Foa, 1993). This commitment will require management and administration to abandon the “real (wo)men don’t type” approach to communication. When new ideas are adopted, leading to various consequences, social change occurs (Rogers, 1995). E-mail and the Internet are already attractive to mainstream faculty, and are fully diffused among EAs. If campus leaders demonstrate their commitment to information technology by adopting changed communication channels, they will start a ripple effect throughout the institution, and indeed, maybe within themselves. And, the use of computers for one purpose encourages future computer use and questions about other technologies (Broholm, 1993).

A role for EAs in the knowledge and persuasion stages of adoption is to share what they have learned about instructional technology with the mainstream through in-house and across discipline demonstrations, campus conferences and symposia. Rogers (1995) posits that mass media channels, as knowledge creators, are often most important for informing people about an innovation, while interpersonal channels are more important in persuading someone to adopt a new idea. EAs play an important role in further diffusion because of their role as opinion leaders in communication channels and social systems. The transfer of ideas in a social system is most effective when participants belong to the same groups or are drawn together by the same interests (Rogers, 1995). Shared meanings and mutual language mean communication is likely to result in greater knowledge gain, attitude formation and change, and overt behavior change. Generally, faculty who are homophilous (degree to which a pair of individuals who communicate are similar) develop stronger communication relationships with each other than those who are heterophilous (not alike on the categorical variable of interest) (Valente, 1996). The similarity may be in certain attributes, such as being in the same faculty or department, type of computer used, and the like. When two individuals share common meanings, beliefs, and mutual understandings, communication between them is more likely to be effective (Valente, 1996).

Change agents and later adopters may have difficulty developing trust and finding common ground if their beliefs about adoption are dissimilar. EAs share characteristics and attributes that make communication between EAs of instructional technology effective (i.e., informal networks composed of Mac users, web-course developers, interface designers, and so on). Interpersonal diffusion networks are mostly homophilous. However, in order for instructional technology to diffuse into the mainstream, interdisciplinary EAs and mainstreamers have to exchange knowledge. Heterophilous network links often connect two cliques, thus spanning two sets of socially dissimilar individuals in a system (Broholm, 1993). These heterophilous links are especially important for exchanging information about innovations, as is implied in Valente's (1996) description of the strength of "weak ties"; there is a higher information exchange potential in communication channels when the communicators are heterophilous (Valente, 1996). Homophilous diffusion patterns cause new ideas to spread horizontally, rather than vertically, within a system. For example, a computer science professor uses web-based publishing as a communication network in a senior class, or a computer engineer discovers a new algorithm to compress video images to a fraction of their current size. It is more likely that the computer science professor will tell other computer science professors, and the programmer will share knowledge of the new algorithm with other programmers who speak his/her language (i.e., horizontal), than either of these innovators immediately sharing their findings with an educator who is intrigued by using video segments and on-line journals on a class web page (i.e., vertical). Homophily therefore can act to slow down the rate of diffusion in a system, thus requiring the work of change agents with various opinion leaders in a system. New ways must be found to encourage more heterophilous communication in the current university structure of disciplines and specializations that encourage homophilous exchanges.

Gilbert (1996) promotes the development of institution wide, collaborative communication networks encourage and promote the diffusion of information technology. He provides guidelines for forming a local Teaching, Learning, and Technology Roundtable (TLTR) that would include two categories of faculty (both early adopters and mainstream), representatives from service organizations (such as library, computing centers, faculty teaching development office, student affairs, facilities management), the Chief Academic Officer and or President, student representation, and a TLT Roundtable Coordinator. The TLTR would be responsible for developing integration plans that address the needs of current, mainstream adopters, by capitalizing on the knowledge and skills of EAs, and the support structures of various campus organizations. No individual faculty member can find or know all teaching options using information technology that may be used for a particular course, much less across campus. Thus, mechanisms for sharing valuable information among faculty and others must be provided (Gilbert, 1996). Mainstream faculty have to contribute their point of view, different motivations, and needs so that a common ground can be reached between early adopter fluency and skill and campus-wide requirements. By organizing a TLTR, heterophilous communication would become part of the university's culture and technology implementation and integration strategy.

There is valuable information to be gained from the early adopter's knowledge and skill as a technology user and integrator and the mainstream's reaction to being new users. For example, from a human-computer interface (HCI) perspective, we can determine from EAs' experiences what obstacles or incentives within the computer systems themselves encouraged the development of their competence (Bannon, 1991; Weber, 1990). Bannon (1991) discuss the need for both novice and expert user input when designing computer systems. Valuable information can also be obtained from first time learner's experiences with computer systems or applications (Howard, 1994). Bannon (1991) also suggests there is much to be learned from an examination of how expert users became competent, skilled users of a system. They can provide information on the obstacles and incentives there are within a system to encourage the growth of competence. In the same way that designers should include both novice and expert users' perspectives and feedback when developing systems or applications, administration should include both early adopter and mainstream faculty in the development of technology integration plans and strategies.

(3) Making a Decision to Adopt or Reject, and (4) Implementation

As noted above, the main reasons that mainstream faculty hesitate to adopt are the lack of effective training and support. A number of different approaches to maximize the communication impact of early adopter knowledge and skill on training come from the literature. Brace and Roberts (1996) suggested developmental workshops, orientations, and one-on-one training sessions. However, integration plans have to take into account that EAs are faculty members with teaching, research, and service workloads much like other faculty. Thus, without release time for the EAs to instruct the mainstream, much of the training and daily support will have to come from other service units on campus. Most institutions did reasonably well in the past 10 years at developing support services appropriate to the character and needs of EAs. However, proportionally more support will be required because the mainstream is more numerous, and those providing it will need better and more varied interpersonal skills and sensitivity to deal with the easily bruised egos of faculty who lack the "special propensity for technology" (Gilbert, 1996) that characterizes the early adopter.

One way service units can capitalize on the knowledge of EAs is by including them in the development of training modules that can be used by service units for workshops (Foa, 1993). This approach must address release time and the merit system for EAs, and the increased financial and human resource needs of service units. Gilbert (1996) suggests involving undergraduate students in the mainstream faculty development plan. Many undergraduates have better skills and more current knowledge about information technology than most faculty and staff members (Gilbert, 1996). Student assistants can help increase the use of information technology for teaching and learning, and alleviate some of the financial and human resource costs of support units, resulting in a win-win situation for the institution, faculty, and students. Students benefit by developing both instructional and technological skills that increase their employment marketability. Another option for increasing the quality and availability of support services while holding down costs is to engage early adopter faculty as peer mentors (Gilbert, 1996) and thus increase the impact of their opinion leadership. Stipends, release time, and professional recognition through the merit system can be used to provide incentives for this type of knowledge sharing and interpersonal communication between heterophilous groups.

(5) Confirmation of Decision to Adopt

Roundtable discussions between different representatives and stakeholders on campus must recognize the importance of on-going support and recognition of integration efforts by mainstream faculty. Integration takes time, there are a number of barriers and pitfalls, and progress often seems painfully slow. Faculty members and educational institutions are more likely to participate in gradual change rather than making a sudden, diametrically opposite choices (Gilbert, 1996). Smith (1996) summarizes an *iterative technology integration process*, which includes awareness and interest, planning and design, support and development, refinement and delivery, assessment, and research. Faculty will want to assess whether their uses of technology for teaching and learning are having any effect. Roundtable discussions have to focus on the successes and failures in order to make relevant changes to the process. It will take time to move through the iterative integration cycle, to implement and then assess the results of innovative efforts, and conduct research on the relative benefits. During the confirmation stage, the individual wants supportive messages that will prevent dissonance from occurring (Rogers, 1995). Recognition for faculty efforts must be provided at each step through incentives and encouragement.

Alternatives to Campus-Wide Plans That Build From Pioneers

Rely on Natural Diffusion Patterns

It seems apparent that there is much we can learn from EAs about possible uses of technology. As opinion leaders, EAs can persuade other faculty to adopt. An alternative to learning from the experiences and characteristics of EAs is to maintain the status quo and rely on natural diffusion patterns of adoption based on critical mass. Individual efforts will continue to be scattered throughout an institution, and eventually these may be adopted by the mainstream. This is not a completely negative scenario for EAs. A collective administrative effort that is developed "top-down" may stifle creativity and initiative by imposing arbitrary and bureaucratic organizational constraints, such as defining policies about the "right-way" to integrate technology for teaching and learning. EAs will continue to flourish in a status quo model because of their interpersonal networks. Few instructional technology theories, laws, and principles have stood the test of time and rigorous validation. The field is still new and constantly evolving because of technological advancements and developments that present new challenges to researchers and educators. EAs will continue to exchange information and develop their knowledge and skills as they wrestle with these challenges. However, a status quo approach ignores the different needs and characteristics of the mainstream. Enthusiastic beginners may be discouraged by unexpected technological barriers, the lack of training and on-going support, and decide to actively reject technology. By not studying and learning from EAs we can continue with "business as usual" and attempt to maintain campuses as they exist now. Administration can focus mainly on technological infrastructure, and individual departments can continue to ignore faculty training and support. However, this strategy greatly impedes participation by the mainstream.

Rely on Cross-Disciplinary Research

An alternative, which deserves additional research and more commentary than it will be given here, is to rely on the increased interrelatedness of various disciplines as they investigate common (but complex) questions to do with technology. Faculty, who are experts in their diverse fields, are often self-constrained by their homophilous, horizontal communication social systems. However, technology seems to be a catalyst for bringing the basic and applied research findings of different disciplines to bear on common questions that require contributions from each part of science in order to better understand the whole. Communication technology facilitates this interdisciplinary exchange. In a recent issue of the American Psychological Association Monitor, Beth Azar (1998) describes how interdisciplinary data pooling and sharing is becoming more common and easier in the social sciences using databases that are accessible using the Internet.

The technology itself also seems to demand and require multidisciplinary collaboration for research to progress. For example, computer scientists were pioneers in investigating the nature of artificial intelligence. Investigations into programming a machine to think, however, requires an understanding of the nature of thinking. Computer science has not traditionally focused its research efforts on teaching, learning, and human development, but an investigation of artificial intelligence demands a better understanding of the human mind, and results in the growth of such disciplines as cognitive science.

The multimedia design and development process is also collective effort requiring diverse individuals with graphics skills, video and audio design skills, content expertise, programming knowledge, and instructional design skills for software development (Liu, Jones, and Hemstreet, 1998). Faculty members who are interested in developing multimedia applications often need to draw upon the skills and capabilities of individuals outside their discipline.

Disciplines, although still distinct, are becoming more interrelated as they investigate common (but complex) questions related to technology. The increase in cross-disciplinary basic and applied research and development may play a role in increasing heterophilous communication about the applications and integration of technology, which may lead to more widespread diffusion of technological innovations on campus.

Present Investigation

In three main sections, this literature review discussed the characteristics that differentiate EAs from others, the implications of developing a long-term campus-wide plan based on the characteristics of EAs, and summarized some alternatives to building from such pioneers. Rogers' (1995) theory of the diffusion of innovations provides a theoretical framework for the present investigation. Survey and interview methods will be used to build and extend upon Rogers' (1995) theory with respect to current adoption patterns and characteristics of EAs and mainstream faculty. The guidelines for conducting on-line research will be discussed with respect to how they were applied in the present study in Chapter Three. Literature on the nature of teaching excellence and the development of teaching expertise was reviewed, and the relationship between early adoption and expert teaching will be explored in this study using qualitative methods. Links between diffusion research and the design of the present investigation were identified. Finally, this review discussed some recommendations from the literature for developing long-term plans for campus-wide diffusion of technology for teaching and learning using Rogers' (1995) innovation-decision process, and alternatives to building from EAs. The results of the present investigation will used to discuss current adoption patterns and characteristics of faculty who integrate technology for teaching and learning, explore web-based research methods, and to develop recommendations for bridging the gap between EAs and mainstream faculty.

Chapter Three
METHODOLOGY

This study is primarily an exploratory investigation designed to gather information from a multidisciplinary group of academic staff about integrating technology into teaching and learning. A mixed-method research design, which used a quantitative methodology (selected-response survey items) in conjunction with qualitative methodologies (open-ended survey response items and semi-structured interviews), was employed for the purpose of investigating the difference between those who readily adopt technology for teaching and learning in higher education, and those who do not. Prior diffusion research promotes the use of both survey and interview methods for gathering data about the time dimension and determining causality (Rogers, 1995). This study employed a new method for conducting educational and psychological research; an on-line, World Wide Web-based version of the survey instrument was designed and piloted for this investigation. The phenomena under investigation seemed to both suggest and support an exclusively electronic method of participation. However, a paper version of the survey was also used in order to include both adopters and non-adopters of technology in the study.

Rationale for Research Methodology

The strength of a mixed-method, or "multi-instrument approach" (Pelto and Pelto, 1978) to educational and psychological research, lies in its "triangulation" of multiple sources of data (Jaeger, 1988; Lincoln & Guba, 1985). Anderson (1994) discusses several advantages which are realized from using a combination of different methodologies. First, educational and psychological research is concerned with both basic and theoretical knowledge, and with the application of findings in practice. Research that combines methodologies increases the potential of the investigation to address both of these ends. For example, qualitative research is often concerned with process as well as with outcomes; descriptive accounts provide practicing educators with a means of drawing parallels and contrasts between the phenomena being investigated and their own practice. Quantitative research seeks to measure and evaluate the phenomena or construct of interest, and provide a means for generalization and reproduction by other researchers. The use of both research methods enhances the value of the investigation as each can extend the usefulness to both practicing educators and theoretical or basic researchers. A second advantage is that each method can build upon the strengths of the other. Qualitative research, which emphasizes understanding, contextualizing, introspection and theory construction, can provide a strong base for wider quantitative measures, scaling, and generalization. Quantitative research, with its emphasis on large samples, can provide an overview of an area that can reveal relationships, patterns, inconsistencies, and so forth that can be further investigated with qualitative methods. Finally, qualitative and quantitative methods can provide distinct but complementary information about the phenomena of interest.

Study Instruments

Survey Item Selection and Construction

The survey instrument was designed as an exploratory tool to gather a large data set of information relevant to faculty adoption and integration of technology for teaching and learning in higher education. The results from the survey were used to: (a) establish baseline data for future comparisons and to measure changes over time, (b) to identify trends, issues, and concerns unique to post-secondary instructors and for subsequent probing during interviews, (c) to differentiate between two distinct groups (i.e., early adopters and mainstream faculty), (d) to measure differences between on-line and conventional survey participation methods, and (e) as a source of demographic and attitudinal data used in descriptive and exploratory statistical analyses.

The 195 items of the "Teaching and Learning with Technology" survey instrument (Appendix A) are divided into eight subscales of selected-response and open-ended items followed by two sections that question participants using open-ended response items. A single standardized survey instrument was not currently available that served the varied purposes of the present investigation. Therefore, a systematic process for survey development, grounded in consideration of the basic purposes for which the test scores would be used (Crocker & Algina, 1986), was employed to develop the present survey instrument. The following section discusses the method by which items in each subscale were selected from prior research and/or constructed to gather information about attitudes, behaviors and psychological constructs relevant to understanding and predicting the integration of technology in teaching and learning in higher education.

Subscale 1: Patterns of Computer Technology Use

The first section of the survey consists of 18 items that gather nominal and ordinal data about individual computer use and purchase patterns, access to technology, personal satisfaction, prior learning, and hours of use. The items in this subscale were developed and/or selected based upon a review of previous research and expert judgement (Crocker & Algina, 1986). Previous investigations of faculty adoption patterns (Anderson, Varnhagen, & Campbell, 1997), computer use by humanities faculty (Jacobson & Weller, 1988), and computer experiences (Mueller, 1997a; Mueller & Jacobsen, 1997) provided items about university roles, access, satisfaction, prior learning, and hours of use. Two computer purchase items were included based upon prior research about adoption and non-adoption of home computers (Dickerson & Gentry, 1983). Three items about the year in which faculty used a computer for various tasks were constructed by the present researcher based upon Rogers' (1995) diffusion-of-innovations research. Results from this subscale will be used to build and extend upon prior research, to compare home and professional computer ownership, and to make recommendations for professional development plans and technology integration plans in academe.

Subscale 2: Computer Experience

The 44 items in the second section of the survey were designed to gather two types of information, ordinal and interval, about a faculty member's experience with computers (i.e., Level of Expertise and Year First Used for Teaching). First, participants rated their current level of expertise with 44 types of computer software and tools using a five-point Likert-type scale (i.e., 0 = None, 1 = A little, 2 = Fair, 3 = Substantial, 4 = Extensive) previously used by Mueller and Jacobsen (1997) in a survey of computer experience. Second, participants indicated the year they first used any of 44 types of computer software and tools in a course they had taught. These items collect information that is useful for exploring Rogers' (1995) theory of the diffusion of innovations and for distinguishing between the early adopter and mainstream faculty groups. The results from this subscale will be used to determine when and whether various instructional technologies have been adopted for use in the classroom, convert self-rated expertise with various types of computer software and tools into a faculty innovativeness score, and to differentiate between early adopters and mainstream faculty. This information will be used to make recommendations for professional development plans and technology integration plans.

Subscale 3: Generalized Self-Efficacy

The third section of the survey consisted of the Generalized Self-Efficacy Scale (GSES), a 10-item scale developed by Schwarzer and Jerusalem (1995) and used in prior on-line research (Schwarzer, Mueller, & Greenglass, 1998; Mueller & Jacobsen, 1997). Respondents use a 4-point scale (i.e., 1= Not at all true, 2 = Sometimes true, 3 = Often true, and 4 = Almost always true) to indicate how well they feel each statement describes them. Schwarzer and Jerusalem (1995) have found that the GSES displays high internal consistency ratings, with alphas ranging from 0.82 to 0.93. Concurrent validity of the GSES has been established on the basis of appropriate correlations with other tests. Expected positive correlations have been found with measures of self-esteem (0.52), internal control beliefs (0.40) and optimism (0.49). Mueller and Jacobsen (1997) found efficacy to be negatively correlated with the test anxiety subscales of worry (-0.30) and emotionality (-0.26). Schwarzer, Mueller, and Greenglass (1998) found the GSES displayed an internal consistency of .87 based on 1,324 participants for data collected on the Internet, and compared to paper-pencil methods found the psychometric properties of the on-line instrument to be satisfactory and in line with previous findings. The GSES was included in the present survey to explore the potential relationship between self-efficacy and early adoption of computer technology for teaching and learning.

Subscale 4: Participant Information

The fourth section consists of 10 items that collect nominal and interval data about the respondent's age, gender, academic rank, type of appointment, years of faculty experience, department affiliation, and number of undergraduate and graduate students taught. The tenth item only appeared on the web-based survey, and collected information about institution (i.e., University of Calgary versus University of Alberta). This item was also used by the researcher to identify results collected using the paper-based survey. The results from this section are to be used for descriptive and exploratory purposes.

Subscale 5: Changes to Teaching and Learning

The fifth section of the survey consists of 10 selected-response items that collect ordinal data about changes to teaching and learning. The items in this subscale were selected from a survey developed by Hadley and Sheingold (1993), who investigated the integration of technology with a large sample of K-12 teachers (n=608). They found that significant changes can take place as teachers integrate computers into instruction. Survey items were modified in order to be more specifically relevant to post-secondary academic staff. Participants used a five-point scale (i.e., 1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree) to indicate their level of agreement with each statement about how the integration of technology may change the post-secondary teaching and learning environment. The data collected in this section will be used to build and extend upon Hadley and Sheingold's (1993) research using post-secondary participants, to examine the internal consistency and content validity of this subscale, and to make recommendations for professional development plans and technology integration plans in academe.

The fifth section of the survey also used two open-ended response questions to gather qualitative data about the nature of changes that occur when technology is used for post-secondary teaching and learning. The use of open-ended questions allowed participants to address, in their own words, the nature of changes they have observed in faculty teaching and in student learning as a result of integrating and using technology for instruction. The questions also provided an opportunity for participants to highlight any ideas which they considered of relevance to teaching and learning with technology which were not dealt with in the 10 selected response items. Participant responses will be condensed to reflect emergent categories and themes, as well as to recommend unique selected-response items that should be included in future versions of this subscale.

Subscale 6: Incentives to Integrate Technology

The sixth section of the survey consists of 12 selected response items that collect ordinal data about incentives to integrate technology for teaching and learning. The items in this subscale were also selected from Hadley and Sheingold's (1993) survey of K-12 teachers based upon their finding that some incentives are more important than others for encouraging teachers to integrate technology in their teaching tasks (Hadley & Sheingold, 1993). Survey items were modified to be used with post-secondary academic staff, and participants used a five-point scale (i.e., 1 = Strongly Agree, a major incentive, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree, not an incentive) to rate each statement about important incentives and motivators. The data collected in this section will be used to build and extend upon Hadley and Sheingold's (1993) research using post-secondary participants, to examine the internal consistency and content validity of this subscale, and to make recommendations for professional development plans and technology integration plans in academe.

The sixth section also used two open-ended response questions to gather qualitative data about the intrinsic motivators, and extrinsic incentives, that may encourage faculty members to integrate and use technology in their teaching tasks. Participant responses will be condensed to reflect emergent categories and themes, as well as to recommend unique selected-response items that should be included in future versions of this subscale.

Subscale 7: Barriers to Integrating Technology

The seventh section of the survey consists of 20 selected-response items that collect ordinal data about barriers to integrating technology for teaching and learning. Some of the items in this subscale were selected from Hadley and Sheingold's (1993) survey, and additional items were constructed by the present researcher based on a review of current literature which identifies a number of barriers that may discourage or prevent faculty from integrating computers for teaching and learning in the campus environment. Survey items were modified to be used with post-secondary academic staff, and participants used a five-point scale (i.e., 1 = Strongly Agree, a major barrier, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree, not a barrier) to rate each statement. The data collected in this section will be used to build and extend upon Hadley and Sheingold's (1993) research using post-secondary participants, to examine the internal consistency and content validity of this subscale, and to make recommendations for professional development plans and technology integration plans in academe.

The seventh section also used one open-ended response question to gather qualitative data about barriers that may prevent faculty members from using and integrating technology into teaching and learning. Rejection and discontinuance frequently occur during the diffusion of an innovation, and this behavior may be rational and appropriate from the individual's point of view; diffusion research should attempt to understand the individual's perceptions of the innovation and his/her situation, problems, and needs. Responses will be condensed to reflect emergent categories and themes, may be useful for recommending unique selected-response items that should be included in future versions of this subscale, and along with responses to incentives and motivators, will provide insight into individual innovation-decisions.

Subscale 8: Learning About Technology

The 28 items in section eight collect ordinal data about an individual's preferred methods for learning about technology. These items are similar in nature to questions used in previous research with post-secondary instructors (Anderson, Varnhagen, & Campbell, 1997; Jacobson & Weller, 1988) and other populations (Mueller, 1997a; Mueller & Jacobsen, 1997). Items were modified in order to collect information related to Rogers' (1995) theory which examines the social environment and relationships of the adopter with other members in a social system, opinion leadership, and sources of information about innovations. Items were presented in three different parts. The first part questioned participants about the importance of various media and methods for acquiring new computer application skills and knowledge. The second part asked participants to rate the importance of various sources of support for help or assistance using computers. Finally, the third part asked participants to rate the importance of different sources of information for keeping abreast of changes/innovations in the area of computers. Participants ranked the importance of each item using a 4-point, Likert-type scale (i.e., 1 = Very important, 2 = Important, 3 = Neutral, and 4 = Not important). The data collected in this section will be used to build and extend upon Rogers' (1995) diffusion of innovation's research with a post-secondary population, and to make recommendations for professional development plans and technology integration plans in academe.

Section 9: Methods For Using and Integrating Technology

This section of the survey used one open-ended response question to gather additional information about the "learned lessons" or methods that have been effective for post-secondary teaching and learning using technology. The purpose of this item was to gather a large amount of baseline qualitative data to explore the specific uses of technology by this group. Participant responses will be condensed to reflect emergent categories and themes.

Section 10: Evaluating the Outcomes of Using Technology

The final section of the survey used one open-ended response question to gather additional information about how individuals determine whether the use or integration of technology is having the intended or desired effects on teaching and learning. The purpose of this item was to gather a large amount of baseline qualitative data to explore how individuals "know" when using technology has "worked", and when it has not. Participant responses will be condensed to reflect emergent categories and themes.

Interviews

Semi-structured interviews were conducted with faculty to gather more in-depth and specific information about the integration of technology for teaching and learning. The primary objective of the interviews was to record, analyze and interpret the individual faculty member's experiences, opinions, and perspectives with regard to integrating technology for teaching and learning. While the interview procedure used a semi-structured format guided by specific topics, it was also open-ended in nature to be responsive to emergent topics and themes. Discussion questions were drawn from the categories of survey items as well as using the following topics as guides: (a) Perceptions of value of computing skills for self and students, (b) Computer use patterns and skill levels, (c) Training and staff development (if any) as well as modeling from mentors, (d) Motivations for using technology (instructional, personal, institutional mandate), (e) Personal experiences with technology (early positive or negative), (f) Degree to which teachers require the use of technology by their students, and (g) Changes in use, practices, and beliefs about computers over time.

Study Participants

Survey Sample

The present investigation surveyed faculty members from across disciplines at two major North American universities (n = 76). An anonymous, 195-item survey instrument was administered to participants using both an on-line, World Wide Web interface stored on a University of Calgary server (i.e., http://www.acs.ucalgary.ca/~dmjacobs/phd), and a near equivalent paper-based, or hardcopy, version of the instrument.

Advertising for the survey was accomplished using a variety of means. A complete list of academic staff at the University of Calgary, along with mailing labels, was obtained from The University of Calgary Faculty Association (TUCFA). Invitations to participate were distributed to a stratified sample of 500 University of Calgary academic staff on January 14, 1998. Using the mailing labels, approximately every other individual from each department and faculty was selected to receive a letter (Appendices C & D) that described the nature of this investigation and invited them to participate in the study by February 18, 1998 using either the web-based interface or the paper form of the survey. 10 paper copies of the survey were distributed to each department and/or faculty with a letter (Appendix B) asking department staff to make the surveys available to academic staff. A second letter was sent to the University of Calgary sample on February 6, 1998 to remind faculty to participate in the study. Additional study participants were solicited for participation by means of an article published in a University of Calgary campus newspaper (Jacobsen, 1998). The campus newspaper article was published in early March, so the deadline for participating in the study was March 20, 1998.

Unfortunately, because access to faculty information constraints, the same sampling procedure for academic staff at the University of Alberta could not be arranged before data collection began in January. Therefore, a letter was sent by e-mail (Appendix E) to a convenience sample of 400 faculty members who subscribe to an educational technology listserv moderated by Dr. Terry Anderson at the University of Alberta. Listserv members were asked to participate in the study using the on-line survey, and did not have access to the paper version. The rationale for inviting listserv subscribers to participate in this investigation was based on the educational technology focus of their discussions as well as the desire to extend the study beyond the University of Calgary.

Despite the variety of means used to solicit participation in this study, a total of 64 out of 500 participants were obtained from the University of Calgary population (i.e., an estimated return rate of 12.8%), and 12 out of 400 from the University of Alberta listserv (i.e., an estimated return rate of 3%). Overall, 55 (72.3%) participants participated using the web-based survey, and 21 (27.6%) submitted results using the paper-based survey. Speculations about the limitations of the sampling procedure will be discussed in chapter 6.

Interview Sample

Previous successful research into the nature of teaching excellence (Andrews, Garrison, & Magnusson, 1996) sought rich and detailed input from a small number of participants. Because of the time commitment necessary for interviews, data transcription, and transcript validation, and the potentially rich data acquired by these methods, a small number of faculty were solicited to participate in this part of the study. Participants were invited to participate in an interview using one or a combination of the following methods: (1) faculty were asked to volunteer for an interview at the end of the campus-wide survey,

(2) identification or nomination (i.e., attributed expertise, Sternberg & Frensch, 1992) by Deans, department heads, and colleagues of early adopters who integrate technology for teaching and learning, and have used computer technology to transform, or reengineer (Hammer & Champy, 1993) the teaching-learning transaction, (3) faculty who have been awarded “Excellence in Teaching” awards who also integrate technology as part of their teaching methods, and/or (4) by word of mouth. An “informal network”, or second-order environment (Bereiter & Scardamalia, 1993), exists that recognizes and supports expert-like individuals who possess both excellent teaching skills and who integrate technology to accomplish student learning goals in undergraduate education. Faculty who described using technology merely as an “add-on” to their teaching were not considered for inclusion in this part of the study. However, newer adopters were included in order to represent the mainstream. A total of 7 faculty participated in a semi-structured, face-to-face interview.

Data Collection Procedures

Web-based Survey Pilot Study

The web-based survey instrument was created for on-line delivery by the present researcher using a cross-platform, hypertext markup language (HTML). The on-line survey was tested using multiple platforms (i.e., PC and Macintosh) and a variety of browsers to ensure that the web-based survey would display effectively using either Netscape Communicator™ or Microsoft Internet Explorer™. The web-based survey instrument was subjected to a number of revisions and tests to improve both its design and validity. The web-based interface was reviewed by 7 faculty members at the University of Calgary, each of whom is actively using technology in either their research or their teaching tasks. Reviewers were regarded as representative of those for whom the survey was designed (Crocker & Algina, 1986). Reviewers were asked to provide feedback about the content validity of the instrument, as well as to make suggestions about how to improve the design of the on-line web interface. Revisions were made to the design and format of the on-line instrument with regard to loading time, ease of use, time to complete, screen design and item presentation. Revisions were also made to individual items and menu presentation for Likert-scales to improve their content validity as a result of feedback from faculty members. Pilot results were saved to a cumulative data file and were used to evaluate the efficacy of the chosen format for data presentation and naming variables.

Web-based Survey Considerations and Administration

Many areas of inquiry can benefit by extending their data collection activities to take advantage of an Internet connection (Mueller, 1997b). The use of a web-based interface for survey research is a relatively new way to conduct psychological research, and offers several advantages over traditional methods. First, web-based surveys can gain access to a large cross-cultural and international sample, as well as save the expense and delay of regular postage and other distribution methods. If sampling error is a concern, researchers have the flexibility to collect data using a local area network configuration (LAN), rather than making the instrument available to "the world" on the Internet. In the present study, the survey was published on the World Wide Web and respondents were selected by conventional methods and referred to the on-line survey in order to complete the questionnaire. Second, instead of using manual or scantron methods for data entry, the data collected using a web-based interface are entered by participants and are stored in a cumulative data file that is ready for analysis with SPSS or SAS software. Third, because the Internet is available to anyone with a computer and a connection, at anytime and from anywhere, data can be collected 24 hours per day without the researcher having to be physically or temporally present and without having to procure laboratory space. Fourth, WWW surveys can benefit both the respondent and administrator through the use of dynamic and interactive forms that provide instant feedback tailored to the user's responses (Schmidt, 1997). Depending upon the survey content, it may be desirable to give feedback about the respondent's results, or to present them with a separate set of survey items. A number of investigations at the University of Calgary and elsewhere have been designed to take advantage of the web as part of their research methodology (Appendix H).

A set of preliminary guidelines have been developed that address some of the practical and ethical considerations regarding on-line research (Mueller, 1997b), and will be used to frame the following discussion about the present investigation. Informed consent was obtained by designing the on-line survey so that the first web page was an information and consent form rather than the first section of the survey. With a web-based survey, it currently is not feasible to get an actual signature, so the participants were instead presented with an on-screen button that said "I Agree", and by clicking on this link the participant implied acceptance of the terms of the consent form and proceeded to the first section of the survey. In fact, this method is considered legally binding by owners of current software install programs. Also included on this first page was mention of the "book draw" incentive (Appendix D), which participants could enter by submitting their e-mail address at the conclusion of the survey. In order to provide a convenient means of pre-survey communication, contact information was provided for the primary researcher and the dissertation supervisor (i.e., mailto: e-mail links in addition to phone numbers) on this first web page.

Voluntary participation was assured because participants had to consciously decide to link to the web-based survey site, then read and click on the "I Agree" button on the consent form before they reached the actual survey. Participants were free to quit the survey at any time. There was little direct pressure on individuals to participate, or even to continue once they started with the on-line (or paper-based) survey. One participant pointed out a limitation with the web-based interface; this individual wanted to scan the list of questions before making their decision to participate in the study. It is possible to provide a link to a web page that allows potential participants to preview the survey items before making the decision to take part in the investigation. Providing this information would make the on-line form more similar to paper version in that participants could scan the survey for length and item content using the scroll bars in a manner similar to flipping through pages.

Anonymous participation was important and was guaranteed to study participants. In general, when results are submitted using a web-based, HTML-generated response form, the cumulative data file lists the date and time the results were submitted and the IP address of the server from which the survey was completed in a header. This information was used only to confirm that participants who submitted results used a University of Calgary or University of Alberta IP address, as well as to check for multiple responses. Because of the length of the survey, the entire survey was published as two separate files to speed loading times. The header information was also used to match parts 1 and 2 for each respondent, and to discard incomplete responses (i.e., from those respondents that completed part 1 but not part 2). Participants were not required to provide any identifying information as a part of the survey proper. However, for those study participants who wanted to receive a report on the results of the investigation, or participate in the book draw, a separate "Thank-you" web page was presented at the conclusion of the survey which asked participants to provide their e-mail or office address if they wanted to receive feedback. Overall, 42 participants entered the book draw, and 44 requested feedback about the study. This information was saved to a third data file which was separate from survey results. This information was only used to respond with preliminary results from the survey and to select a winner for the book draw. No attempt was made to link this identifying information with the data provided in the study.

An additional advantage of the web-based survey instrument is that a researcher can provide links to additional materials on-line with little danger of biasing the outcomes of the study. For example, as a result of feedback from a pilot survey reviewer, a decision was made to provide information about the purpose of the study and links to additional resources about this line of research on the “Thank-you” web page at the conclusion of the survey. It is unlikely that similar resources would be provided using the traditional hardcopy method of surveying individuals, both because of the cost and the increased potential for biasing the outcomes of the research. Study participants were also provided with on-line contact information for the primary researcher and the dissertation supervisor (i.e., mailto: e-mail links in addition to phone numbers) which provided a convenient and immediate post-participation method of communication. All survey responses were saved to a cumulative data file in the investigator’s ACS directory on the University of Calgary server.

Paper-based Survey Procedure

An equivalent paper-based form of the survey was developed and made available to academic staff for two reasons: (a) to provide a means for non-adopters of technology to participate, and thus include more mainstream faculty in the sample, and (b) to avoid excluding any potential participants from this investigation who may not be comfortable using the web-based form. The format and page layout was based upon a similar instrument used to survey academic staff at the University of Alberta (Anderson, Varnhagen, Campbell, 1997). Data from the completed paper surveys was entered by the present researcher using the web-based interface and saved to the same cumulative data file in the investigator’s ACS directory on the University of Calgary server. Item 10 in the Participant Information subscale of the web-based survey collected data about institution (i.e., University of Calgary versus University of Alberta) and was used by the researcher to record whether a participant used the paper-based survey to take part in the study. This data will be used to determine whether there is a significant difference in responses between those who participated on-line and those who participated using the paper-based survey.

Interview Procedure

Interviews were conducted with faculty to gain an in-depth understanding of unique and common issues and concerns related to integrating technology into teaching and learning in higher education. The investigator conducted a series of 7 semi-structured, face-to-face interviews with faculty members at the University of Calgary from January 22, 1998 to April 30, 1998. Interviews took from 1 hour 15 minutes to 1 hour 30 minutes each. Six male faculty and one female faculty member participated in an interview session, and participants represented a range of disciplines (i.e., psychology, education, management, computer science, information services and humanities). Five of the participants have been using technology in their teaching for a number of years, and two have recently adopted technology for teaching tasks.

Although a list of topics and question categories were used to structure the interview session, the results from each interview were unique. The direction each interview took was influenced by the nature of the individual's integration efforts, length of experience using technology, areas of specific interest, their research program, and discipline area. For example, four of the faculty interviewed are actively involved in basic and applied research on the application of computers for learning. The remaining three faculty are pursuing research in other content areas with technology serving as a medium for teaching and communication, but not as an area of active research.

Interviews were audio recorded and transcribed verbatim by the primary investigator. The interview transcripts were returned to participants for validation and approval. Participants were encouraged to make additions to the transcribed record prior to analysis, and one individual took this opportunity to add to their transcript. The anonymity of interview participants was protected using the following methods: (a) all identifying information was stripped from the transcribed interview after validation, including references to courses, individuals, and so forth, and (b) quotations used for publication are framed in such a way that the individual's identify is masked, and (c) pseudonym's are used where necessary. Despite these precautions, it may still be possible to discern an individual's identity from the unique nature of comments, opinions, and descriptions of projects.

The transcripts of interviews will be analyzed for common and emergent themes using a constant comparison method, and sorted into major themes using a combination of categories derived from prior research on teaching excellence (Andrews, Garrison, and Magnusson, 1996) and from Rogers' (1995) innovation-decision process: (1) Knowledge, (2) Persuasion, (3) Decision, (4) Implementation, and (5) Confirmation.

The following categories derived by Andrews, Garrison, and Magnusson (1996) have been modified to reflect the use of technology in teaching and learning: (1) Values, beliefs and characteristics of faculty members, (2) Expected outcomes and benefits from integrating computer technology, (3) Processes used to attain the outcomes, (4) Specific instructional strategies that support the processes, and (5) Motivators and impediments to integrating computer technology.

Chapter Four

ANALYSIS AND INTERPRETATION OF RESULTS

The following chapter summarizes the survey results from this investigation. Interview results will be reported by case in Chapter Five. Survey data collection proceeded as described in Chapter Three, beginning on January 14, 1998 and concluding on March 20, 1998. The survey data has been subjected to a number of statistical analyses in order to explore, describe and interpret results from the entire sample for each subscale, as well as to determine whether significant differences exist as a result of method of participation and faculty innovativeness. Results about the whole sample will be reported by subscale, as well as reporting on the differences between groups along two dimensions: (1) electronic versus paper participation, and (2) earlier adopters and mainstream faculty. Qualitative data from open-ended response questions will be summarized and reported by subscale.

Survey Results

Participant Information

Complete survey data was obtained from 76 participants (29 [38.2%] female and 47 [61.8%] male), who are on average 45.5 years old, and hold various academic ranks in their institution (i.e., 19.7% assistant professor, 35.5% associate professor, 26.3% professor, 18.4% lecturers and sessionals). Over 65% of participants hold appointments that are tenured (56.6%) or leading to tenure (9.2%). Although the average years of experience as a faculty member was approximately 12.5, the largest group (26.3%) had from 1-3 years of experience, and the majority (59.2%) had from 1 to 12 years of experience (Table 1).

Table 1. Years of Experience as a Member of an Academic Staff (n = 76)

Years	Frequency	Percent	Cumulative Percent
1-3	20	26.3	26.3
4-6	6	7.9	34.2
7-9	10	13.2	47.4
10-12	9	11.8	59.2
13-15	7	9.2	68.4
16-18	4	5.3	73.7
19-21	6	7.9	81.6
22-24	1	1.3	82.9
25-27	3	3.9	86.8
28-30	4	5.3	92.1
>30	6	7.9	100

As can be expected, the number of years that participants have been teaching undergraduate and/or graduate students is very similar to number of years of experience as a faculty member. For example, the majority (59.2%) have been teaching students for a total of 1 to 12 years, and the largest group (17.1%) has been teaching for 1 to 3 years. However, the percentages are higher for 4-6 (10.5%), 7-9 (15.8%), and 10-12 (15.8%) years of post-secondary teaching experience, which can probably be explained by the tendency for graduate students to gain undergraduate teaching experience as they are preparing for an academic career.

The majority of respondents (67.1%) teach 100 or fewer students per semester (Table 2), with earlier adopting faculty teaching statistically more students $t(74) = 2.33$, $p < .05$ (**Ms** = 125 vs. 75) per semester than mainstream faculty. A surprising finding was that a large proportion of respondents do not currently supervise graduate students (42.1%). However, 39.4% currently supervise between 1 and 4 graduate students, and 18.4% supervise between 5 and 20 graduate students.

Table 2. Average Number of Students Taught by Faculty Per Semester

# of Students	Frequency	Percent	Cumulative Percent
1 - 25	16	21.1	21.1
26 - 50	9	11.8	32.9
51 - 75	11	14.5	47.4
76 - 100	15	19.7	67.1
101 - 125	6	7.9	75
126 - 150	5	6.6	81.6
151 - 200	5	6.6	88.2
201 - 250	4	5.3	93.4
251 plus	5	6.6	100

This is truly a campus-wide, multidisciplinary sample with participants representing a range of academic disciplines: Agriculture (9.2%), Continuing Education (1.3%), Education (19.7%), Engineering (2.6%), Environmental Design (2.6%), Fine Arts (3.9%), General Studies (5.3%), Humanities (5.3%), Kinesiology (1.3%), Management (5.3%), Medicine (11.8%), Nursing (5.3%), Science (11.8%), Social Science (13.2%), and Social Work (1.3%).

Sample Representativeness

Because of the small sample size and unequal participation from two large institutions (U of C, n = 64; U of A, n = 12), it is difficult to speculate about the nature of the sample as compared to the population. However, current demographic information (i.e., as of December, 1997) was obtained from the Information Management and

Administration Group (IMAG) at the University of Calgary for the purpose of a post-hoc comparison to explore the general representativeness of the present sample. Figures 3, 4, and 5 represent the similarities and differences between the sample and the population of academic staff at the University of Calgary.

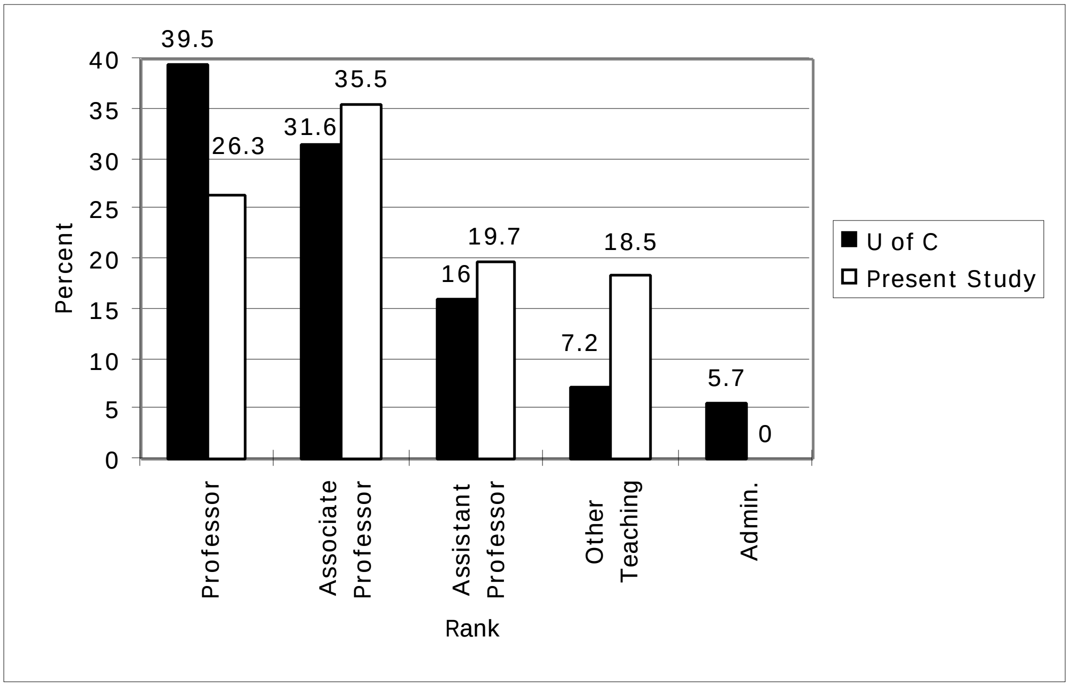

Figure 3. Academic Staff by Rank (University of Calgary, as of December 1997)

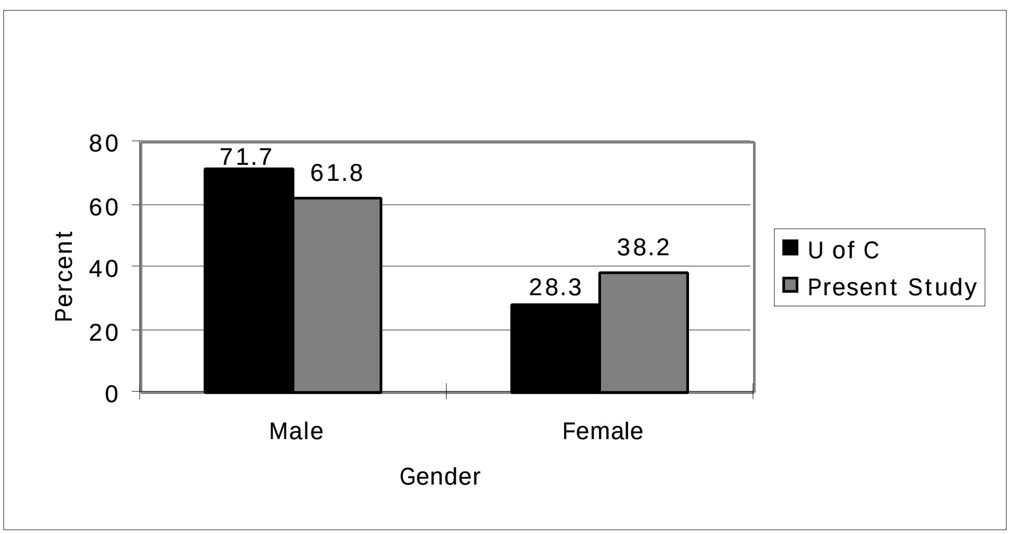

Figure 4. Academic Staff Distribution by Gender (University of Calgary, as of December 1997)

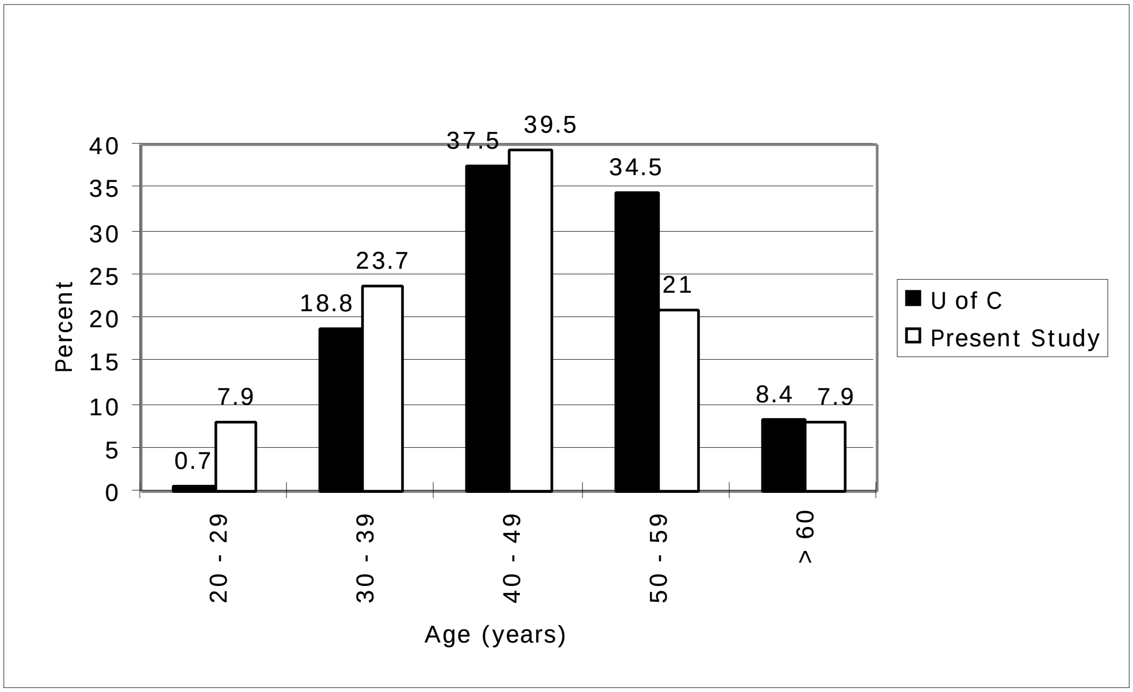

Figure 5. Academic Staff Distribution by Age (University of Calgary, as of December 1997)

Of those who participated in this study, there was a smaller proportion of professors (Figure 3), a higher proportion of associate and assistant professors, and more than twice the proportion of other teaching staff (i.e., sessionals & lecturers) than are represented in the University of Calgary faculty population. It appears that a higher proportion of females (Figure 4) participated in the present study than are represented in the University of Calgary academic staff population, so this sample may be somewhat more gender-balanced than for the institution as a whole. It also appears that a higher proportion of academic staff aged 20 to 49 participated in the present study (Figure 5) and a lower proportion of academic staff over 50 years of age than are represented in the University of Calgary population. So, this sample may be somewhat younger than the university academic staff population as a whole. Recognizing that this post-hoc comparison is exploratory, and thus no statistical tests were performed, it still seems fair to suggest that the sample is fairly representative of an academic staff population at a large university.

Method of Participation

Collecting data using the Internet is a relatively new research methodology. As such, it is important to test and validate this new procedure to determine if equivalent results can be obtained in comparison to those collected using conventional survey procedures. Participants were divided into two groups to determine whether there was a significant difference as a result of method of participation. Of the 76 participants, 55 (72.3%) used the web-based survey and 21 (27.6%) the paper-based version to take part in the study. In order to determine whether there were differences in the mean responses of the two groups for method of participation, t tests were performed on responses to all survey items. Significant differences were found between the electronic (WWW) group and paper group for 38 of the 195 items on the survey.

The electronic group was statistically **t** (74) = 2.85, **p** < .01 (**Ms** = 45 vs. 50) younger than the paper group, and have fewer years of experience as faculty members **t** (74) = 2.173, **p** < .05 (**Ms** = 9 vs. 14). The electronic group were more likely to have first used computers on campus as a graduate student while the paper group first used computers as a new or experienced faculty member. The year that the electronic group first used a computer for personal, professional academic tasks (i.e., between 1980 and 1981) was statistically **t** (74) = 2.04, **p** < .05 earlier than the paper group (i.e., between 1984 and 1985) which corroborates the finding that this group first used computers before becoming faculty members. The electronic group reported higher levels of satisfaction than the paper group for two of four items about support, training, and investment plans for technology on campus; Item 10: **t** (74) = 2.77, **p** < .01 (**Ms** = 2.38 vs. 3.23); Item 11: **t** (74) = 3.12, **p** < .01 (**Ms** = 2.80 vs. 3.76). The electronic group was more satisfied with the support and training made available on campus for teaching related tasks, as well as being neutral rather than dissatisfied **t** (74) = 2.06, **p** < .05 (**Ms** = 3.01 vs. 3.71) about current campus investment plans to acquire computers for teaching and learning activities.

The electronic and paper groups differed on only 5 of 88 items on the computer experience subscale, which suggests that level of self-rated expertise and earlier adoption of technology for teaching were not important influences on the choice to use either the web-based or paper survey. The electronic group had statistically higher levels of expertise **t** (74) = 2.14, **p** < .05 and integrated Windows 3.x, NT earlier in their teaching than the paper group. Alternatively, the paper group used the Sun operating system earlier for teaching than the electronic group, and had more expertise with drafting (CAD) programs. The electronic group used WWW page creation and editing statistically earlier in their teaching **t** (74) = 2.24, **p** < .05 than the paper group, many of whom have not used it yet.

The paper group reported higher levels of self-efficacy on 5 of the 10 items on the Generalized Self-Efficacy Scale which will be discussed in more detail in a later section. There were no significant differences for method of participation for the 5th subscale, Changes to Teaching and Learning, however, the electronic group expressed statistically higher levels of agreement than the paper group on 7 of the 12 Incentive items in the 6th subscale (Table 3).

Table 3. Significant Differences on Incentives for Electronic Respondents Versus Paper Survey Respondents

Item	t	df	p	Means
Computers enable me to make a subject more interesting.	3.33	74	.001	2.07 vs. 2.85
Computer tools enable me to communicate and interact more with students.	3.20	74	.002	2.09 vs. 3.00
By integrating technology, I am helping students to acquire the basic computer education they will need for future careers.	3.10	74	.003	1.70 vs. 2.47
I enjoy figuring out how to use computers effectively for a variety of teaching situations.	2.88	74	.005	2.14 vs. 2.95
Students are enthusiastic about the subjects for which they use computers.	2.67	74	.009	2.49 vs. 3.09
Computers provide a means of expanding and applying what has been taught.	2.20	74	.031	2.14 vs. 2.71
Computers provide an environment that appeals to a variety of learning styles.	2.19	74	.032	2.49 vs. 3.09

The electronic group also had statistically higher levels of agreement on 4 of the 20 Barrier items on the 7th subscale than the paper group (Table 4).

Table 4. Significant Differences on Barriers for Electronic Respondents Versus Paper Survey Respondents

Item	t	df	p	Means
There are too few computers for the number of students.	2.77	74	.007	1.69 vs. 2.33
The reward structure does not recognize faculty members for integrating computers for teaching and learning.	2.65	74	.010	1.83 vs. 2.66
There are problems scheduling enough computer time and/or resources for different faculty members' classes.	2.16	74	.033	1.65 vs. 2.14
There is less control over classroom instruction when using computers.	2.03	74	.045	3.25 vs. 3.80

Finally, in subscale 8, Learning About Technology, the electronic group rated 8 of 28 items as more important than the paper group. In terms of media and methods for acquiring new computer knowledge and skills, the electronic group rated hardcopy materials **t** (74) = 2.15, **p** < .05 (**Ms** = 1.81 vs. 2.38) and a mixture of manuals and hands-on **t** (74) = 3.15, **p** < .01(**Ms** = 1.41 vs. 1.95) as statistically more important than the paper group. It is worth noting that the methods rated as more important by the electronic group support independent or self-structured learning as opposed to the more "teacher-directed" learning generally available in workshops and structured courses. In terms of help or assistance with using computers, the electronic group rated media center support staff **t** (74) = 2.22, **p** < .05 (**Ms** = 2.18 vs. 2.80) as more important than the paper group. In order to keep abreast of changes/innovations in the area of computers, the electronic group's more neutral rating of refereed computer journals was statistically different **t** (74) = 2.29, **p** < .05 (**Ms** = 3.09 vs. 3.71) from the paper group's not important rating. The electronic group rated conferences, demonstrations and workshops **t** (74) = 2.31, **p** < .05 (**Ms** = 2.40 vs. 3.04), on-line computer newsgroups and websites **t** (74) = 3.00, **p** < .01 (**Ms** = 2.32 vs. 3.14), on-line computer journals **t** (74) = 2.87, **p** < .01 (**Ms** = 2.81 vs. 3.57), and publications from major computer vendors **t** (74) = 2.07, **p** < .05 (**Ms** = 2.90 vs. 3.47) as more important sources of information than the paper group. It is worth noting that for all of the mentioned items, the paper group's average rating of the media or method was neutral to not important, which may indicate that the paper group does not currently exploit the potential value of a particular source of information, are indifferent about its value, or simply do not know enough about the information source to state an opinion.

Faculty Innovativeness

Respondents were assigned to either the earlier adopter (EA) or mainstream faculty (MF) subgroups using a scoring procedure developed by Anderson, Varnhagen, and Campbell (1997) in a similar study of faculty adoption patterns. Using the data that individual faculty provided for self-rated expertise in the second subscale, a composite score was calculated for *innovativeness* by summing the level of expertise (i.e., 0 for None, 1 for A little, 2 for Fair, 3 for Substantial, and 4 for Extensive) indicated for each of the 44 types of computer software and tools. Rogers (1995) defines *innovativeness* as the degree to which an individual is relatively earlier in adopting new ideas than other members of a social system. The assumption being made here is that for one to have developed "extensive" expertise with a particular tool, they have been relatively earlier to adopt than one who rates their expertise as "a little". The total possible cumulative score for *innovativeness* is 176; sample scores ranged from 9 to 121, and when plotted resembled an S-shaped curve which lends confidence to the present assumption of normalcy. Rogers' (1995) adopter categories and individual *innovativeness* scores were used to predict how many of the sample were EAs and how many were MF (i.e., 2.5% innovators + 13.5% early adopters = 16% EA; 34% early majority + 34% late majority + 16% laggards = 84% MF). As a result, the present sample was divided into two groups (EA, n = 13 and MF, n = 63) for statistical comparison. In order to determine whether there were differences in the mean responses of the two groups for *innovativeness*, t tests were performed on responses to all survey items. The outcomes of the t tests revealed that there is a significant difference between EA and MF responses for 82 (42%) of the 195 survey items. EAs report significantly higher levels of expertise than MF for 38 (86%) of the 44 expertise items. This result both provides support for the method used to predict the distribution of the group, and adds confidence to the interpretation of subsequent findings based on faculty innovativeness. To facilitate reporting and interpretation of these results, specific item differences will be reported by subscale.

Patterns of Computer Technology Use

The first subscale gathered information about computer use and purchase patterns, access to technology, personal satisfaction, prior learning, and hours of use. Participants provided or selected the response that best represented their experience, situation, or opinion. Of the 76 participants, 22 (28.9%) indicated they first used computers on campus as an undergraduate student, 24 (31.6%) as a graduate student, 14 (18.4%) as a new faculty member, and 13 (17.1%) as an experienced faculty member. 3 participants (3.9%) failed to indicate any response. The majority of these respondents first used computers on campus as a student (60.5%), with the remainder first using computers as new or experienced faculty members. EAs were more likely to have first used computers as a student $t(74) = 2.49$, $p < .05$ (**Ms** = 1.46 vs. 2.30) than MF.

Items 2, 3, and 4 asked participants to indicate the year they first used a computer for (a) personal, professional academic tasks (i.e., writing, e-mail, grade sheets, etc.), (b) research tasks (i.e., data collection, statistical analysis, etc.), and (c) teaching tasks (i.e., demonstration, modeling, instructional, etc.). Table 5 presents a summary of the years at which these respondents first used a computer for these various tasks.

Table 5. Percentage of Faculty by Year First Used a Computer For Various Tasks

Task	< 1965	1966-1972	1973-1979	1980-1986	1987-1993	1993-1997	Never used
Professional	2.6	5.3	9.2	52.6	23.7	1.3	5.3
Research	3.9	11.8	11.8	35.5	26.3	5.3	5.3
Teaching	1.3	5.3	2.6	19.7	31.6	25	14.5

A comparison of the different diffusion patterns of computer use reveals that faculty have different adoption thresholds (Rogers, 1995) for using the computer for various tasks. For example, a higher percentage of these respondents had used computers for professional tasks (69.7% by 1986 and 93.4% by 1993) and research tasks (63.1% by 1986 and 89.4%

by 1993) than they had for teaching tasks (43.4% by 1986 and 75% by 1993) in the same years.

One can also observe the different adoption thresholds by comparing the adoption curves generated by plotting the years that respondents first used computers for the three different tasks (Figure 6). Respondents appear to have adopted computers approximately a decade earlier for professional and research tasks than they did for teaching tasks.

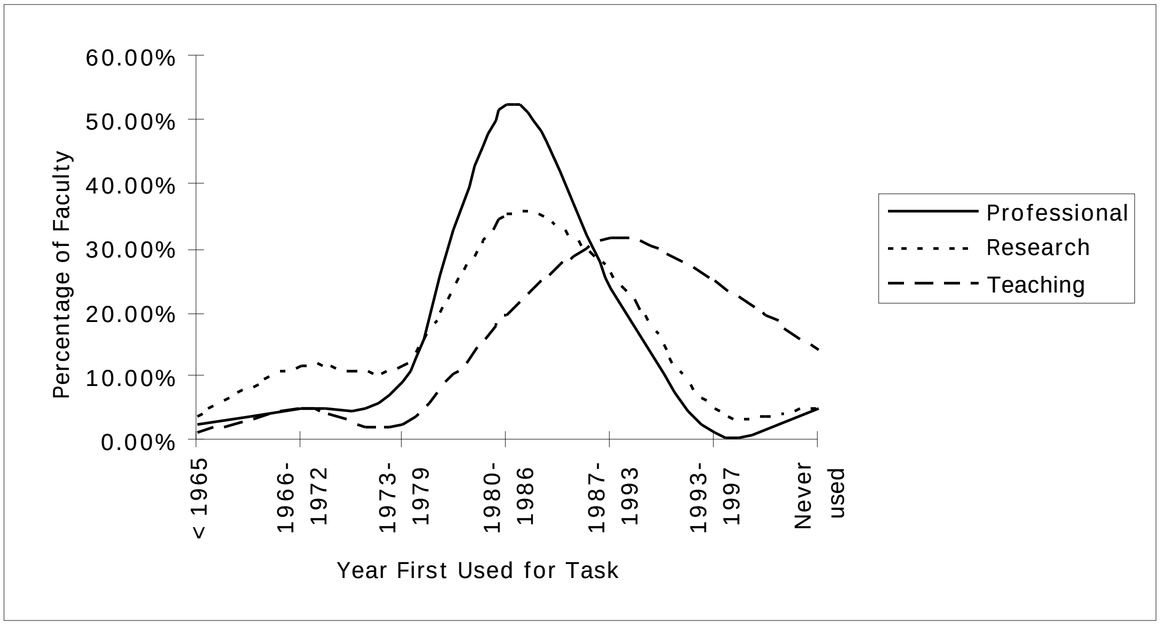

Figure 6. Adoptions Curves of Faculty's First Computer Use for Various Tasks

Dickerson and Gentry (1983) found that early adopters of home computers were middle-aged, had higher incomes and more education, were opinion leaders, and information seekers. Items 5 and 6 asked respondents to indicate the year in which they first bought a computer for (a) personal/home use, and (b) professional use.

Table 6. Percentage of Faculty by Year First Purchased a Computer for Personal/Home or Professional Use

Computer Purchase	< 1980	1981-1989	1990-1997	do not own
personal/home use	10.5	56.5	26.5	6.5
professional use	7.9	50	27.6	14.5

An examination of Table 6 reveals that both personal/home and professional ownership of computers is almost completely diffused among these respondents with only a small percentage of individuals not owning a computer for either of these purposes

(Complete frequency data is available in Appendix F). There is a larger percentage (14.5% versus 6.5%) of respondents who indicated they do not own a computer for professional use. However, this difference may actually be an indication that the institution instead owns the computer that these participants use at work. It is worth noting that there is no statistical difference between the EA and MF for either computer ownership variable. One might expect that earlier adopters would have purchased their own computer much earlier than the mainstream. This non-significant difference may be partially explained by the tendency for earlier adopters to have first used powerful mainframe computers, with greater processing power, for their personal and research tasks. Certain statistical analyses, such as a factor analyses, would have required the processing power of a mainframe in the early 80s to get expedient results. It would not make sense for an individual, who had access to powerful mainframe computers on campus, to purchase an expensive desktop computer in the late 70s or early 80s that had limited processing power. A future study may want to examine the difference between early mainframe and early desktop use to examine whether it's true that early adopter use of university mainframe computers affected subsequent desktop computer purchasing decisions and related desktop computer usage patterns.

Participants were asked to indicate the number of computers they have owned since buying their first computer. An examination of Figure 7 reveals that the majority of respondents (61.9%) have owned at least 5 computers since buying their first one, a smaller percent (31.6%) have owned 6 or more computers, and a smaller percent (6.5%) have owned no computers at all.

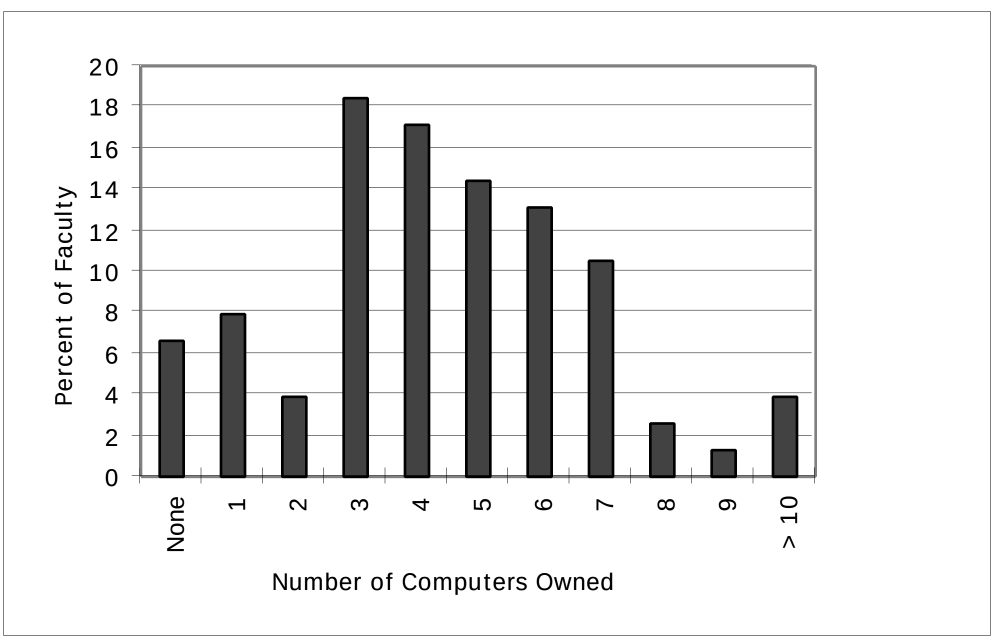

Figure 7. Number of Computers Owned by Faculty Since Purchasing First One

Access to computers for professional use and teaching tasks appears to be adequate for the majority of respondents. In response to item 8, which asked participants whether they had exclusive access to a computer for professional use, 86.8% responded yes, 3.9% responded no, 3.9% responded sometimes, and 5.3% made no response. In response to item 9, which asked whether they have ready and convenient access to computers, software and needed equipment for teaching tasks, 77.6% of these respondents answered yes, 2.6% responded no, 15.8% responded sometimes, and 3.9% made no response. Despite adequate access for the majority, nearly one in five of the respondents (18.4%) indicated that ready and convenient access to computers and/or software for teaching tasks was inadequate or inconsistent.

Items 10 to 13 were designed to measure satisfaction with support and training for computer-related teaching tasks and current campus investment in computers for individual faculty and for teaching and learning. Participants used a five point Likert-type scale (i.e., 1 = Very Satisfied, 2 = Satisfied, 3 = Neutral, 4 = Unsatisfied, and 5 = Very Unsatisfied) to indicate their response to each item. Except for item 10, the mean responses appear to indicate that these respondents are neutral about training and computer acquisition plans on campus (Table 7). However, the high degree of variability in responses indicates that satisfaction is widely dispersed. As previously mentioned, the electronic group reported significantly higher satisfaction for items 10, 11, and 13 than the paper group. There were no statistical differences between EA and MF for items 10 to 13.

Table 7. Means and Standard Deviations for Faculty Satisfaction with Support, Training, and Computer Acquisition Plans on Campus

Satisfaction Item	**Mean**	**SD**
10. Support for teaching tasks	2.6	1.25
11. Training for teaching tasks	3.1	1.27
12. Acquiring Computers for individual faculty	3.3	1.48
13. Acquiring Computers for teaching and learning	3.2	1.34

The greatest percent of participants (36.8%) indicated they were satisfied with the support made available on campus for computer-related teaching tasks. However, one quarter of the participants (25%) indicated they were unsatisfied or very unsatisfied with the available support on campus. The largest proportion of participants (35.5%) were neutral about the training made available on campus for teaching-related tasks, but 32.9% were either unsatisfied or very unsatisfied. A majority of respondents (51.3%) are either unsatisfied or very unsatisfied with current campus investment plans with regard to the acquisition of computer technology for individual faculty, while 21.1% indicated they were satisfied or very satisfied and 21.1% were neutral. Finally, 76.4% of respondents are neutral to very unsatisfied with current campus investment plans for computer technology for teaching and learning, and only 17.1% are satisfied. The neutrality expressed by some respondents could be an indication of a lack of knowledge about the support and training available on campus for computer-related teaching tasks. As demonstrated by responses to Items 2 - 4, there is still a large number of respondents who either have not adopted technology for teaching tasks, or have only recently adopted, and they could be unaware of available support and training (i.e., New Media Centers, Academic Computing Services).

Items 14 and 15 collected information about how participants acquired their computer knowledge and skills. When asked about acquiring initial computer skills, 64.5% of respondents indicated they were self-taught, 15.8% indicated a combination of self-teaching and formal courses, and 6.6% learned their skills from a colleague. Responses to item 15 indicated that the range of computer knowledge and skills possessed by respondents are primarily the result of self teaching (75%), both self-teaching and formal courses (13.2%), and colleague teaching and support (6.6%). The satisfaction expressed by one-third of the respondents with support and training on campus could be related to the high degree of self-teaching and colleague support enjoyed by this group. The 32% of respondents who were dissatisfied with support and training probably prefer other learning methods and may feel abandoned when they have to struggle alone.

In response to item 16, 28.9% of these respondents indicated that they had taught computer courses, while 65.8% had not. So, approximately two-thirds of this sample could be described as “users” of technology and one-third as “techies” who teach about technology. Item 17 asked participants to indicate the level of computer course taught. Of those who responded, 1.3% indicated high school, 13.2% indicated undergraduate, 13.2% indicated graduate (71.1% did not respond).

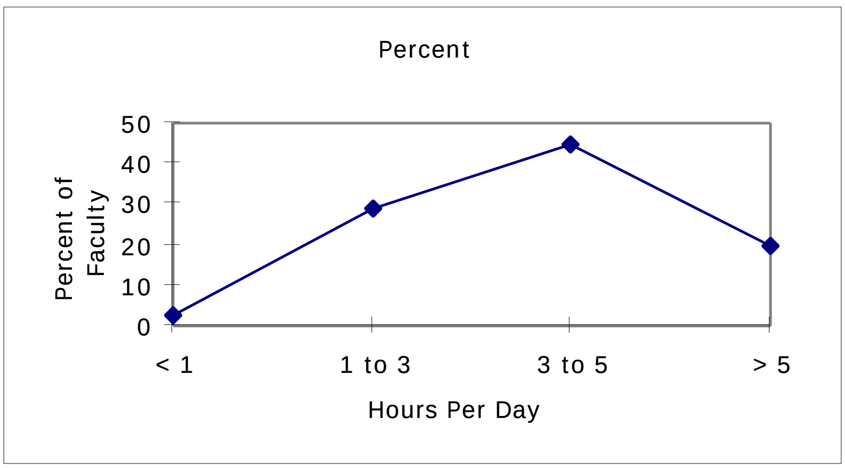

Figure 8. Hours Per Day Faculty Spend Using Computers

Participants were asked to indicate the average number of hours per day they spent using computers (Figure 8). These respondents are generally quite heavy computer users; only 2.6% indicated they spend less than one hour per day, 28.9% spend 1 to 3 hours per day, 44.7% spend 3 to 5 hours per day, and 19.7% spend more than 5 hours per day using a computer. As expected, EA use computers statistically more hours per day $t\ (74) = 3.11$, $p < .01$ (**Ms** = 2.23 vs. 0.76) than MF.

Computer Experience

The second subscale of the survey was designed to collect two types of information about a faculty member's experience with 44 types of computer software and tools: (a) their current level of expertise, and (b) the year in which the faculty member first used this software/tool (if ever) in a course they taught. These results are presented in the following two sections: (a) faculty expertise, and (b) computer use in classrooms.

(a) Faculty Expertise

The task in this section is to quantify respondent's personal expertise with computers in order to explore Rogers' (1995) theory of the diffusion of innovations. Participants rated their level of expertise using a five-point, Likert-type scale (i.e., 0 = None, 1 = A little, 2 = Fair, 3 = Substantial, 4 = Extensive) for each of 44 types of computer software and tools. An estimate of the internal consistency of this subscale yielded a coefficient alpha of .93, which is a relatively high rating of item homogeneity and an indication that faculty responded consistently across items.

In order to estimate the diffusion of computer technology in this group, the proportion of respondents who rated their expertise as "A Little" to "Fair" have been combined, as have faculty ratings of "Substantial" and "Extensive" expertise to calculate a Total Adoption percentage. Although the Total Adoption estimate gives no information about time of adoption or the stage at which an individual is in the innovation-decision process, the assumption here is that in order to develop *any* level of expertise, respondents had to adopt the innovation at some time. Total Adoption will be interpreted as the percentage of respondents who have some degree of personal facility using each type of computer software or tool. The Total Adoption percentage was used to estimate the diffusion of each innovation using Rogers' (1995) adopter categories.

Table 8 presents the diffusion results for 10 software/tools that have been personally adopted by the early majority (as indicated by 16% to 50% total adoption using Rogers' categories and normal curve) and Table 9 presents the diffusion results for 26 software/tools that have been personally adopted by the late majority (as indicated by 50% to 84% total adoption using Rogers' adopter categories and normal curve). There are 8 tools that have only diffused into the innovator and early adopter categories (i.e., music composition, drafting/CAD, Toolbook, Linkway, HyperStudio, Integrated Learning Systems, robotics, and virtual reality have been adopted by < 16%) and thus are not represented in the tables. The mean score (**Ms**) is the average level of expertise reported by the whole sample, and the standard deviation (**SD**) is the amount of variability in respondent's self-rated levels of expertise. For example, respondents report having substantial expertise on average (Table 9) with both word processing (**Ms** = 3.2, **SD** = 1.07) and e-mail (**Ms** = 3.00, **SD** = 1.10), and fair to substantial expertise on average with World Wide Web searching and browsing (**Ms** = 2.60, **SD** = 1.25).

Presenting the results using individual tables for computer software and tools that have diffused into the early majority and the late majority allows for a comparison between the two. For example, one can determine from an examination of Table 8, that instructional software tools, such as tutorials, drill and practice, games, and simulations, have only been adopted by one third or less of faculty. Even though all faculty have to manage grades and maintain records for student's performance in a course, less than one half of respondents indicate they have adopted grading packages. Out of the four authoring tools in the survey, only the Macintosh-based Hypercard has diffused into the early majority.

Table 8. Percentage of Diffusion by Level of Expertise, Percentage of Total Adoption into the Early Majority, and Means and Standard Deviations of Expertise by each Software/Tool

Software/tool	**A little (1) - Fair (2)**	**Substantial (3) - Extensive (4)**	**Total Adoption**	**Mean**	**SD**
Paint program	36.9	10.5	47.4	0.90	1.11
Grading package	30.2	13.1	43.3	0.90	1.22
Online video, audio	36.9	2.6	39.5	0.60	0.88
Tutorials	26.3	7.9	34.2	0.60	1.05
Games	26.4	3.9	30.3	0.50	0.92
Simulations	17.1	6.5	23.6	0.50	1.04
Hypercard	21.1	2.6	23.7	0.40	0.78
Drill & Practice	13.2	9.2	22.4	0.50	1.06
Videodisk	18.4	1.3	19.7	0.30	0.67
Sun	13.1	3.9	17.0	0.30	0.68

An examination of Table 9 reveals that with the exception of on-line video/audio, seven of eight types of communications software (i.e., e-mail, WWW searching and browsing, on-line databases or library catalogues, FTP, listservs, gopher, and newsgroups) have diffused into the late majority and have been adopted by over 59% of these respondents.

Table 9. Percentage of Diffusion by Level of Expertise, Percentage of Total Adoption into the Late Majority, and Means and Standard Deviations of Expertise by each Software/Tool

Software/tool	A little (1) - Fair (2)	Substantial (3) - Extensive (4)	Total Adoption	Mean	SD
Word processing	14.5	81.6	96.1	3.20	1.07
E-mail	19.7	75	94.7	3.00	1.10
WWW searching and browsing	36.8	55.2	92.0	2.60	1.25
On-line databases or library catalogues	50	36.8	86.8	2.10	1.28
Text editing	25.0	57.9	82.9	2.50	1.49
Databases	52.7	22.4	75.1	1.50	1.22
Win 95	43.4	31.5	74.9	1.70	1.35
FTP	46.1	26.3	72.4	1.60	1.35
Spreadsheets	39.5	30.3	69.8	1.60	1.36
PC-DOS	44.7	25.0	69.7	1.60	1.32
Charting & graphing	42.2	25.5	67.7	1.50	1.38
Statistics package	42.2	25.0	67.2	1.50	1.36
CD-ROM materials	47.4	18.5	65.9	1.30	1.23
Listservs	39.5	25	64.5	1.50	1.44
Gopher	51.3	13.1	64.4	1.20	1.14
Macintosh	27.6	36.8	64.4	1.60	1.48
Desktop publishing	48.7	14.5	63.2	1.20	1.24
Newsgroups	39.5	19.7	59.2	1.20	1.32
Presentation software	36.9	21.0	57.9	1.30	1.37
UNIX	47.3	7.9	55.2	1.11	1.00
Web page creation	30.2	22.4	52.6	1.20	1.48
Clipart	36.8	14.5	51.3	0.90	1.20
Any programming language	32.9	18.4	51.3	1.10	1.35
Apple OS	26.3	23.7	50.0	1.10	1.35
Win 3.x, NT	22.4	27.6	50.0	1.30	1.45
Drawing program	30.2	19.8	50.0	1.10	1.35

Though they differed significantly on 38 of the expertise variables, EA and MF had similar levels of expertise for 6 of the 44 types of software and tools. Four of these variables were operating systems (i.e., PC-DOS, Win 3.x, NT, Win 95, and Sun) and the other two were for statistics packages and music composition software. It is worth noting that EAs had statistically higher levels of expertise with Apple $t(74) = 3.35$, $p < .001$ (**Ms** = 2.15 vs. 0.85), Macintosh $t(74) = 2.78$, $p < .01$ (**Ms** = 2.61 vs. 1.41), and UNIX $t(74) = 2.71$, $p < .01$ (**Ms** = 1.69 vs. 0.80) operating systems than MF.

The higher level of UNIX expertise may be partially explained by the tendency for EAs to have developed more experience using mainframe computers. One might speculate that greater EA expertise with Apple and Macintosh operating systems may be related in some way to the relative appeal of using or conducting basic research on the graphical user interfaces available in the early 1980s with this platform, in contrast to command line interfaces available on other machines, and/or the high number of education faculty in this sample.

(b) Computer Use in Classrooms

In order to examine the adoption of technology using *time* as a measure of the diffusion of innovations (Rogers, 1995), participants were asked to indicate the year in which they first used any of 44 types of computer software and tools in a course they taught. In the electronic version of the survey, participants had the option to select a “never” response. Non-responses to these items in the paper version of the survey were treated as “never” when this data was entered using the web-based survey interface.

The adoption of technology by respondents for classroom use appears to have become more widely diffused in 1997 than was the case for faculty adoption two years ago (Green, 1996). Word processing has been used in the classroom by 60% of these respondents, spreadsheets by 38%, charting and graphing by 36%, databases by 34%, presentation software by 34%, and 18% have used CD-ROM materials. A proportion of respondents use instructional courseware for teaching: tutorials 18%, drill and practice 14%, simulations 17%, and games 6%. More than one-quarter of respondents use desktop publishing software (28.9%) in the classroom, and 35.5% use statistics packages. E-mail is used by 67% of respondents in their teaching, on-line databases or library catalogues by 46%, newsgroups by 21%, listservs by 29%, and FTP by 23%. Newer communication technologies, like the World Wide Web, have been adopted by 56% of respondents for searching and browsing, and by 36% for web page creation and editing. It seems fair to suggest that communication technologies could be the proverbial carrot that entices mainstream faculty to adopt technology for teaching and learning (Foa, 1993). Tools that have been available since the 1970s, such as tutorials and simulations, are not as widely diffused in the population as the relatively newer technology of the World Wide Web. Once faculty are intrigued by tools such as e-mail and the Web, they may start asking questions about other technologies (Gilbert, 1995). Desktop instructional delivery methods may get renewed attention as faculty consider ways to use the World Wide Web for teaching and learning. Another possible explanation for the widespread adoption of the Web may be found in the features and capabilities of the software. Using graphical browsers, such as Netscape Communicator™ and Microsoft Internet Explorer™, faculty can easily display a variety of media (i.e., text, graphics, audio, video and animations) at the click of a mouse. A relationship may exist between the user-friendliness of a point-and-click, graphical user interface (GUI) and earlier adoption for teaching. An examination of adoption rates for various operating systems between 1985 and 1992 reveals that almost twice the number of respondents adopted computers with a graphical, mouse-driven interface for teaching (i.e., Macintosh 25%) than computers with a command line and keyboard interface (i.e., PC-DOS 13% and Windows 3.x 13%) during this period. Similar results are found for adoption of Windows 95 for teaching (35.5%) in the last three years. A future study may want to examine the hypothesis that early adoption of technology for teaching is related to the more user-friendly characteristics of graphical user interfaces.

Rogers' (1995) identified the segment of the diffusion curve between 10 and 20 percent adoption as "critical mass" and it represents the transition from the early adopter level of innovativeness to the early majority. Of the 44 types of computer software and tools, 29 have been used in the classroom by more than 16% of respondents (see Table 10, Classroom Use) and thus, have exceeded critical mass. Of the 29 types of software/tools that have exceeded critical mass (i.e., adopted by early majority [EM]), 3 have diffused into the late majority (LM), which means that these technologies are used by more than 50% of the respondents in their teaching (i.e., word processing 60.5%, e-mail 67.1%, and WWW browsing and searching 56.6%). In order to visually examine the late majority results using Rogers' (1995) theory, which claims that the diffusion of innovations over time resembles a normal curve (or an S-shaped curve if plotted cumulatively), the classroom adoption patterns for these tools are presented using histograms which plot the year each innovation was first used by faculty for teaching and the cumulative percent adoption curve (Figures 9, 10, and 11). Complete frequency data for the adoption of word processing, e-mail, and WWW browsing and searching for teaching is presented in Tables 11, 12, and 13.

Findings comparing faculty expertise with the year that faculty first used the software or tool in their teaching indicate that faculty tend to develop a level of personal expertise with a particular computer technology before attempting to integrate it into their teaching. Table 10 facilitates a comparison between the percentage of Total Adoption with the percentage of respondents who report having used these tools in a course they taught. For example, 96.1% of respondents indicated they had from "A Little" to "Extensive" expertise using word processing, however, only 60% indicated that they have used word processing in a course they taught. Just over two-thirds of respondents report some level of expertise with statistics applications (67.1%), but only 35.5% use this software in the classroom. More than 65% of respondents have personally adopted CD-ROM materials, but only 18.4% use these in the classroom.

Table 10. Percent of Total Adoption of 44 Types of Software/Tools by Individual Faculty Versus Percent of Adoption for Classroom Use

Software and Tools	Total Adoption	Classroom Use	
Electronic mail	94.7	67.1	LM
Word processing	96.1	60.5	
WWW browsing, searching	92.1	56.6	
Text editing	82.9	48.7	EM
On-line DBs (&/or library catalogues)	86.8	46.1	
Spreadsheets	69.7	38.2	
Charting-graphing	67.1	36.8	
WWW page creation/editing	52.6	36.8	
Macintosh	64.5	35.5	
Statistics package	67.1	35.5	
Win 95	75	35.5	
Database	75	34.2	
Presentation package	57.9	34.2	
PC-DOS	69.7	31.6	
Desktop publishing	63.2	28.9	
Grading package	43.4	28.9	
Listservs, BBS	64.5	28.1	
Win 3.x, NT	50	27.6	
UNIX	55.3	26.3	
Any programming language	51.3	23.7	
Drawing program	50	23.7	
FTP (upload, download files)	72.4	23.7	
Apple	50	22.4	
Newsgroups	59.2	21.1	
CD-ROM materials	65.8	18.4	
Clipart	51.3	18.4	
Gopher	64.5	18.4	
Tutorials	34.2	18.4	
Simulations	23.7	17.1	
Paint program	47.4	15.8	EA
Drill & Practice	22.4	14.5	
On-line video, audio	39.5	10.5	
Videodisk	19.7	7.9	
Games	30.3	6.6	
HyperCard	23.7	6.6	
Drafting, CAD	14.5	5.3	
HyperStudio	6.6	3.9	
Integrated Learning System	13.2	3.9	
Linkway	3.9	2.6	
Robotics	5.3	2.6	
Sun	17.1	2.6	
Toolbook	5.3	2.6	
Music Composition	5.3	1.3	
Virtual Reality	7.9	1.3	

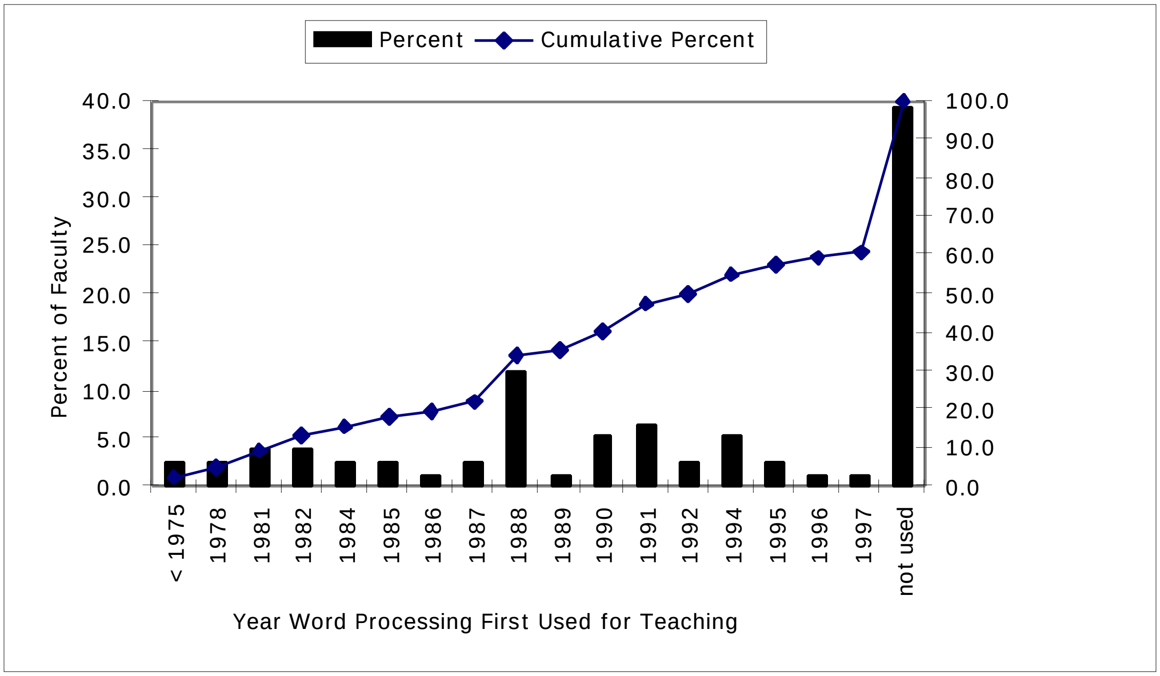

Figure 9. Adoption of Word Processing by Percent of Faculty for Teaching by Year and by Cumulative Percent

Table 11. Frequency Data for Year Word Processing First Used By Faculty for Teaching

Year	Frequency	Percent	Cumulative Percent
< 1975	2	2.6	2.6
1978	2	2.6	5.3
1981	3	3.9	9.2
1982	3	3.9	13.2
1984	2	2.6	15.8
1985	2	2.6	18.4
1986	1	1.3	19.7
1987	2	2.6	22.4
1988	9	11.8	34.2
1989	1	1.3	35.5
1990	4	5.3	40.8
1991	5	6.6	47.4
1992	2	2.6	50.0
1994	4	5.3	55.3
1995	2	2.6	57.9
1996	1	1.3	59.2
1997	1	1.3	60.5
not used	30	39.5	100.0

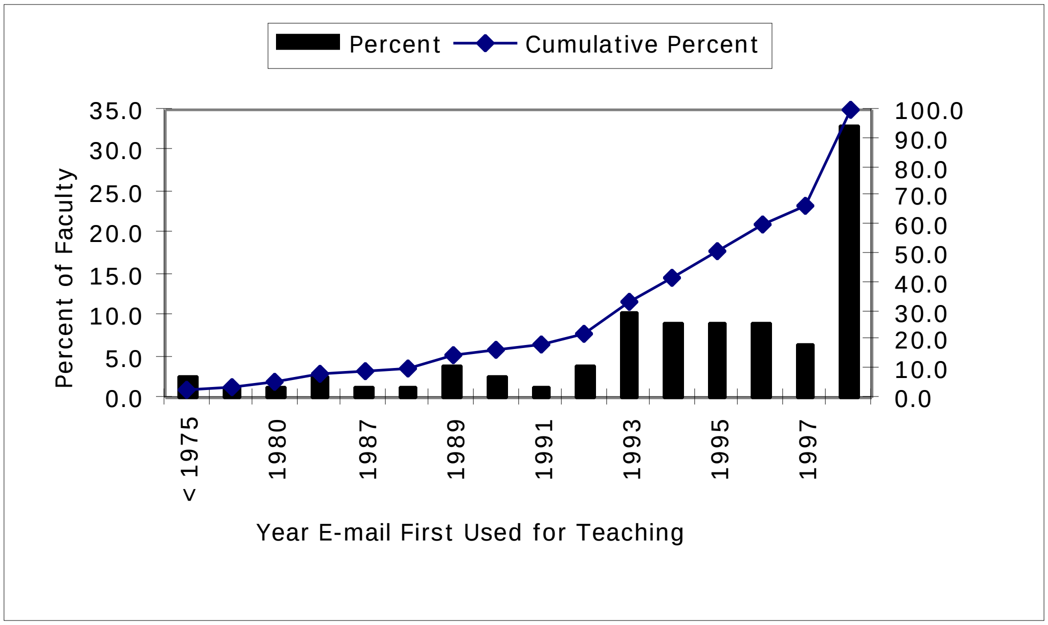

Figure 10. Adoption of E-mail by Percent of Faculty for Teaching by Year and by Cumulative Percent

Table 12. Frequency Data for Year E-mail First Used By Faculty for Teaching

Year	Frequency	Percent	Cumulative Percent
< 1975	2	2.6	2.6
1978	1	1.3	3.9
1980	1	1.3	5.3
1981	2	2.6	7.9
1987	1	1.3	9.2
1988	1	1.3	10.5
1989	3	3.9	14.5
1990	2	2.6	17.1
1991	1	1.3	18.4
1992	3	3.9	22.4
1993	8	10.5	32.9
1994	7	9.2	42.1
1995	7	9.2	51.3
1996	7	9.2	60.5
1997	5	6.6	67.1
not used	25	32.9	100.0

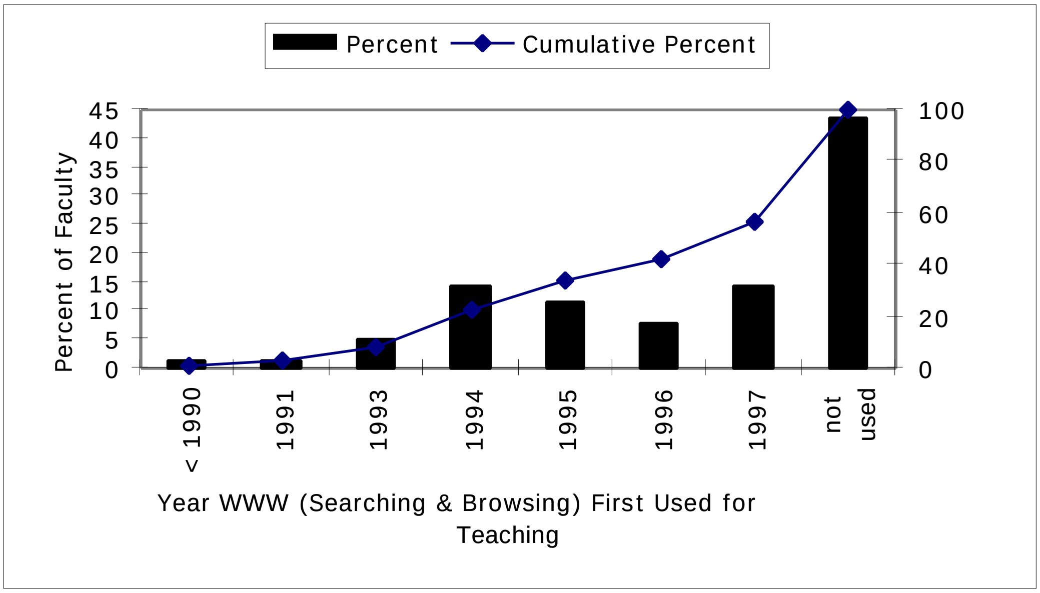

Figure 11. Adoption of the WWW for Searching and Browsing by Percent of Faculty for Teaching by Year and by Cumulative Percent

Table 13. Frequency Data for Year WWW (Searching and Browsing) First Used By Faculty for Teaching

Year	Frequency	Percent	Cumulative Percent
< 1990	1	1.3	1.3
1991	1	1.3	2.6
1993	4	5.3	7.9
1994	11	14.5	22.4
1995	9	11.8	34.2
1996	6	7.9	42.1
1997	11	14.5	56.6
not used	33	43.4	100

Adoption of Word Processing For Teaching. An examination of Table 11 reveals that 39.5% of respondents have not used word processing in a course they have taught. Faculty adoption of word processing for classroom use reached the critical mass stage (i.e., 10 to 20 percent adoption) between 1986 and 1987 when this innovation diffused from the EAs into the early majority, and diffused into the late majority by 1992. There were no statistical differences between EA and MF for the year word processing was first used in teaching, which suggests that relative advantage was high for both groups.

Adoption of E-mail For Teaching. As of 1997, 32.9% of respondents had not used e-mail in a course they taught (Table 12). However, adoption of e-mail for classroom use exceeded the critical mass stage (i.e., 10 to 20 percent adoption) between 1991 and 1992, and diffused into the late majority (i.e., greater than 50% adoption) by 1995. It is interesting to note that 44.7% of respondents have adopted e-mail for classroom use since 1993, around the year that the WWW first became widely available. It was also around this time that e-mail clients began appearing that utilized a graphical format and became easier to use, which may have facilitated more widespread adoption for both faculty and students. There were no statistical differences between EA and MF for the year e-mail was first used in teaching, which suggests that relative advantage was high for both groups.

Adoption of the World Wide Web in Teaching for Searching and Browsing. An examination of Table 13 reveals that 43.3% of participants had not adopted the WWW searching and browsing for teaching and learning as of 1997, but the critical mass stage (i.e., 10 to 20 percent adoption) was reached between 1993 and 1994 when this innovation diffused from the early adopter stage into the early majority. By 1997, 56.6% of respondents had used the WWW in the classroom (i.e., 24% of whom adopted since 1995), which indicates that this innovation has now diffused into the late majority. It is interesting to note that 48.7% of those who have used the WWW for searching and browsing in the classroom have adopted this innovation since 1994. Compared to word processing, this innovation has a relatively shorter innovation-decision cycle. That is, respondents have not taken as long to adopt the WWW for searching and browsing as they did to adopt word processing for teaching. This trend may be related to greater access to computers on campus, ease of use, the advent of graphical web browsers such as Mosaic, as well as a result of the relatively lower costs for computers. EAs used the WWW for searching and browsing statistically earlier in their teaching t (74) = 2.51, $p < .05$ than did MF. A complete summary of the 27 of the 44 types of computer software and tools that EAs used earlier than MF is presented in Appendix G.

Generalized Self-Efficacy

It has been suggested that EAs have higher self-efficacy than later adopters (Rogers, 1995). General perceived self-efficacy is a self-confident view of one’s capability to deal with most of life’s stressors. Previous research has linked high self-efficacy individuals with choosing to perform more challenging tasks, setting higher goals and the investment of more effort and persistence than individuals with low self-efficacy (Schwarzer, Mueller, & Greenglass, 1998). Self-efficacy was measured in this investigation to examine the relationship between self-efficacy and faculty innovativeness. Participants used a four-point scale (1 = Not at all true, 2 = Sometimes true, 3 = Often true, 4 = Almost always true) to indicate how well they felt each of 10 statements described them.

Descriptive results indicate that self-efficacy was relatively high in this sample (Table 14). Results from this administration of the GSES yielded an internal consistency of .91, which is consistent with other administrations of this scale. Factor analyses confirmed the unidimensionality of the scale which replicates findings from previous investigations (Schwarzer, Mueller, & Greenglass, 1998). As predicted by Rogers (1995), EAs reported higher self-efficacy than MF for three items: Item 1 t (74) = 2.12, $p < .05$ (Ms = 3.69 vs. 3.19), Item 4 t (74) = 2.00, $p < .05$ (Ms = 3.53 vs. 3.06), and Item 6 t (74) = 2.03, $p < .05$ (Ms = 3.69 vs. 3.17), of the GSES. EAs have been described as being risk takers, more willing to experiment, generally self-sufficient, and interested in the technology itself. Mainstream faculty view ease of use as critical and want proven applications with low risk of failure. Findings here suggest that EAs and MF differ in beliefs about managing to solve difficult problems if they try hard enough, confidence in dealing with unexpected events, and beliefs about their ability to solve most problems by investing the necessary effort.

Table 14. Self-Efficacy Item Means and Standard Deviations

Item	Mean	SD	
1. I can always manage to solve difficult problems if I try hard enough.	3.27	0.79	*
6. I can solve most problems if I invest the necessary effort.	3.26	0.85	*
9. If I am in trouble, I can usually think of something to do.	3.23	0.81	**
4. I am confident that I could deal efficiently with unexpected events.	3.14	0.79	*
10. No matter what comes my way, I'm usually able to handle it.	3.14	0.89	
3. It is easy for me to stick to my aims and accomplish my goals.	3.02	0.89	**
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.	2.96	0.85	**
8. When I am confronted with a problem, I can usually find several solutions.	2.94	0.86	**
7. I can remain calm when facing difficulties because I can rely on my coping abilities.	2.86	0.82	**
2. If someone opposes me, I can find means and ways to get what I want.	2.53	0.72	

*Note: * EA higher than MF, ** Paper respondents higher than Electronic respondents*

Differences were also found for method of participation. The paper group reported higher self-efficacy than the electronic group for five of the ten items in the Generalized Self-Efficacy scale: Item 3 t (74) = 2.19, $p < .05$ (Ms = 3.38 vs. 2.89), Item 5 t (74) = 2.42, $p < .05$ (Ms = 3.33 vs. 2.81), Item 7 t (74) = 2.16, $p < .05$ (Ms = 3.19 vs. 2.74), Item 8 t (74) = 2.49, $p < .05$ (Ms = 3.33 vs. 2.80), and Item 9 t (74) = 2.62, $p < .05$ (Ms = 3.61 vs. 3.09). Reasons for these differences are not readily apparent from the data. One might speculate that these differences indicate that the paper respondents, who rated these items in the context of a conventional survey method, considered the self-efficacy construct in an overall general way, as opposed to the electronic participants who may have considered the self-efficacy construct differently because of the computer context.

A one-way analysis of variance (ANOVA) was conducted using the composite Self-Efficacy score as the independent variable and gender as the dependent variable. Female faculty report higher overall self-efficacy $\underline{\mathbf{F}}$ (1,75) = 5.80, $\underline{\mathbf{p}} < .05$ than male faculty (**Ms** = 32.5 vs. 29.1) which is inconsistent with previous gender difference findings for the GSES (Schwarzer, Mueller, & Greenglass, 1998). The number of female participants was higher in this sample given projected stereotypes of gender differences in computer use, as well as higher proportions of male faculty on campus. One might speculate that female faculty, having achieved academic success in two traditionally male domains (i.e., both academic and technological), have self-confident views of their ability to solve difficult or challenging problems by investing effort, to set and accomplish goals, and to persist and remain calm with handling unforeseen situations than individuals with lower self-efficacy.

Changes to Teaching and Learning

Selected Response Items

Participants used a five-point scale (i.e., 1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree) to indicate the level of agreement with 10 statements. Table 15 summarizes the responses to these items, and presents the items in descending order from those the faculty respondents agreed with most.

Table 15. Means and Standard Deviations by Changes to Teaching and Learning Items

Item	Mean	SD	
10. Faculty will spend more time preparing materials and resources for instruction.	1.77	1.00	
1. Faculty can expect more from students in terms of their pursuing and editing their work.	2.05	0.84	
8. Faculty will spend more time acting as a guide and facilitator with individual students.	2.44	1.19	
5. Faculty are better able to tailor students' work to their individual needs.	2.48	0.95	*
3. Faculty can be more comfortable with students working independently.	2.59	1.21	
4. Faculty are better able to present more complex material to students.	2.60	1.10	
7. Faculty spends more time working with smaller groups who are pursuing project-based work.	2.69	1.02	
9. Faculty spend less time with the whole class practicing or reviewing material.	2.81	1.18	*
6. Faculty spends less time lecturing to the entire class.	3.02	1.27	
2. Faculty can spend more time with individual students.	3.10	1.18	

*Note: * EA higher than MF*

An estimate of the internal consistency of this subscale yielded a coefficient alpha of .88, which is a relatively high rating of item homogeneity and an indication that faculty responded consistently across items. While six of the high agreement items in Table 15 describe direct benefits to student learning, it is also clear that respondents do expect to invest additional time preparing materials and resources when they integrate technology into teaching and learning. Except for two neutral items, respondents appear to be in agreement with K-12 teachers (Hadley & Sheingold, 1993) about changes that result when technology is integrated into teaching and learning. Respondents appear to be neutral about technology facilitating their ability to tailor student work for individual needs and being able to spend more time with individual students, which deserves more study. However, EAs expressed statistically higher agreement $t(74) = 2.05$, $p < .05$ (**Ms** = 2.00 vs. 2.58) that "faculty are better able to tailor students' work to their individual needs" and that "faculty spend less time with the whole class practicing or reviewing material" $t(74) = 1.99$, $p < .05$ (**Ms** = 2.23 vs. 2.93) than MF. These differences may be explained by the greater amount of time needed, at least initially, by MF to integrate technology into teaching and learning. EAs may be enjoying the accrued benefits of this time investment more than mainstream faculty.

Open-Ended Responses

Two open-ended response items provided a forum for participants to discuss their ideas, offer opinions, and elaborate on the nature of changes that occur when technology is used for teaching and learning. Of the 76 participants, 70 (92%) commented on the nature of changes that occur in teaching, and 61 (80%) commented on changes to student learning as a result of integrating technology. Overall, faculty comments about changes to teaching and learning were far from neutral. The following two sections present a summary of responses by major themes which are illustrated with excerpts from source data.

Changes to Teaching. The length of responses ranged from 4 to 158 words, and were an average of 55 words each. Responses were sorted into categories in order to estimate the proportion of responses that were positive (48%), negative (28%), both positive and negative (16%), or neutral (8%) about the changes to teaching as a result of integrating technology. Responses that were both positive and negative described benefits and drawbacks, while neutral comments were those that reserved judgement, "*too soon to tell*," or indicated that there were "*few fundamental changes*."

The most immediate change for faculty is the additional amount of time needed to learn new technologies, develop new materials, resources and teaching methods, deal with technical problems, and to provide student support. More than half of the responses to this question described how integrating technology into teaching increases faculty workload, at least initially, and for a number of reasons takes more preparation and support time than traditional teaching methods. *"I spend much more time 'translating' student submissions from one electronic format to others. Technical problems often interfere with the continuity of the learning experience. When it works, it works well. When it fails, it fails miserably."* Earlier adopting faculty are probably better equipped to quickly deal with technology failures than someone who is just starting out. Although respondents strongly agreed that it takes more time to prepare for instruction using technology, as one individual explained, "*it increases preparation time in the short run (first year or two), but allows for rapid changes/updates in web materials in the long run.*" So, many respondents believe that the investment of time will eventually yield a return.

The integration of technology into a course presently requires that provisions are made for student access and training. *"Every professor who does this has to ... tutor students whose skills are not on a par with average students ... (It is) somewhat easier to integrate ideas across the curriculum, but the <u>faculty time involved is still a serious impediment."</u>* Technology may enable faculty and students to communicate ideas and exchange files over a network, but these capabilities still require a great deal of support: "... *class and personal contact time has had to be spent giving students basic technology skills, such as how to send and receive electronic mail, download a file using FTP, etc.. The current group of students (Feb. 98) is the first cohort I have dealt with in which no one requires such instruction.*" Student access and training issues may represent a short-term trend; as more students encounter computers in primary school and own a computer at home, there may be less pressure on institutions to provide on-campus access and less need for professors to teach basic computer applications skills.

A number of respondents described teaching situations that might benefit from a computer-based solution or increased computing resources on campus. For example, *"...lecturing is more fun with a wider range of ways to present information. I can see it getting a whole lot better if I were to find a package that allowed me to integrate a variety of media and to access it via my computer, rather than having to load and run a laser disk, then cue up a video tape then find a transparency all while maintaining a strong narrative flow in the lecture.*" The next individual has realized personal benefits from using technology, and would likely adopt computers for classroom demonstrations if appropriate resources were available. *"I am personally able to access a wider range of resources via the internet, WWW, etc....I would also be able to demonstrate certain specialized techniques of analysis to a larger classroom of students if the technology were available to me on this campus."*

A number of respondents are very enthusiastic about the benefits of using Internet applications for instructional delivery, support, and or for making course materials and resources available on-line: "*In a technology-delivered (in my case, Web-based) course, interactive materials posted for the students to engage with freed my time as instructor for more mentoring and facilitation of learning*." A number of individuals also mentioned that instruction is becoming more flexible, and less time and location dependent, as a result of the Internet: "*Students are able to participate in internet courses at times that are convenient to them and from a variety of locations*." Respondents report using listservs and newsgroups to participate in international discussions with colleagues about integrating technology into their teaching, collaborating with peers at other institutions for course development and delivery, using of a wider array of media (through CD and WWW formats), and also sharing more of their own work with students. "*I believe that computers open a new means of communication with students...allow the instructor to generate specific material for the course they teach...customize material to individual student needs. The instructor may spend less time with the students individually, but can still interact with many students through e-mail and discussion groups*." A number of respondents believe they can provide more up-to-date information for their students using the web and other electronic databases. Several respondents commented on the importance of evaluating the credibility and usefulness of web sites and how this skill, along with effective searching strategies, were necessary for efficacious use of the web.

Faculty comments provide evidence that the integration of technology supports a shift from a primarily "knowledge-transfer" mode of content delivery to a more "knowledge-construction" type of teacher-student interaction. An individual described how CMC (i.e., computer-mediated communication) is "*...a strong move away from teacher-centered towards student-centered teaching strategies/styles...*" and enables this instructor to be "*more responsive to individual students' learning goals/needs*", offer "*more cooperative and collaborative learning assignments which create a more cooperative and collaborative learning environment*" and that students participate in "*overall more dynamic 'discussions' in terms of level and content*." Others described how there are increased opportunities, using tools such as the web and e-mail, to encourage collaboration between students and to accommodate student-driven initiatives.

While some respondents worry about a shift in focus from the content to the tool, others describe ways in which they have woven the use of technology into their courses: "*...I have embedded the need for certain kinds of computer literacy into the courses that I teach ... the majority of readings for one graduate course are documents from the Internet. In another course, we take virtual field trips to visit and discuss certain sites, which requires a degree of literacy ...written products and projects in most courses require that students produce professional quality material and this means thinking through how to* *desktop publish the submissions...also, with the growth of educational stuff on CD's, I have found it necessary to include access and examination criteria for many of these resources. I have also had to focus on the simple question of how to best access these resources and use them in a classroom teaching situation (K-12)."*

While the majority of responses are enthusiastic and positive about technology, it is also very clear that some respondents regard the changes that come with technology as negative. In addition to voicing concerns about workload, training and support, and communication issues, some respondents do not believe the benefits are substantial enough to justify large investments of time and resources in technology. The following comment summarizes many of these concerns, as well as expressing frustration about the mismatch between faculty and administrative expectations, the rate of technological developments, and tensions between service and instructional staff: *"I have observed increasing resistance by Faculty to technological innovations in teaching, which replaces a previous attitude of indifference. Part of this antipathy relates to the timing of institutional expectations for the integration of technology coinciding with budget reductions and more work and stress for individual academic staff members. There is no time to learn. Part relates to the lack of support for learning and using technology, for hardware, software and training. The pace of innovation is also a problem. The institutional waffling on projects such as the Evergreen Project doesn't help - do we get up-to-date hardware regularly or do we not? The bureaucratic in-fighting at UCS is a nightmare and all one can do is stay far away from using their services*." Mainstream faculty are frustrated by the lack of support for their increased training needs, and sense more than just an experience gap between those who have adopted technology for their teaching, and those who have not: *"I have greater 'just in time' learning needs which are not met and thus more frustration about lack of support and resources at my campus. <u>A great gap of communication and collegiality between those who try to use and learn technology, those who do not, and those who are technology experts</u>."* There are also those faculty who are discouraged by what they regard as the *"...attempt to stuff technology into places that it isn't necessary...the emergence of a bunch of courses, graduate and undergraduate, that purport to teach theoretical content, but only teach technical school level computer programming and application skills...,"* and the concern that *"...some instructors are using the new technology effectively - but actually very few. There is no incentive or time set aside for instructors to learn to use them - they do it only if they have a specific interest. Until the performance contingencies changes and the time needed to learn to use the new technologies is provided, and the resources for appropriate support (technical personnel and hardware & software) the use of technology* *will continue to be implemented piece meal and with little to no coherence across the University*."

For many respondents the jury is still out on whether there are great gains to be made from investments of time and resources on integrating technology for teaching. *"I find I'm spending more time on computers than ever before, and don't necessarily find that it improves content - since we still, fundamentally, are dealing with teaching of concepts and strategies. Where computer-based technology, to a limited degree, has proven useful is in preparation of teaching aids (whether overheads, simulations, etc.) and in creation of communication technology. So, for example, I have taught distributed courses using both Internet technology, and video-conference technologies, both of which are essentially computer driven - hence, reaching more students over greater distances. But, in my view, computer technology is still in the 'promising' stage, and hasn't really arrived yet in fulfilling its promises."* It seems clear from the nature of these responses that there is a gap between faculty who are experiencing success with their integration efforts, faculty who are discouraged by the limited returns on time invested, and those who believe that technology is not the answer. All of these different perspectives must be included in a consideration of campus-wide plans for continued and future integration of technology.

Changes to Learning. Responses from faculty about changes to learning ranged from 4 to 191 words in length, and were an average of 45 words long each. The distribution of responses by category was similar to those for the previous question, which suggests that respondents also hold strong opinions about the impact of computers on learning. A large proportion of respondents wrote comments that were positive (49%) about changes to learning as a result of integrating technology, one quarter wrote comments about negative changes (26%), some comments were both positive and negative (13%), and some were neutral (12%). Responses that were rated as positive and negative described both costs and benefits, while neutral comments usually indicated that there is insufficient evidence about changes to learning.

Faculty who advocate the integration of technology cite a variety of learning benefits for students: (1) access to a wide variety of resources through the Internet, (2) opportunities to communicate in real time or asynchronously with instructors, peers, and experts around the world, (3) better writing and presentation skills facilitated by applications such as word processing, desktop publishing, spreadsheets, and presentation software, (4) improved learning of difficult subject matter as a result of the increased practice time, unlimited repetition and automated feedback features of computer assisted learning, and (5) participation in a new, on-line publishing medium: "*Students are learning how to create web-sites, which have the possibility of synthesizing knowledge related to* *the content areas being worked on*." In addition to these learning benefits, some faculty believe that becoming comfortable with technology and learning how to solve problems are valued outcomes: "*Introducing technology into the classroom helps students unfamiliar with it to both learn its use and increase their comfort level with its use. As something always goes wrong in my experience in the classroom, the instructor's dealing with technical problems is also beneficial modeling for the students*." Respondents are also positive about the increased opportunities for a different population of students through distance education: *"...students who previously were denied education because of distance, parental status, employment now have the opportunity to pursue studies."* Although they admit the increased volume of e-mail communication takes more time than campus office hours, some faculty believe that this technology increases their opportunities to communicate with students. However, other faculty believe that students sometimes use e-mail for inane and inappropriate questions, and this is an unproductive use of their time. Strategies for using e-mail effectively with large classes are discussed by early adopters in the cases reported in chapter 5.

The benefits that faculty associate with using computers for learning do not appear to be universally available to students. There are probably a number of reasons why some students are able exploit the potential of computer-based tools, and others are not. First, some faculty believe that the level of prior computer knowledge and skills may alternately advantage or disadvantage students. "*Students who can use but do not understand the principles of computing technologies often get frustrated by technical challenges and this deflects their learning. When a student does understand the principles, the learning can be very greatly enhanced."* Other faculty also comment on the "have-nots" and the additional workload these students face in a course that requires the use of computers. "*Currently there is a broad range of experience students bring to computer work. Some students have little experience and therefore adding computer work adds a further obstacle to their learning the discipline material."* Second, using technology for learning appeals to some students, and not to others: "*Some of my graduate students are frustrated when I ask them to try to use new technological tools...those who have an open mind and flexible learning style like using technology enhanced instruction; others do not and resent the demand on their time to change. Some of the more shy and quiet students blossom in terms of their learning when technology is introduced."* The previous comment suggests that computers may appeal to those with an open and flexible approach to learning. In the previous section, faculty described some of the fundamental changes that technology integration seems to both enable and require of teachers and learners. Thus, integrating technology may create barriers for students who prefer a more traditional approach to post-secondary teaching and learning: "*I still struggle with students who are conditioned to a system of grades and dependency ...who are reluctant to take responsibility for their own learning. However...a small number of students do seem to be catching on to the idea that they are in charge of their learning and willingly take risks*." There appears to be a number of reasons why some students can fully participate in computer-based, or computer-assisted, learning opportunities.

Although communications technology may provide increased opportunities for some students to pursue post-secondary studies, faculty opinions vary about the effectiveness and potential learning outcomes from this method of course delivery. *"Students miss personal contact and their dedication to a technology-based course seems to be lower than it may be in a face-to-face course. An 'integrated' course that permits personal exchange between instructor and student 'as well as' use of technological resources is a better way to go."* Some faculty are willing to give up the personal contact between teachers and students because of perceived gains in the quality of learning. *"Although most students say they miss the teacher/student contact when they participate in computer-based instruction or internet courses, I find the discussions on listservers between students are far superior (i.e., more in-depth, longer discussions, more theoretical, more participation, etc.) when compared to in-class group discussions."* Though some students appear to be dissatisfied with the reduced faculty-student personal contact in a distance course, some faculty feel that students are actually more successful at participating in electronically mediated discussions.

Respondents described what they believed to be some of the negative impacts of technology on students and learning: (1) limited access to technology frustrates and disadvantages some students, (2) insufficient lab resources on campus, (3) the use of technological resources as a substitute for class attendance, (4) decreased writing and reasoning ability, (5) hours of wasted time fighting with technology, and (6) emphasis on the medium rather than the message. In contrast to those who believe that students' writing and presentation skills are improving, one faculty member wrote that *"...student writing skills seem to be deteriorating - they may be learning to use the spell check facility, but have less capability in syntax and, often, in reasoning capability..."* and another is concerned that "*...graduate students (are) focusing more on the technology, which could be done by low-level clerical staff, and less on the theoretical bases of their disciplines*."

Finally, there is a concern that a wholesale reliance on the Internet and other electronic resources for access to information and post-secondary learning will actually impoverish students: *"...hard copy library resources have been cut back with economic restraints, but we don't yet have equivalent electronically available content - leaving* *students frustrated with their inability to access needed resources for their research*." The following comment summarizes concerns expressed by a number of faculty about the quality of information available electronically, student's ability to critically evaluate and use this information, beliefs about the role of technology in the delivery of instruction, and the impact on student learning: *"Students are accessing the WWW with greater frequency. While it can be a good source of initial materials, I feel that students are losing the ability to conduct sound research. They do not know how to utilize library reference systems and to find primary sources of information in the library. In addition to an inability to function in a library, they seem to have the misconception that WWW information is APPROPRIATE referencing material. The availability of CD ROM technology, computer listservs, and other 'distance-learning' mechanisms scares me. I still believe there is great value in the 'lecture' method of learning. While these technological advances should be used to ENHANCE learning or to provide auxiliary sources of information (optional courses, etc.) to students who cannot attend those courses at their own university, it should NOT be the primary method of learning. A student with a CD ROM degree is going to be LESS qualified for a job in the human workplace than one with a traditional 'lecture-seminar' degree."* It is clear that a number faculty are strongly opposed to integrating technology in general, and regard the shift towards more technology supported instructional opportunities as a negative development in higher education. A number of faculty preferred to reserve judgement on the impact of computers on student learning citing the lack of sufficient evidence for gains when compared to conventional approaches.

Depending upon the purpose or agenda of a particular group or individual, it would be tempting to report only the positive or negative beliefs expressed by faculty. However, when discussing the changes to teaching and learning as a result of integrating technology, it is important to solicit and report the opinions and beliefs of faculty from across disciplines who have a range of experience using computers. It is important to invite both advocates and those opposed to discuss, assess, and evaluate both the perceived benefits and drawbacks in order to make informed decisions about on-going integration efforts.

Incentives to Integrate Technology

Selected Response Items

Given the time and effort required to integrate technology into teaching, different reasons tend to motivate and keep faculty engaged with this task. Participants used a five-point scale (i.e., 1 = Strongly Agree, a major incentive, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree, not an incentive) to indicate the extent of their agreement with 12 items. An estimate of the internal consistency of this subscale yielded a coefficient alpha of .88, which is a relatively high rating of item homogeneity and indicates that faculty responded consistently across items. The first 3 items in Table 16 emerged as the most important incentives for respondents, followed in descending order by the remaining items.

Table 16. Means and Standard Deviations for Incentive Items

Item	**Mean**	**SD**	
5. I get personal gratification from learning new computer knowledge and skills	1.80	0.84	
1. Computers are a tool that help students with learning tasks, such as writing, analyzing data, or solving problems.	1.82	0.98	
8. By integrating technology, I am helping students to acquire the basic computer education they will need for future careers.	1.92	1.01	**
11. Technology tools enable students to help each other and cooperate on projects.	2.22	0.97	
3. Computers enable me to make a subject more interesting.	2.28	0.97	**
6. Computers provide a means of expanding and applying what has been taught.	2.30	1.03	**
7. Computer tools enable me to communicate and interact more with students.	2.34	1.17	**
9. I enjoy figuring out how to use computers effectively for a variety of teaching situations.	2.36	1.14	* **
10. Computers provide more opportunities for gifted students.	2.57	1.08	
2. Students are enthusiastic about the subjects for which they use computers.	2.65	0.91	**
12. Computers provide an environment that appeals to a variety of learning styles.	2.65	1.10	**
4. Technology tools enable me to better diagnose learning problems.	3.22	1.10	

*Note: * EA higher than MF, ** Electronic respondents higher than Paper*

While four of the five highest rated incentives have to do with providing enriched learning opportunities for students, the number one incentive for integrating technology is the personal gratification a faculty member gets from learning new computer knowledge and skills. EAs expressed statistically higher agreement **t** (74) = 2.72, **p** < .01 (**Ms** = 1.61 vs. 2.52) that they enjoy figuring out how to use computers effectively for a variety of teaching situations than did MF. The greater enjoyment that EAs experience figuring out how to use technology in teaching may be related to the incremental amount of time needed to add to their existing repertoire of computer knowledge and skills, and the greater success they may already have experienced using technology in their teaching. It seems fair to suggest that MF have to invest more time than the EAs to develop a repertoire of computer knowledge and skills, as well as investing time figuring out how to integrate technology into their teaching. Therefore, the greater amount of time needed by MF for these two tasks may not translate into the enjoyment that EAs experience experimenting with technology.

Open-Ended Responses

An attempt was made to differentiate between internal and external factors that make the integration of technology appealing to some faculty and not to others. Two open-ended response items provided a forum for respondents to discuss the intrinsic motivators and extrinsic incentives that encourage them to integrate and use technology in their teaching tasks. Of the 76 participants, 54 (71%) used this part of the survey to describe what motivates them to integrate technology into teaching and learning, and 66 (87%) described the incentives. Responses to the two questions were often interrelated and overlapping. Responses ranged from 1 to 230 words, and were an average of 34 words in length. The following two sections present a summary of faculty responses by major themes which are illustrated with excerpts from the source data.

Motivators. Respondents described a number of motivators that were not addressed by the 12 items in subscale 7. In addition to describing the current state of affairs, the following summary also addresses the motivators that might encourage non-adopting faculty to begin integrating technology into teaching and learning.

Many of the reasons that respondents are motivated to use technology in teaching are directly related to improving student learning and satisfaction. Some faculty believe that technology helps them to better communicate difficult ideas, improve their presentations, engage students in the learning process, and help students to acquire skills and competencies they will need in their future careers. A few of the respondents indicated that the favorable reaction by students, both in the classroom and as indicated on student ratings of faculty, are important motivators for using technology. A number of respondents described the changed learning environment and their changed teaching role as positive motivation for integrating technology. One faculty member described their *"personal compatibility with the role of 'facilitator' (i.e., resource person and 'learning guide') that is required on-line as opposed to 'teacher as expert' that has been the key role in traditional face to face classrooms*", while another faculty member describes how *"...technology allows the focus to be taken off a teacher-centered approach to a learner-centered approach."* A large number of respondents described the ability for both students and themselves to communicate with others all over the world as an important motivator. *"The capability to give students access to communities with similar interests without geographic constraints, to facilitate collaborate and group learning."* One individual believes that entertainment value of computers is an important part of the educational process of today's "screenagers".

There are a number of personal reasons that motivate faculty into using technology in their teaching. Some faculty are motivated by the sheer enjoyment of learning new things about technology, *"I like to learn new things, this happens weekly (if not daily) when working with computer technology,"* while others describe the technology itself as fun and easy to use. A number of respondents indicated that they enjoy learning about new ways to engage students in their discipline, while others adopt technology because it is a time saving device (i.e., increased personal efficiency, calculating grades, editing course notes and student handouts). One faculty member described how important it was for academic staff to continue developing their own skills to keep themselves marketable.

Integrating technology is a challenging and time consuming task. A number of respondents described the importance of informal recognition and support from colleagues and their department as being a motivator for using technology in teaching. One individual wrote that is was motivating to get "*...some slight attention for being an innovative teacher, but this is offset by increased work and the difficulty of maintaining good student ratings when one never manages to master a delivery or a method in the face of constant change*." Another person said they were very motivated to use technology in their teaching when they observed a colleague experiencing success.

A number of respondents indicated that there are very few or no motivators on campus or in their department to use technology in their teaching. However, some respondents also described the conditions that *would* provide a motivating environment for integrating technology in their teaching: (1) release time to develop their own technology skills and on-line resources (i.e., Web-based courses and support materials), (2) better student access to up-to-date hardware and software, (3) small start up grants or financial support to purchase equipment, (4) technical support on a timely basis, (5) inexpensive and convenient training opportunities, (6) recognition of time and effort required for technology-based teaching at annual report time, and (7) evidence that technology improves teaching and learning. A number of respondents are not convinced that technology adds any value to student learning over conventional methods of teaching, and would prefer to see proven methods before adopting.

A few respondents described what is demotivating about the current conditions on campus. For example, *"There is no point in requiring students to be in a course that has a large computer requirement when they do not own their own computer and it takes them three to four hours to get onto the campus computers because of overuse by thousands of students."* In order to advance their career, faculty must make decisions about allocating their research, teaching and service time. It only makes sense that that which gets rewarded will receive the most attention: *"The systemic advancement and institutional incentives have tended to lag seriously behind here, so I have found that a relatively small percentage of the professoriat ventures into CAI - only because the pedagogical and professional* *gains, for them, outweigh the risks."* While it is clear that some faculty have chosen to adopt technology for their teaching tasks despite the lack of external reward or recognition, other faculty will not.

Incentives. A number of faculty submitted responses that elaborated upon the incentive items presented in the survey. First, there is clearly a gap between the convinced and unconvinced with regard to the value that technology can add to the classroom. For example, the following faculty members have applied technology as a targeted solution, rather than a panacea for all teaching: *"I am convinced that I can provide a better introduction to complex subject matter using interactive, computer-based technology than I can using either the traditional classroom or any paper-based medium,"* and *"Certain information can be presented much more effectively with the use of new graphical programs...in my field, I have used the computer to display molecular modeling images that can be rotated to provide a 3-dimensional impression. I think this imparts a more intuitive and easier understanding of some of the molecules we study."* Some respondents remain unpersuaded about the potential contribution that technology offers to the learning environment: *"To be perfectly honest, I am resisting the entire idea that a lot of technology should be integrated into teaching the kinds of things I teach. I use communications technology because it allows communication outside of 'real time' constraints but fancy CD-ROM stuff would be icing on a cake not the meat and potatoes of the courses*." Others are strongly opposed to using technology without external pressure: *"I only adopt technology if I am a) forced to (my preference, I would now avoid use of e-mail with large classes if I could, but my department won't let me or b) I am convinced that it saves my time and my students' time and enhances teaching/ learning."* Faculty opinions about the role of technology in their classroom clearly differ. Some respondents see the value of technology for enhancing specific learning outcomes, while others appear to be waiting for conclusive data that the use of technology is clearly superior to what they are doing now. The "insufficient data" gap may be somewhat one-sided, and may be related to who has first hand knowledge of what technology *can* contribute to specific teaching methods and learning outcomes, and who does not. Those who do not have first hand knowledge may be defending their non-adoption decisions with a claim that there is no evidence of successful applications of technology for teaching and learning. It may also be the case that many faculty members have decided that current barriers which impede the integration of technology are too high.

Second, a large number of respondents have been attracted to using technology in their classrooms because of tasks and operations that computers perform more efficiently than previous methods. For example, *"...one can simulate complicated phenomena using a* *computer - this allows for more sophisticated demonstrations and provides insight into physical processes not otherwise accessible."* Some of the benefits of using computers appear to be discipline-specific: *"I teach applied mathematics. In some areas technology is indispensable in others useful. When I integrate technology it is done as an extra to the course and is usually to allow the students to tackle more realistic problems by relieving them of the task of performing mundane arithmetical or algebraic computations*." Some respondents have leapt past the printed page/overhead/slide stage, and use the web as an all-purpose resource to facilitate in-class presentations and distribution of materials. The incentives for one instructor to post course handouts to a webpage are: (a) access simultaneously to many students, and (b) the ease of linking to other sources of information for students who are interested in extending their understanding of course concepts. A large number of respondents enjoy the increased ease of communicating with their students using e-mail, rather than relying on office hours and the telephone. For someone who is a non-adopter or relatively new adopter of technology, it would be harder for them to imagine the real and potential benefits that computers can offer an individual or a classroom. Thus, the attributes and applications of computers may not be as important an incentive.

Third, the pure enjoyment factor seems to really appeal to some respondents who like using technology and figuring things out new ways to apply technology to their teaching. These individuals have realized personal benefits of using computers, and seem to want to extend these benefits to their students. *"I just plain like (technology). It coheres closely with the content of my courses. I hate typing and depend heavily on the delete key rather than a bottle of whiteout (I don't mean this to be flippant--it really is a motivator). I like students to be able to share their projects with each other, not just me."* For many respondents an additional incentive to integrate technology is the belief that the need for technology expertise will increase in the future. *"I enjoy working with the technology and have seen the difference that using technology has made for my own work. I believe that professionals now and even more in the future need to be very competent with technology. We have a responsibility to prepare them for this as much as we can."* In addition to the campus-wide recognition that computer science and software engineering graduates will be in great demand (Urquhart, 1998), many respondents advocate increasing computer competencies amongst all graduates, for example: *"I firmly believe that the more knowledge and skills a person has with computers will aid them in finding a job at the completion of their schooling."* Thus, the incentive to integrate for some respondents is based upon the enjoyment they experience using computers and the belief that having computer knowledge and skills is an advantage to students who are seeking employment.

An important incentive for many respondents is the belief that integrating technology helps them to become a better teacher. *"I like the flexibility of teaching a course on the computer. I find the students in my computer courses very motivated and excited about the prospect of working on the computer. I can be creative when using the computer and develop a variety of activities to challenge and motivate my students."* The following faculty member believes that computers are a catalyst for personal creativity: *"Computers seem to expose a creative or artistic vein in me. This is a diffuse but very powerful incentive. The power of word processors and grade-sheet spread sheets to manage class related clerical duties has simplified my work, reducing enormously my need to manage workflow through others (e.g., secretary, teaching assistants)."* Many respondents believe that technology not only helps them to increase their own efficiency, but it also helps them to make material more interesting to students which helps them to learn.

Fourth, there are faculty who are hesitant about rushing into widespread adoption of technology without a careful examination of the costs and benefits, the successes and the failures, and the intended and unintended outcomes. These "reflective observers" are justified in their call for <u>more</u> assessment and evaluation of the impact of technology on teaching and learning: *"I feel that current technology can be of immense value in enhancing our teaching and student learning. I worry, though, about the lack of critical commentary concerning the problems associated with our bland acceptance of technology. We shouldn't just accept technological innovations; rather, we should evaluate them for their impact on learning. Not all innovations are productive and not all information we take off the internet or WWW is valid or worthwhile."* It is important to balance the enthusiasm of EAs with the hesitant acceptance of others as institutions develop plans for more widespread adoption of technology for teaching and learning, and develop strategies to better assess and evaluate the outcomes of technology integration efforts.

Finally, the incentives for some faculty seem to based upon a desire to see technology used effectively for learning without disadvantaging students or reducing the overall quality of a post-secondary education: *"I am fundamentally motivated by a fear that others will use technology badly (that is, to foster a more efficient delivery of information with no real attention to learning issues). I do what I do as a kind of counter-resistance. I guess my motivation is somehow political in that I am most concerned that technology (might) serve to increase social inequity and/or to justify a lesser education for the underprivileged."* It may fall to the collective efforts of a number of faculty to guard against the implementation of technology for purely profit driven reasons, such as to increase access, while increasing awareness of the teaching and learning issues.

Barriers to Integrating Technology

Selected Response Items

Many faculty are highly motivated to integrate computers for teaching and learning. Although many have developed impressive personal expertise and have adopted computers in their classrooms, to a greater or lesser extent, all faculty experience barriers when they attempt to integrate computers in their teaching. Participants used a five-point scale (i.e., 1 = Strongly Agree, a major barrier, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Disagree, not a barrier) to indicate the level of their agreement with 20 barrier items.

Table 17. Means and Standard Deviations for Barrier Items

Item	Mean	SD	
1. Faculty members lack enough time to develop instruction that uses computers.	1.50	0.82	
2. There are problems scheduling enough computer time and/or resources for different faculties' classes.	1.78	0.89	**
10. Financial support for computer integration from administration is inadequate.	1.80	0.86	
5. There are too few computers for the number of students.	1.86	0.94	**
12. There is inadequate financial support for the development of instructional uses of computers.	1.88	0.93	
4. The reward structure does not recognize faculty for integrating computers for teaching and learning.	2.06	1.26	**
11. There is not enough support for supervising student computer use.	2.19	1.03	
7. There is a scarcity of printers and/or other peripherals in order to effectively use computers for teaching and learning.	2.34	1.11	
17. There are too few training opportunities for faculty members to acquire new computer knowledge and skills.	2.39	1.16	
6. There are too few computers for individual faculty.	2.44	1.26	
9. There is limited research literature that shows significant improvements in learning as a result of computer integration.	2.52	0.94	
20. There is no recognition for using computers for post-secondary teaching and learning.	2.53	1.18	
3. Hardware is unstable and always breaking down.	2.64	1.04	
16. Computer manuals and materials are inadequate and unhelpful.	2.65	1.09	
8. There is not enough time in the course schedule for computer related instruction.	2.73	1.33	
14. I am unsure how to effectively integrate computers into instruction.	2.84	1.37	*
13. Faculty members are not interested in using computers for instruction.	2.90	1.09	
15. Available software is not adaptable to my instructional needs.	3.03	1.17	
18. There is less control over classroom instruction when using computers.	3.40	1.08	**
19. Computers do not fit the course or curriculum that I teach.	3.46	1.32	*

*Note: * EA higher disagreement than MF, ** Electronic respondents higher agreement than Paper respondents*

An estimate of the internal consistency of this subscale yielded a coefficient alpha of .87, which is a relatively high rating of item homogeneity and indicates that faculty responded consistently across items.

The first six items in Table 17 describe barriers that most respondents agreed or strongly agreed were impediments to integrating technology on campus, followed by the remaining items in descending order. Respondents agreed with 17 of the 20 items that Hadley and Sheingold (1993) found to be barriers that prevented or discouraged classroom teachers from integrating technology into their teaching. The mean responses appear to indicate that respondents are neutral about 3 items (i.e., 15, 18, and 19), however, the high degree of variability in responses indicates that faculty agreement is widely dispersed. More than one-third (38.2%) of respondents disagree that available software is not adaptable to their instructional needs (Item 15), 40% disagree that there is less control over classroom interaction when using computers (Item 18), and 57.9% disagree that computers do not fit the course or curriculum that they teach (Item 19). The responses to these three items suggest that post-secondary instructors may regard technology as more adaptable to their needs and a better fit with their courses than K-12 teachers. Additionally, one might expect that post-secondary and K-12 teachers view control over classroom interaction differently. The EA and MF groups differed in their responses to items 14 and 19. EAs expressed stronger disagreement $t(74) = 3.86$, $p < .001$ ($Ms = 4.07$ vs. 2.58) than MF that they were unsure how to effectively integrate computers into instruction. EAs also expressed stronger disagreement $t(74) = 2.12$, $p < .05$ ($Ms = 4.15$ vs. 3.31) than MF that computers do not fit the course or curriculum that they teach. It is interesting to note that EA and MF did not differ on item 17 about adequate training opportunities for faculty to acquire new computer knowledge and skills.

Open-Ended Responses

In response to a request to elaborate upon barriers that may prevent or discourage faculty from using technology in their teaching tasks, 61 (80%) of the 76 participants submitted responses that were on average 55 words long and ranged from 3 to 390 words in length. The following section presents a summary of faculty responses by major theme which are illustrated with excerpts from the source data.

Overall, the barriers that may prevent faculty from integrating technology seem to be related to inadequate infrastructure, perceived lack of administrative support and recognition, personal/internal reasons, lack of time, and lack of evidence about improvements over conventional methods. First, a large number of respondents described infrastructure-related barriers, such as buildings not being wired for computers, insufficient hardware and software resources, poor projection capabilities, and poor lighting, that make the integration of technology by individuals difficult. For example, *"most of the rooms have inadequate lighting control for computerized presentations. Most of the rooms are not equipped with the hardware and projection capabilities so one needs to extensive support from technology units and Comm-Media to even make a presentation possible."* One faculty member indicated that separate department budgets for infrastructure lead to barriers for individual faculty: *"...technical support, software support, budget control, etc. are each managed separately, focusing on local concerns, hence integrating the various administrative entities to support classroom teaching is a nightmare."* A number of respondents believe they should not have to invest personal resources to acquire the hardware and software necessary for integration: *"The only way I've been able to get technology on my desk is by buying it, either out of my own pocket or out of $$ I've earned through extra stipends of various kinds. Usable technology should be supplied by the university in the same way it supplies desks."*

Second, a majority of respondents located the barriers to integrating technology in administration. Several respondents suggested that the importance of research over teaching in annual merit reviews creates a barrier to integrating technology for teaching and learning. *"Faculty are negatively rewarded for using technology in their teaching (i.e. spending time developing a CAI program is NOT given the same credit as equivalent time spent pursuing/publishing research in the discipline."* Some respondents indicate that there is a *"...lack of recognition that teaching via computer (i.e., CMC) takes more time than teaching face to face and therefore should translate into lower teaching load expectations."* One faculty member's comment suggests that *"the barriers are not specific to computers but are the general lack of any reward whatsoever for effort put into teaching excellence*." Another individual makes a case for the relationship between undervaluing teaching and integrating technology: *"Good teaching is not valued very highly in the University reward system. Computers may contribute to good teaching. Thus the University does not explicitly reward this use. Hence, you do a lot of it on your own time."* A colleague corroborates the belief that *"everything has to be done as an 'extra' over and above an increasingly heavy teaching, service, and research workload. Lack of reward is less of problem, but when prioritizing tasks, it is a factor."* In general, these respondents believe there is insufficient administrative and institutional support for quality teaching, and that there are few rewards or recognition for using technology in particular. However, to be fair, the apparent lack of emphasis on teaching cannot be blamed entirely on the institution. There are a number of faculty who place a higher priority on their research than on teaching. *"My primary occupation (and interest) is research. I have limited time to devote to teaching and as a consequence it is difficult for me to find the time and energy to devote to* *radically changing the format of my teaching."* One has to wonder, if there was a sudden increase in rewards and recognition for teaching excellence and early adoption of technology by the institution, whether there would be a similar increase in faculty efforts to become better teachers and to integrate technology into teaching and learning.

Additional barriers are related to the institutional support system for technology use and integration for teaching and learning. It often appears that academic staff and support staff may be working against each other rather than towards common goals. One individual suggested that, *"there is a lack of communication between the support staff who care for the technological infrastructure and the academic staff who are the human infrastructure. Once you become familiar with ways of doing things, the technicians change things so you feel you are back at the beginning. For example, the printing process ... changes often, but nobody knows until they go to print a document and it won't work. When you try to get help, you are told the new way of doing things. Even faculty who are experienced with the network have trouble printing documents sometimes...so, even when you are trying to do regular tasks, like print a letter or a paper, you encounter technical difficulties. How are we supposed to feel confident using something more complicated in our classes?"* The communication gap between the "teachies" and the "techies" appears to extend to campus computing support systems beyond the individual department or faculty. According to some respondents, the "techies" speak a different language than newcomers: *"Staffing help desks with computer whizzes who cannot communicate is a futile exercise whose main effect is to raise frustration levels and lead us to delay rather than speed up implementation."* It seems clear that academic and support staff suffer from inadequate methods for handing off expertise to each other. Another faculty member described the difficulty of communicating with staff in the on-campus computer store: *"...I have listened patiently to all of the reasons why you cannot help me, can you please direct me to somebody who can help me?"* It seems likely that EAs, who have greater expertise with technology, can communicate more effectively with the "techies" or have less need of external support systems than the mainstream. The difficulty that many mainstream faculty experience attempting to communicate with the "techies" increases their frustration with technology and may lead to discontinuance or rejection.

A common explanation for limited adoption was the sheer amount of time it takes to learn how to use technological tools as well as to learn new methods for teaching. *"The main problem is simply that it takes an immense amount of time to learn to do it well. Whoever said that computers save time ought to try developing and debugging some course materials some time!!"* Faculty who have developed computer-based media and materials also comment on the time commitment: *"Creation of a work of art such as a graphic, web* *page, or slide, takes an incredible amount of time. Similarly, learning resources attain the levels of stand-alone programs or textbooks. The burden of creation of these entities can be overwhelming. Software and hardware integration into the classroom can also be a huge undertaking."* In addition to time barriers, there is the perception that earlier adopters hoard resources and make it harder for later adopters to access them: *"...only the old dinosaurs get the lab space and time..."* and *"I tried to schedule the computer facilities for my course this semester and they were booked 1 1/2 years in advance. For my course, we only needed computer access for a single week of 'lab sections', but it was impossible to schedule."* It may be more the case that current resources on campus are insufficient to meet new demands, and are being over-utilized by all faculty, not just the EAs.

A number of barriers can be described as internal to the individual. For those at the beginning of the adoption cycle, the *idea* of adopting and integrating technology is probably a huge barrier. For example, faculty described barriers such as *"...fear and ignorance of technology*" and the complexity and threat of the new as reasons for non-adoption. Others commented on the great deal of resources needed to scale the *"...steep learning curve of the technologically illiterate"* and the major *"...time commitment necessary for 'non-computer types' to learn how to use technologies and select among available technologies."* Unlike EAs, who have an existing repertoire of technology knowledge and skills to build from, later adopters may be overwhelmed by the seemingly boundless array of technology tools. In addition to the initial requirement to build up a repertoire of technology skills, there is an on-going need to learn about technology and integrating computers in the classroom because of the rapid pace of technological development and innovation. *"One of the major impediments here may be the lack of suitable training that is required to keep faculty members abreast of new and innovative technology."* In order to remain competent and up-to-date, EAs probably enjoy constantly upgrading their computer knowledge and skills, while mainstream faculty probably see this as a huge barrier.

There is also the stress of keeping up with the new generation. "*Each new group of graduate students in our graduate program demonstrated higher levels of computer skills and more willingness to be self-directed - which demonstrates to me that the faculty will soon fall behind students in terms of their ability to effectively use this technology if we do not get our act together!!"* In his book about 'screenagers', Douglas Rushkoff suggests that "we may not like who's following us down the slopes, but they're gaining on us" (p. 38). Technology will be ubiquitous to the next generation of university students, and they will have different expectations for their post-secondary educational experience. In a Vygotskian sense, the traditional older-to-younger learning cycle is upset and reversed because today's children have grown up with technology while many faculty have not, and children tend to approach technology differently. It is probably unsettling and stressful for some faculty to be unseated by students who have greater expertise and comfort with the technology than they do.

A number of respondents indicated that "just in time" training and support would remove some of the current barriers to integrating technology. *"The most important and critical form of support is having a peer physically nearby who can instantly answer a small, urgent question."* There is nothing more frustrating that encountering a technical glitch when there is no one around to help. Support and training needs do not follow a Monday to Friday, office-hours-only schedule. For example, a faculty member explained that they often need *"...someone who can help with problems when I am working nights or weekends."* Some respondents identified the need for *"instruction for those with little basic skill with computers ... more small group teaching or individualized teaching tutorials on computer network so individuals could proceed at their own speed."*

Finally, among many respondents, there is the perception that technology is still an unproved instructional intervention: *"Due to the fact that there is insufficient data to support the efficacy of computerized teaching, only the risk takers in academics are prepared to spend the time developing courses for this medium*." It appears that EAs integrate despite the potential risks to their careers. One faculty member commented that *"...many of us are skeptical as to whether computer assisted techniques actually are any better than what we do now."* In contrast to those who cite insufficient evidence as a barrier, the following individual believes that the integration of computers has actually had a negative impact on student learning: *"Programs interfere with complex integration of knowledge by emphasizing information, linear thinking. Student 'wisdom' has decreased as a result of computer technology because they confuse information with complex processing and non-linear problem solving."* Mainstream faculty appear to have a greater need for convincing exemplars of successful integration than EAs before they will risk adopting computers for their teaching. There is a need to increase communication between those who are experiencing first hand success using technology in their classrooms and those who have not and are unconvinced or the compatibility with existing methods.

Learning About Technology

Individuals tend to have preferred methods for learning more about technology. Participants were asked three questions for which they were asked to indicate the importance of different methods for learning about technology, getting help and support, and accessing information about innovations.

In terms of media and methods for acquiring NEW computer application skills and knowledge, respondents ranked six items using a four-point scale (i.e., 1 = Very Important, 2 = Important, 3 = Neutral, and 4 = Not Important). Descriptive results by item are presented in descending order (Table 18).

Table 18. Means and Standard Deviations for Media and Method Items

Media and Method Items	**Mean**	**SD**
c. hands-on experimenting and trouble shooting	1.32	0.55
d. mixture of manuals and hands-on	1.56	0.69
b. hardcopy materials, books, etc.	1.97	1.04
a. on-line manuals	2.28	1.00
e. workshops and presentations	2.32	0.98
f. structured courses and guidance	2.72	1.09

A good number of Technology Integration Plans recommend that faculty need more workshops and structured courses in order to acquire the knowledge and skills they need to adopt technology. The present results indicate that respondents do regard workshops and structured courses as important. However, future plans for professional development should be informed by respondent's expressed preferences for more hands-on experimentation and trouble shooting, as well as hardcopy materials.

In terms of HELP or ASSISTANCE with using computers, respondents ranked the following seven sources of support using the same four-point scale. Item results are presented in descending order (Table 19). It seems that respondents prefer to get help from colleagues and graduate students, and want one-one-one assistance, rather than relying on outside professionals or colleagues at another institution. Combined with the preferences expressed in the first part, it appears that the most successful professional development would be to have just-in-time, one-on-one access to colleagues and experienced graduate students when one runs run into trouble experimenting and playing around with new technologies.

Table 19. Means and Standard Deviations for Help and Assistance Items

Help / Assistance Items	**Mean**	**SD**
b. colleagues on campus	1.63	0.84
g. one-on-one assistance	1.86	1.01
a. experienced graduate students	2.25	1.07
e. media center support staff	2.35	1.12
f. hot-line, or telephone assistance	2.47	1.11
d. outside professionals trained in technology use	2.69	1.16
c. colleagues at another institution	2.78	1.16

In terms of help or assistance with using computers, EAs rated experienced graduate students as more important **t** (74) = 2.10, **p** < .05 (**Ms** = 1.69 vs. 2.36) than MF. Depending upon the nature of the discipline, it is possible that many MF do not encounter graduate students who have helpful levels of expertise using technology.

Respondents were asked to rate the importance of 15 sources of information for keeping abreast of changes and innovations in the area of computers using a four-point scale. Ten items emerged as being important sources of information, and are presented in descending order in Table 20. The highest ranked source of information is a colleague, followed closely by friends, family, and innovative graduate students. Respondents prefer to learn about changes and innovation from people they know and to whom they have immediate access. Of the ten items, hardware and software stores, vendors, and suppliers, as well as hardware and software catalogues and brochures were regarded by respondents as only slightly important overall; the majority of respondents rated these as neutral sources of information.

Table 20. Means and Standard Deviations for Information Items rated as "Important"

Sources of Information Items	**Mean**	**SD**
b. colleagues on campus	1.71	0.86
a. an informal network of friends and family	1.85	1.01
f. innovative graduate students	2.10	1.02
k. on-line computer newsgroups & websites	2.55	1.11
j. conferences, demonstrations and workshops	2.57	1.12
c. colleagues at another institution	2.65	1.17
g. popular newspapers and television	2.75	1.05
h. popular computer magazines	2.75	1.14
o. hardware and software stores, vendors, suppliers	2.82	1.02
n. hardware and software catalogues and brochures	2.98	1.08

Five items were ranked as neutral to not important sources of information about changes and innovations in the area of computers, and are presented in ascending order in Table 21.

Table 21. Means and Standard Deviations for Information Items Rated as "Neutral"

Sources of Information Items	**Mean**	**SD**
d. department chair	3.43	0.91
e. university administration	3.34	1.05
i. refereed computer journals	3.26	1.08
m. publications from major computer vendors	3.06	1.08
l. on-line computer journals	3.02	1.07

Faculty participants apparently do not look "up" to their department chair or the university administration for information about technological innovations, nor do they appear to rely on vendor publications or refereed journals. It is interesting to note that respondents who have indicated high levels of personal expertise and classroom use of the WWW, do not rate on-line computer journals as important sources of information about changes/innovations in the area of computers.

Of the 15 items in this section, EAs rated the following 5 sources of information for keeping abreast of changes/innovations in the area of computers as more important than MF: refereed computer journals t (74) = 3.42, $p < .001$ (Ms = 2.38 vs. 3.44), popular computer magazines t (74) = 2.70, $p < .01$ (Ms = 2.00 vs. 2.90), innovative graduate students t (74) = 2.57, $p < .05$ (Ms = 1.46 vs. 2.23), conferences, demonstrations and workshops t (74) = 2.38, $p < .05$ (Ms = 1.92 vs. 2.71), and on-line computer newsgroups and websites t (74) = 2.00, $p < .05$ (Ms = 2.00 vs. 2.66). Perhaps because of their greater interest in the technology itself, EAs regard computer publications and meetings about computers as important sources of current information about technology.

Methods for Using and Integrating Technology in Teaching and Learning

A goal of the current investigation was to gather information about the "learned lessons" or methods that have been effective for post-secondary teaching and learning using technology. In response to a request to elaborate on methods used to integrate technology in their teaching, 57 (75%) participants submitted responses, which were from 3 to 162 words in length, and averaged 41 words each. The following section highlights selected responses from respondents about how they integrate technology in their courses. The qualitative data provides complementary information to the survey data gathered in the computer experience subscale (i.e., year first used for teaching) and expands the analysis from whether or not and when faculty have adopted a technology, to building an understanding of the specific ways in which faculty have woven the technology into their teaching and learning.

A majority of respondents use tool applications to increase their own productivity as a teacher. For example, respondents use word processing to create classroom materials and assignments, spreadsheets and grade programs for record keeping, and programs such as PowerPoint to create slide shows for classroom and conference presentations. A large number of respondents are using e-mail to keep in touch with students, to broadcast course information and discussion questions to an entire class, and as a means for students to submit their assignments electronically.

A large number of respondents are actively teaching with and about technology. A standard methodology for introducing computer applications to students is to demonstrate the software during lecture and provide for hands-on practice during labs. In addition to using computer applications as productivity tools, respondents are using computers to support learning. Instructional applications, such as tutorials and simulations, are being used to model complex processes and to provide additional practice and reinforcement with concepts. Internet applications, such as e-mail, newsgroups, listservs, and discussion groups are being used to build and extend upon lectures and in-class discussions, and to provide an additional forum for student ideas. Statistical packages and spreadsheet programs are being used along with faculty-provided data sets to explore and analyze a variety of problems.

The World Wide Web is mentioned often by respondents, and is being used for a wide variety of instructional purposes. The majority of respondents use the web to post course materials and resources to supplement conventional lectures and labs. Some respondents include web-based research as a part of their course and teach students how to search for relevant information. Others use the web as a demonstration tool for animations and video, and post links to other sites of interest on their course webpage. A few respondents require that students create their own webpages as part of the course. One individual describes the value of students publishing their work on the web: *"...the Internet and web facilitate collaborative projects and to provide a 'corporate memory' extending the community of learning across cohorts."* A web-based archive of student's work from previous sections of the course provides a valuable modeling and instructional device to reinforce and extend performance expectations. A small number of respondents have developed interactive websites for off-campus instructional delivery, some of which include audio, video, and animated graphics. A number of respondents are also very critical consumers of web-based information, *"...the WWW...wastes so much time - too much garbage, frequently the servers are down, seems superficial (80:20 rule, 80% useless to 20% valuable),"* and describe the need for students to critically evaluate the credibility of web-based resources. Others who have created web-based resources emphasize the importance of instruction and guidance in order for students to make full use of these materials: *"I have established a WWW site in support of the courses I teach. Virtually all of the information students need is available on that site. Classroom interaction is essential for helping students to understand material in depth and to critically analyze information."*

A small number of respondents (<15%) are actively involved in developing their own interactive applications for the classroom using tools such as Authorware, Macromedia Director, Hypercard, HyperStudio, and JAVA. These classroom applications include a tutorial that teaches writing skills, dynamic overheads for statistical analysis and modeling, a simulation about decision making and risk, and an interactive website that interfaces with audio and video files on a CD-ROM. High-end development of graphics, animations, audio and video clips are of interest to a small number of interested and experienced faculty.

A number of respondents indicated that they use distance learning technologies, such as teleconferencing, the Internet, and computer mediated communications (CMC), to reach students that are geographically and temporally dispersed. The following comment illustrates how using one such technology, CMC, can also lead to reflections on the teaching process itself. Using CMC *"...expanded my concept of 'teacher' to include 4 different roles: 1. pedagogical, 2. social, 3. manager, and 4. technical (see Serge, 1995); b. (I) have students do more team assignments in order to promote 'cross-dialogue' on-line; c. (I) have become much more flexible in negotiating focus of student assignments and direction of on-line discussion; All of these 'methods' work equally well in enhancing my face to face teaching - I am coming to the conclusion that in the process of figuring out how to become an effective on-line teacher, I've become a more effective teacher generally...."* A number of other respondents commented upon the return to in-depth reflections on the teaching and learning process as a result of their attempts to use technology to enhance and transform instruction.

Evaluating the Outcomes of Using Technology for Teaching and Learning

How does a faculty member determine whether the use and integration of technology is having the intended or desired effects? How does one "know" when using technology has "worked", and when it has not? In order to gather information to begin answering these questions, respondents were asked to elaborate on the ways in which they evaluate the outcomes of using technology in their teaching. 52 (68%) participants submitted responses to this open-ended question, ranging from 5 to 269 words in length and averaging 39 words each.

Most of the faculty responses in this section focused on student success and student satisfaction with technology-enriched or technology-delivered instruction. A majority of respondents go straight to the source by eliciting student feedback on the relative outcomes and benefits from integrating technology. In addition to the conventional, end-of-course student evaluation, a number of faculty administer written student surveys, with both closed and open-ended questions, solicit informal feedback from students throughout the course, and observe the use of technology by students in the computer lab. One faculty member uses the following approach to gather "just-in-time" reactions from students:

"I have organized selected classes into ad hoc focus groups to get feedback on technical developments." Some respondents described methods for evaluating specific uses of technology. *"I have incorporated a survey into my internet course which addresses the effectiveness of using an 'internet-based' course. I also include technology based questions in my course evaluations."* Another faculty member makes informal assessments based upon the *"...quantity and quality of discourse in computer mediated environments."* The following individual describes an on-going process of assessment and evaluation: *"(I) constantly seek feedback from the students on which software packages are worth the time and effort to use, i.e. do they actually benefit from the time spend on the computer. (I) constantly evaluate new software for its potential use in teaching."* A large number of respondents also describe a variety of summative and formative evaluations of student success, such as the attainment of course objectives, quality of performance on assignments and exams, and observations of student use of technology in labs. The following instructor points to specific expected outcomes as well as identifying a future direction for integration: *"As for projects, I look for analysis and understanding of major issues; With simulations, there are two components: 1. who wins, and 2. what they are learning about decision-making; It would be nice to do some interactive exercises in classrooms, but we don't have the technology."* One faculty member evaluates *"...the cumulative record of student learning portfolios on the web"* in a course where students publish all of their coursework on individual webpages.

A good number of faculty participants described other ways in which they, as teachers, determine whether the integration of technology is having the intended or desired effects. Some faculty refereed to their *"instructor's intuition"* , while others called it gut-feeling, but however it was described, many respondents indicated that they rely upon and trust their own observations and expert judgement to gauge the effectiveness of integrating technology, a *"...personal perception that technology adds value to existing teaching methodology."* A number of respondents emphasize that instead of employing formal quantitative measures, they use more qualitative, or subjective, measures that increase their awareness and understanding about whether the integration of technology has been effective. "*I look for feedback from my students. If I am able to see them (I) pick up cues the same as you would in any classroom. I know they are comfortable with videoconferencing when they start eating their lunch because they have forgotten the camera. Then the discussion becomes free and clear. When students want individual contact and flame on the computers then I know that things are not going well. When I have five e-mail messages from the same student on one evening problems are obvious. Computer conferencing is new to me and I am not sure whether I can provide any definitive* *ideas on success except that the students told me that they thought this was the best way for doing papers that they had ever experienced. Not objective responses at all!"* There is growing awareness of the need to develop new methods for evaluating this type of instruction. It appears that evaluation methods, like teaching methods, have to adapt and evolve as technology becomes more integrated, adoption more widespread, and as student and teacher roles change. Conventional methods, such as course evaluations and testing, may not be the best way to evaluate the potentially unique outcomes and effects of using technology for teaching and learning.

Most experienced instructors would agree that student success depends at least in part upon the individual student's motivation and personal investment in the course. *"The most telling piece of information came from this year's course evaluations ... students were very supportive of having the web site and all felt it helped them. The one negative comment I received on over half of the responses was that I should include the figures I teach from on the web site, as they have no access to that information. This astonished me, as each lecture was linked to other web sites, which I pointed out to the students from the first lectures. All the figures I used were from these web sites, which indicates to me that over half the class never looked at these sites. So it seems to me it doesn't matter if we teach from textbooks using a chalkboard or make information available on computers, those students who are interested and motivated will learn and those just putting in time will do just that."* So, some students will be motivated and interested in taking advantage of the opportunities that technology-enriched instruction can offer, and others will not.

Finally, for some faculty the evaluation of technology integration cannot be done without a consideration of what constitutes excellent teaching. Quite simply, technology itself is not the point for some faculty. Rather, it is important for faculty members to understand the fundamental teaching and learning issues, and why and how one might use a given technology resource for a particular learning outcome. For example, the following faculty member commented upon an ineffective use of technology for teaching, and hints at the need for more reflection on putting technology to best use: *"I've seen too many people use PowerPoint presentations and think that having students sit in the dark for 75 minutes is using technology in the classroom. This is a very misunderstood area of learning and teaching and too many people are buying into the hype without understanding implications."* Technology, like any other classroom intervention, can be misapplied and used inappropriately. The following faculty member emphasizes that instructors should focus on the importance of good teaching rather than on the integration of technology.

> *"I am not convinced that after 2 years of heavy involvement in computerized teaching that it offers much advantage. Good teachers are going to be good teachers*

> *with chalk and a blackboard. Poor teachers can use the technology as a crutch for as long as the technology is novel. The next generation will not be impressed. What we need to teach is how to think. That still is best done in small groups with time to interact with and challenge students. The tutorials and the time I spend working with the kids in the labs is where I see them grow. The students who make good use of computers as a means to learn did as well with the books. They only need us a sounding boards for their ideas. The average student can be fooled into thinking he is getting a better education because he was taught on a computer. In actuality, if we had smaller classes some of these average kids may have been pushed to new levels of thought. When I hear most people talk about computer assisted learning it is in the context of information transfer. There has never been a shortage of information, just people who know how to use it. The average lecturer using computers today are simply using them as glorified overhead projectors, thinking they are bringing new technology to their classes.*"

The beliefs and values expressed by this faculty member are somewhat reminiscent of LOGO's fall from grace amongst K-12 teachers. The early LOGO successes described by Papert (1980) were achieved in a learning environment that was discovery-based; in general, teachers facilitated student interaction and discovery with LOGO so that students would construct their own understanding of mathematics and physics principles. Instead of implementing LOGO in a similar learning environment, as Papert (1980) intended, classroom teachers *taught* LOGO using familiar teacher-directed and behaviorist methods. The subsequent rejection of LOGO by K-12 teachers was not as a result of the inherent features and capabilities of the software. Instead, K-12 teachers rejected LOGO after years of inappropriate and misdirected implementation. Perhaps the same phenomena is occurring on campus with some faculty. Instead of harnessing the potential of technology to transform teaching and learning environments, some faculty might be just using technology as an add-on to teach in the same ways that they taught before. For example, instead of using computer-based tools to increase faculty-student interaction in the classroom, or extend the learning environment beyond classroom meetings, instructors may only use computer-based presentations to "spruce up" former lecture notes and materials for primarily teacher-directed instruction.

Technology adoption for teaching and learning appears to have reached a different type of critical mass stage, in that a number of faculty have developed impressive expertise using and evaluating computer applications for specific student outcomes, and others are using technology to teach the same way that they taught before (i.e., using PowerPoint slides instead of transparencies). The uninitiated and unconvinced want exemplars of effective technology integration in order to change their values and beliefs about this innovation. Those who believe they are using technology effectively cringe at the ineffective and awkward uses by others. Perhaps the appropriate next stage of technology integration will be the diffusion of ideas and methods for better realizing the intended outcomes and benefits, relative advantages, and compatibility of integrating computer technology by emphasizing more appropriate and effective teaching and learning methods.

Chapter Five
INTERVIEW RESULTS BY CASE

> It should not be assumed that the diffusion and adoption of all innovations are necessarily desirable ... the same innovation may be desirable for one adopter in one situation, but undesirable for another potential adopter in a different situation.
>
> Rogers, 1995, p. 12

Overview

Sternberg (1997) profiles the views of expert professors who teach introductory psychology and have written textbooks for the course. His rationale for profiling expert teachers is that the best help comes from seasoned instructors who not only have taught for many years, but have thought deeply about the course, and have come up with new and exciting ideas about how to teach it. There was remarkable consistency in what the individual professors regarded as important and valued instructional goals. There was also great diversity in the characteristics of instructors, their values and beliefs, and their specific methods for teaching introductory psychology. Sternberg's (1997) approach to documenting teaching excellence captured both the similarities and variabilities between experts, and is useful to professors across disciplines who want to improve their teaching.

Qualitative research that profiles individuals who are both EAs of instructional technology and excellent teachers could fill a similar need by providing role models for those who want to adopt technology in their teaching. The case-by-case analyses of interviews here is an attempt to model Sternberg's (1997) framework by documenting instances where the adoption of technology and excellent teaching exist in the same individual. The rationale for collecting this information is based upon the value of providing descriptive accounts of this expertise for the benefit of faculty members who wish to develop both their technology and teaching knowledge and skills. Post-secondary instructors from across disciplines can benefit from the collective wisdom of those who have thought about and taught with technology for a number of years. The individual experiences represent great diversity. Faculty members profiled here are from both the social and physical sciences, as well as administration and management, and range from being enthusiastic beginners to seasoned experts at integrating technology in their teaching and research. What these individuals share is a passion for excellent teaching and finding new ways to integrate technology to fundamentally improve teaching and learning. Each case is based upon a single interview, and as such should be regarded as a “snap-shot” view of the individual’s beliefs and experience.

Interview transcripts have been analyzed using a constant comparison method, and sorted into major themes using a combination of categories derived from prior research on teaching excellence (Andrews, Garrison, and Magnusson, 1996) and from Rogers’ (1995) innovation-decision process. The following categories will provide a framework for a consideration of the individual experience of adopting technology for teaching and learning:

1. Knowledge: Values, beliefs and characteristics of faculty members, as well as felt needs/problems and degree of innovativeness,
2. Persuasion: Expected outcomes and benefits from integrating computer technology, as well as perceived characteristics of the innovations such as relative advantage and compatibility with existing teaching methods,
3. Decision: Processes used to attain desired outcomes, and factors influencing the decision to adopt or reject the innovation,
4. Implementation: Specific instructional strategies that support the processes, and
5. Confirmation: Motivators and impediments to integrating computer technology, as well as descriptions of continued adoption or discontinuance.

The following cases present a selective summary of interview results illustrated with condensed excerpts from source transcripts. Cases are presented in no particular order, and pseudonyms are used to provide anonymity for participants.

Case 1

The following faculty member has been awarded “Excellent Teacher” awards at the University of Calgary, and has integrated various technologies into their classroom teaching in the past few years. This individual volunteered to participate in an interview after completing the on-line survey. What follows is an abridged version of the interview session organized by the categories noted above.

Knowledge

This faculty member increases their awareness-knowledge about ways to integrate technology in the classroom using a variety of means. Completing the on-line survey as part of the present investigation was treated as a learning opportunity: *“I found it interesting to go through the questionnaire, because it occurred to me that there was a whole lot there that I had heard of, ...I am doing stuff like that, and I am doing that, and so on..., and there was a bunch of stuff that I hadn’t really thought about using for the classroom.”*

Another way to increase awareness-knowledge is becoming part of a network of faculty members who are investigating ways to integrate technologies and realize economies of scale by working with faculty members across the province.

> *"We applied for and got some Learning Enhancement Envelope money (i.e., a Provincial fund for innovative technology projects), and there will be additional meetings of the department to decide what we are going to do. We may want to establish a resource library in the province for materials that might assist in teaching these large courses. ... we were trying to get some of the publishers to think about the possibility of providing a more loosely structured site license ... as it is now, publishers think in terms of one book, one course, the adoption. We are trying to get them to think of giving a site license to the whole province to use some of the add-on materials, things like simulations and models that students can manipulate and learn from. We might share resources that have been put together by people teaching introductory, so my notes might be made available on-line to other instructors. We also wanted to look at situations like ... teaching essentially two large sections of basically the same course with the same textbook, and giving one group access to stuff like study guides and CD-ROM-based study material, and the other group not, and ... see if there were differences. It could be a little dicey, but then we could see what happens."*

This faculty member also described a number of instructional strategies that are being considered by her/his department to integrate technology to enhance the experience of first year students in the context of large enrollment (250+) sections. One idea that has been discussed is including CD-ROM-based study guides produced by textbook publishers and developing web-based, self-paced instructional modules. While this individual expressed some reservations about technology-delivered courses, it seems there are others who are interested in developing an instructor-less version of introductory courses; the rate of the material would be structured, exams would be set, and students would complete the course on their own. Exams would be written at specified times, or students would have the freedom to write the exams when they are ready as long as everything was done by the end of term. This individual mentioned some of the security and practical issues that are of concern with web-based teaching and testing: (a) course enrollment and student identification, (b) record keeping for assignments and tests, and (c) the feasibility of developing and using huge test item banks to randomly select items. *"I have never found a test item bank that I was comfortable enough with to make random selections for me. I prefer to go through manually and pick out the items I am going to give students."* Although s/he would support initiatives to integrate technologies like the web into courses, this individual expressed a desire to remain involved in what students were learning, and how they would be tested for the material.

Persuasion

A faculty member's favorable or unfavorable attitudes toward technology can be influenced by information sought from near-peers whose subjective opinion of the innovation is most convincing (Rogers, 1995). Faculty members may seek out the opinions of peers who have integrated the technology about expected outcomes and benefits, as well as forming attitudes and beliefs based upon their peers' experiences.

> *"We have had several meetings over the last while about things like the standardization of technology ... we had a presentation done by a couple of people from another department who had run a chunk of their course through the Internet ... the student signs on and gets notes off the Internet, there are fewer classes that they actually go to ... there are assignments that involve searching the net, gathering together information, collating it, writing a report about what you found and submitting that as an attachment directly e-mailed to the instructor. (This person) has done a lot of that in our department ... what (this individual) has been finding, I have heard, is that students now know that they have the choice, they can either go to her/his section or someone else's section. The first time or two that s/he ran it ... half the class thought it was just great and the other half of the class just hated the professor for it. S/he suffered in the evaluations, not necessarily because the process was bad, but because the perception was that s/he was now teaching half the load ...s/he in fact spent more than half the normal time ... responding to all of this stuff, struggling with email messages that were not quite working, or coming in weird in different formats and all that."*

An important factor in considering whether or not to integrate technology is the potential impact on a professor's teaching evaluations. It is probably more difficult to form a favorable attitude towards integrating technology if the end result is potentially disadvantageous to a faculty member's career.

Decision

When asked about the factors that may influence a faculty member's decision to adopt or reject technology, this individual describes the qualitative difference between using technology and figuring out ways to integrate technology into the curriculum.

> *"I both notice and understand the reticence that some faculty have with technology. There are certainly a number of technologies that I have taken up just because it seems to fit, the time seemed right, and I could manage it. I don't even think of it so much as using technology; its just sort of what works, its a way of getting some*

particular thing done that couldn't have been done easily the old way. For example, I no longer use a typewriter because of the ease and flexibility of word processing. However, the leap from word processing to talking about technology in the classroom seems like a huge step for some faculty. For example, I currently use a laserdisk in the classroom that has a whole bunch of neat stuff on it that I access using bar-codes, and I also use a bunch of videos. A lecture maker program comes with this laserdisk that I can load on my computer that will allow me to preselect the stuff I want to use for a lecture. The version that just came out is a lot better than the first one, which I avoided because I heard really nasty things about it. However, I just don't have the time, right now, to sit down and actually figure it out. This term I am doing two sections of a large freshman course with 500+ students and I also have 40+ students in my senior course. So, I don't have time to pause and incorporate new stuff, because I've got to make sure the stuff that I already use is working."

So, it seems that the desire to integrate technologies to improve instructional processes may exist, but the time to incorporate these ideas into teaching is not always easy to find, even for earlier adopters.

Implementation

This early adopter discussed different approaches to integrating technology with large enrollment classes.

"How do I handle 350 students at a time? Well, you get into it slowly. When I started teaching, the same course had only 125 students, and that seemed like huge numbers. Once you get past a certain number, maybe 30 or 40, you are past being able to have any sort of serious back and forth in the classroom, so teaching becomes more of a performance. One of the things I have added that seems to be helpful is to get the computing center to create email accounts for all of the students. I also get them to put together a global mail account which is basically just an alias list of addresses, so I can send something out to the entire class, and it adds some back and forth interaction for those who need it. I also took my overhead notes, shrunk them down from 24 point to 10 point, and e-mailed them out so they could make hard copies. One of the advantages of e-mail is that when I get a standard question, I can copy the question and answer to all of the students. I still get the same kind of questions, but at least I can send answers out effectively. It takes a fair bit of time to keep up on that, but its not too bad. E-mail extends office hours a bit. There are a few students who come by regularly, but otherwise not many at all."

E-mail can be a convenient technology for increasing interaction between the professor and students, as well as providing a means to distribute course materials. However, widespread use and acceptance of e-mail for these purposes is still not diffused into the entire student population.

> *"I discovered that sending the overhead notes out by email was actually going too far for some students. There are some students who just couldn't figure out email. Even if they figured out e-mail, they either couldn't figure out how to download stuff, or they didn't have access at home, or the library couldn't quite figure out the printers, and it wasn't working or it wasn't formatted well. So, I still do the email stuff, but I have taken a step back. I offer photocopied overhead notes at cost for those who want them, and then these students have the notes and don't have to muck with e-mail. So, e-mail works for those who want it, and for those that don't it doesn't matter."*

Even if an innovation offers a relative advantage over previous methods of communication, professors and students can expect to encounter problems with access, steep learning curves, and supporting previous methods while attempting to incorporate the new.

Another idea that this individual would like to explore using technology involves capitalizing on the communication capabilities of e-mail and the web for peer-reviewed writing assignments.

> *"We were also interested in trying to develop some way to provide our introductory undergraduates with some sort of writing experience that wouldn't kill us as far as marking. I'm not prepared to spend a lot of my time developing it, but the kind of thing that I had in mind was to encourage students to set up groups of 3 or 4, and share their writing assignments with one other using e-mail or the web. We could set up a website or do it locally through email. Their assignments would be two-fold: they would contribute a piece of writing, and also provide some critique and analysis for someone else's performance. Essentially, the peer review process. We would have to provide criteria for both cases. Let us say that the student is going to design an experiment. The first part would be to address each of these ten questions that we laid out, for example, it must indicate what are the independent variables, the dependent variables, how are you going to handle random assignment, all that sort of standard stuff. And then ... read everybody else's and evaluate them in terms of how well they have addressed these points... it would be a matter of having some sort of system to collate the results so they would submit these as a group, send them around to one another, then they would submit their evaluations of one another's work to the course instructor. And I think this would be fairly easy*

to set up electronically, I mean you would want to spend a lot of time figuring out what you want them to do."

Taking an idea from the conceptualization stage to the implementation stage requires how-to knowledge as well as a belief that this method will improve previous processes. An institution or department would benefit from investing resources to improve communications and connections between faculty member's who have ideas for how technology might change educational methods and those who have the skill and knowledge to implement these ideas.

Confirmation

How does an instructor decide whether the time invested to make technology work for instruction has actually paid off? This individual discussed a variety of indicators, both motivators and impediments, that impact her/his evaluation of the relative advantages of continuance or discontinuance.

"Whatever we do we want to look at evaluating it so that we actually get a clear sense of how well it works. I think that ... you can get better bells and whistles with some of the technology ... but, there is a fundamental ethical issue of access here ... if we are going to set up a course in such a way that requires students to access these course materials through various technologies when we cannot guarantee that everybody would have equal, easy access, its a lot tougher for some of them. If you require access to the Internet, recognize that some of the students have a computer at home ... they are allowed use, or the WAVE, so they can get easy access. If they are having to go to the labs here ... find the hot-wired labs so that they can actually get at the Internet, its tougher ... and some students just haven't got the training to know how to do it."

This individual also discussed the increased multimedia development and production by publishers, and the potential use of these resources in the classroom.

"There is a lot of people running around trying to create new multimedia applications for their particular course, when in fact publishers ... are falling all over themselves to do it and do it a hell of a lot better than we could do it ... there is a lot of money there for putting it together. For example, ... the next generation of CD-ROM-based study guides are going to have web browsers built in so that they will have a web page set up and the two will interact ... they are going put all of the heavy hitting stuff on the CD-ROM, the videos and stuff like that, so you don't have to worry about loading time, and then everything else, the test item files, the practice questions, all that text stuff is on the web site. I get a bit cynical ... I always look for sort of the hidden agenda, which of course is profit motive on their

> *part, right. But things like study guides ... its not rocket science putting the hardcopy ones together, and if you have a decent multimedia outfit working with you, the CD-ROM stuff ... was absolutely dynamite ... really nice little modules they put together, nice development work."*

Instead of mainstream faculty having to invest time and resources into developing multimedia materials for a single course, newer adopters will soon have the option of selecting high-end CD-ROM and web-based products to supplement a course.

Finally, the individual reflected on some of the impediments to integrating computer technology.

> *"It's sort of what works, you know, I certainly find that the difficulty I had last term was really basic. I had been teaching in the professional faculties building ... it was set up quite nice, touch screen controls for the lights and the volume ... the touch screen to switch back and forth between the VCR and the laserdisk player and you can mute it so that is blacks out and you can use the overheads. I had just gotten used to that, and it worked, and then I switched over to (another classroom) ... it's just a little shabbier ... stuff is not built in, there are old lighting controls, and a least a quarter of the time I wanted to use something it would go wrong. I've got five minutes before class starts and if its not working I don't have any time to do anything about it."*

While the university is in the "change-over" stage, a professor may find themselves teaching in a well-equipped room that facilitates and supports the use of various technologies, or they may be assigned to a room where bits and pieces are wheeled in on a cart. Even though this individual has integrated a number of technologies into their teaching repertoire, s/he admits, *"I still find myself running into 'steep learning curves' all over the place."* It seems fair to say that even EAs encounter situations where the technology does not work as expected, the conditions are not conducive to easy integration, equipment and connections fail, and there is always one more application to learn.

Case 2

This individual brings more than two decades of experience in information technology to a consideration of the difference between EAs and MF. As such, this individual's retrospective analysis of some of the issues surrounding the integration of technology is rich and in-depth. Results from this interview will be presented in light of perceived relationships between the individual's reflections and various stages of the innovation-decision process.

Knowledge

One of the characteristics attributed to EAs is a persistence with technology, seemingly in spite of institutional incentives and expectations.

> *"They certainly have tenacity, because in many cases they, certainly as I look at educational technology, are in some instances doing it in spite of their appointment, in spite of impediments that are thrown at them by people that think they are wasting their time, and in some cases at sacrifice ... academic advancement is measured by certain yardsticks, and the things we are talking about do not appear on those yardsticks, still don't appear on those yardsticks, they appear in the lip-service about what is on the yardstick, but when people get to use the stick in faculty promotions committees, it still comes back to what you have published. You could have in fact have produced a piece of software that has had significant penetration in the educational world, but if it hasn't been peer reviewed it doesn't count."*

A review of the policies and procedures for the annual assessment of academic staff at the University of Calgary confirms that there are two criteria, one for teaching and one for research activities, that are relevant to present discussion (Appendix I). It appears that there provisions have been made for the informed peer review of the "success" and "usefulness" of teaching and research activities involving information technology. A potential limitation to the application of the assessment criteria at annual review time is the level of skill and knowledge about computers possessed by those who conduct the review. In a field as innovative and constantly changing as information technology, it is possible that Deans, department heads, and other colleagues, who may not be adopters themselves, have insufficient awareness and how-to knowledge about computers, and insufficient motivation to apply these criteria, in order to conduct an informed and fair peer review of an individual's teaching and research involving technology.

The committee who is conducting the peer review may also have different values and beliefs about the relative advantage of the innovation than the adopter, and weight their evaluation of teaching and research time spent on the innovation accordingly. This individual talked openly about how the integration technology for teaching and learning may be

> *"... recognized, but it may not be weighted ... I can think of one person who ... essentially sacrificed their chances at a professorship by spending too much of their time helping in the evolution of teaching, particularly in these technologies, rather than pursuing their own individual line of research. So, this person eventually moved over to a non-teaching appointment. So its a real frustration. You get to a*

faculty promotions committee, and if I can use the analogy with figure skating, if you hold up your teaching and you get a 5.8, and they hold up your innovation and you get a 1.0, what they may be saying is innovation is not important here. It is hard. The other area where there is a problem is when you start getting into appeals, which is where, as in most areas of litigation, is where you sort out your principles. Its largely in the hands of 9 members of the academy, chaired by the Vice-President of Academic. So, if they come along and say we don't believe that this work, that someone spent 40% of their time doing, is appropriate ... then it is gone. I think that is the impediment. This is not yet seen as mainstream expectation. A couple of years ago, teaching wasn't even seen as being a mainstream expectation, it all hung on research, and so we first had to go through the reform of teaching per se, and now the issue is how you teach, and the effectiveness of your teaching."

So, the integration of technology for teaching and learning, and the perceived value that the institution places on this endeavor, is interrelated with how the institution values teaching compared to research and service.

This individual also suggested that there are characteristics that differentiate individual innovators and EAs, that

"...there are literally levels of innovation. There are people who innovate to solve a problem ... and then there are the generalizers. Sometimes the generalizers come first, and then somebody, a specific innovator applies it to a situation, and sometimes it comes the other way around. Somebody looks around at a bunch of these individualized solutions and comes up with a generalization, and the generalizations are very important to the portability of an innovation. Somebody has always got to come along and drag that innovation out of being a problem fix into being an innovation. Most innovations are not recognized as such in the first instance ... you are just doing something, and had to develop a new tool in order to do this, because you want it later on ... for example, (Bob) is still focused on how to get that gas through that thing, and the fact that (Bob) has invented a totally new way to control gas and heat is not his concern. So, the innovation has taken place, but it is not seen as an innovation, and has to be elevated to a generalization. So, you can appear later ... and see patterns of understanding, patterns of applicability."

Pronounced breaks do not occur between each of Roger's (1995) five adopter categories, and one can imagine that in practice, the innovator or inventor of a new idea is not always the one to carry that idea through the social system. The innovator plays an important role in the diffusion of an innovation, that of launching a new idea in the system by importing the innovation from outside the system's boundaries. The early adopter often serves the generalization function by decreasing uncertainty about a new idea by adopting it, and then conveying either a subjective or an objective evaluation of the innovation to peers through interpersonal networks.

The characteristics and roles of innovator and early adopter are affected by the nature of the innovation itself. In the case of information technology, the inventors and generalizers do not necessarily have to be trained or schooled academic experts working at the edge of their fields.

> *"When we start dealing with technology, which is hot at the moment, a hot skill, in great demand, it is the least credentialed skill that we have probably had in fifty years. There is no credential for technology. There are credentials in technology, but there are no credentials required to be successful with technology. If you are twelve years old, and you can do things, and job which no one else can, you are an expert. This is quite an interesting phenomena because it breaks molds. One of the things I think we have seen in the application of technology in universities, when computing first came along it was for engineers. Maybe physicists, mathematicians, but it was essentially science and engineering. And then people in medicine, and applied medicine started using it, and it started creeping out, and now it totally permeates this place. I think it is safe to say that almost no one can succeed in starting an academic career now who doesn't have a competence in exploiting technology. It doesn't have to be a specialty in it, but unless they can exploit the technology in manners relevant to their job, so if you are a Classicist, or an Art Historian, or a Kinesiologist, they all require you to exploit this technology. There are not many places where technology hasn't penetrated."*

In some cases, information technology is no longer the domain of specialists or traditional experts, and special credentials do not appear to be required for one to exploit the potential of technology. The diffusion of this innovation across campus, indeed throughout society, seems to also have created new expectations for those who want to pursue a career in academia, and new criteria for "competence" no matter what the discipline.

Persuasion

Persuasion to adopt is influenced favorable or unfavorable attitudes toward an innovation based upon perceived characteristics of the innovation, such as relative advantage, complexity, and so on. In response to a direct question about the difference between EAs and mainstream faculty, this individual believes that the answer varies over time:

> *"...we have been dealing with a maturing technology, as well as the maturing of interest in the technology. If you go back and look at who the early adopters were;*

they were often people who were frustrated by the cumbersomeness of something, or the inability to do something. And, rather than just complain, and say 'God I hate marking exams' or 'I hate doing this' or 'Why can't we' or 'Why does it always take 6 hours', they say 'There has got to be a better way', and are prepared to go out and get a sense of what is the better way. I think there may even be two quite distinct groups; there are those who, particularly in computing, those who understood the technology as a technology and said 'Now, how can this help me in my role in the learning process', and started looking at that. And others, who didn't come from the computing perspective at all; they come with a problem looking for a solution, and others come with a solution looking for application to a problem. I don't think that one is superior to another, it is just the nature of the beast. Having done that, having expressed a willingness to venture into new territory, then issues of the environment, peer attitude, availability, all of the impediments started coming along."

Some EAs were persuaded to adopt an innovation because they saw how it could solve an existing problem, and others encountered technology as a general solution to a number of problems.

This individual was particularly interested in the innovators, the pioneers on the edge of their field who literally developed new technological tools to address certain problems:

"Its been rare, when I look at people, I consider the innovators. They've never sat around waiting for somebody to parachute in with a solution to their problems, they go out and look for it. So, I guess the first instance is the character of the innovator, the self-starter, a desire to get on with something, not just.... There are a lot of academics who, I won't say go through the motions, but there are a lot of academics who pursue the normal cycle in the normal way. They meet their classes, they write research papers, they supervise graduate students, and whether they contribute anything to the body of knowledge is questionable. But I think that most of the professoriate, certainly a significant portion of the professoriate are ... effective, competent, participants in process. The people that we are talking about are process-changers."

This view is reminiscent of Bereiter and Scardamalia's (1993) work on competent teachers and expert teachers, and the difference between them in investing cognitive resources in progressive problem solving. Innovative faculty appear to be constantly pushing the edge of the problem, and as soon as it gets close to being solved, they reformulate the whole thing and start again.

Comfort working on the edge of one's competence, and comfort challenging the current state of affairs, seem to be characteristic of the early adopter's attraction to integrating technology.

> *"Its good that we have used the term 'competence'. I wrote something a number of years ago ... about the 'duty to change', that if you are competent, and you do nothing to adjust to change, you are in fact on the road to incompetence; by doing nothing you are in fact sliding backwards. So, the process-changers that we are talking about, are in many ways, I think, redefining the nature of competence ... because they are never satisfied with the 'status quo', and the truth be known the 'status quo' is usually the 'end of process'. Everything we do is as a result of change somewhere along the way, now whether the change was a hundred years ago or the change was a hundred days ago, at some point when it stabilizes and becomes the 'status quo', if you will, then that is the end of the cycle. Most people are prepared to live at the end of a cycle; some will live at the end of the cycle and then when it is quite clear that a new cycle is coming along they will shift to it; some people will see that there is work to be done on the new cycle and will go work on it and get involved; and there is the very few who say there has got to be a new cycle, or there will be a new cycle, and will in fact go out and invent it. I look at the people I have seen being early adopters of one technology or another, I have seen it in medical research, in libraries, in education, law, some aspects of computer science engineering, these are people who, its not ever taking NO for an answer, but they are never satisfied with a proven answer, its like the proof of the theorem is not the end, it is what you do with the theorem now."*

Insight into the possible motivation of EAs to work on the edge of their competence may be provided by Bereiter and Scardamalia's (1993) descriptions of the progressive element to maintaining flow: at least a bit of daring is required; working at the edge risks failure and loss of esteem, but it also provides a certain excitement, which is probably addictive. Perhaps there is a relationship between EAs and the characteristics of individual experts who do not merely adapt to constant change, but keep raising the ante, setting a higher standards of performance, reformulating problems at more complex levels, or increasing the knowledge that is presupposed.

Decision

This individual was asked to consider the factors that might influence a faculty member's decision to adopt or reject technology for teaching. It seems that the culture and vision of an institution may provide a more supportive environment for innovators and EAs, but will not necessarily lead to widespread adoption. For example, even the

Massachusetts Institute of Technology (MIT) experiences non-adoption, *"... one of the characteristics of MIT, although it suffers from some of the same limits, not everyone at MIT is doing this kind of work, but it has certainly more tolerance as one of the inventive institutions. In this country I think we perceive Waterloo to be in that state, and then we have inventive people, and in some cases it is a whole community. If your community removes some of the natural impediments, you still don't have everybody in that community being innovators or early adopters. I think the environment is merely a determinant of speed, it is not a determinant of activity."*

The individual was asked to consider the potential influence of increased personal access to computers on faculty decisions about adopting computers.

> *"An interesting example, starting six or seven years ago, every member of the Faculty of Management was given a state of the art microcomputer, that was the Dean's policy, everybody got the latest. In the first iteration, over about 3 years, there were still a couple of machines that still had the cards in the disk drives, the floppy drives, so clearly they were 'works of art', they had never been used. Other people had long before gone back for upgrades to their machines because the things they were doing were stretching the limits, and so forth. So, even having neutralized the barriers, 'what are all of the reasons I do not innovate?', a lot of the points that will come forth are environmental, and even if you neutralize all of the environmental reasons, there are characteristics of the individual people."*

This individual's observation about environmental factors seems to contradict the opinions expressed by some faculty in response to open-ended questions about incentives and barriers to adoption. Faculty in the present investigation suggested that, if the university readily provided more equipment and resources, the "if you build it, they will come" belief, then more faculty would be encouraged adopt technology. However, even when all academic staff are given easy and convenient access to technology, there will be some who display high use innovativeness (i.e., EAs), some who may start using computers, and still others who will not make the decision to adopt. It is difficult to speculate whether such non-adoption represents active or passive rejection. Active rejection means considering and trying the innovation out on a limited basis, and deciding not to adopt. Passive rejection, also called non-adoption, consists of never really considering the use of the innovation.

Implementation

When asked to comment on the process that early adopters undertake when they implement a technological solution, this individual commented on the apparent ability of a small minority of faculty to recognize and reformulate problems that others do not see:

"... we all see things differently, when you look at any kind of change, its like ten wise men with an elephant ... everybody saw something different ... its agile and flexible because it has the trunk, or its big and ponderous because its got the leg, and so on. It is essentially the recognition that everybody sees a set of circumstances differently, but they act upon what they have seen. And I think that in innovation, many people ... don't see the problem, some people see the problem but don't see the solution, some people see that there might be ways of doing it and do nothing about it, and other people invent solutions. The people you are talking about, that first group, are in that minority that see problems that others do not see and produce solutions that others have not yet thought about."

The characteristics attributed to innovative EAs here are similar to the progressive problem solving attributes that Bereiter and Scardamalia (1993) have found in expert teachers.

This individual identified some of the ways that technology has been implemented on campuses, and made some predictions about possible outcomes in the future:

"... for the last five years there has been a totally new factor, and that is your ability to network with anonymous persons, or network with persons you do not know through the web and newsgroups and so on, so your ability to create and draw benefit from that supportive community can be almost instantaneous. So the days of working in a vacuum I think is rare. ... you throw a term into the search engine, and I found people in about four other institutions and I found a couple of web sites that had some depth on it, I mean you look at the Year 2000 issue and there are dozens of significant helpful Year 2000 websites, so you as the single institution or small college attempting to address this issue are no longer in isolation. This is a very interesting leveling agent that is going to have an impact on the major universities. It used to be you were a great university, a good university, a mediocre university, or a bad university, well I think the issue is going to be are you a great scholar, a good scholar, a mediocre scholar, or a bad scholar, because there are fields that you can be a college state teacher's college and still be an innovator and a leader in your community, because your community is in 15 countries or 16 institutions. ... a theory of innovation that was developed prior to the existence of newsgroups and the web may not behave the same way."

So, there appear to be both intended and unintended results from the integration of technology on campus. Time, distance, and location are not limiting factors for those faculty who want to forge connections with colleagues at other institutions: *"I have had been involved in conference organizations, I have worked with other people on papers, I* *have been involved in mentoring, all over the Internet."* So, for this individual, one of the results of implementation is the increased ability to participate in professional activities.

Finally, this individual commented on the need for technology to become less problematic and more invisible to be widely accepted on campus:

> *"... there has to be a mechanism whereby either the innovator or somebody else takes the invention and moves it up into some form of general application. In the early days of computing applications ... there were literally hundreds of word processing applications, people would develop their own, they would know them inside and out, but nobody else could use them. Now we have moved up to levels of where we have, for all intents and purposes, less than a dozen packages, and for domestic consumption we are probably down to two. And that is moving it from innovation, which is what it was when you had no word processing and we started doing things with word processors, to irrelevant, its mundane, it is invisible. Do we get excited when we see a word processor now? We make all sorts of assumptions about fonts, and colors, and we take it all for granted. If you have ever written a document using punchcards you know that there is a lot going on between the tool and the program."*

The likelihood that mainstream faculty will share the early adopter's enthusiasm and tolerance for programming new applications, or experimenting with novel applications, is low. However, perhaps if EAs spread the word about applications and strategies that work reliably, there may be more enthusiasm and more widespread adoption by mainstream faculty.

> *"We are now at that level with a very interesting problem on campus, where there are so many students on campus now want to use things like PowerPoint for their presentations that we have trouble getting enough projectors, we don't have enough projectors and such for them to use, because it has come down to that level where it has become mundane. I think that is a very important part of innovation, you don't want to have something where everyone is admiring it on high and saying 'Oooh, look at the innovation', you want to get it to the point where nobody even knows it is there, like the telephone or the photocopier, or on-line catalogues to libraries, all of these things, like the WWW."*

Related to the ease, compatibility, and relative advantage of integrating technology, ubiquitous computing on campus should be the goal, rather than investing resources trying to make everybody as diversely skilled and interested in the technology as an innovator or early adopter.

Confirmation

It has been argued that faculty need on-going support and recognition, and supportive messages that will prevent dissonance from occurring (Rogers, 1995), to prevent discontinuance or rejection during the implementation and confirmation stages of the innovation-decision process. Comments from this individual suggest that EAs may have less need of external messages of support, and instead seem to be self-reinforcing when it comes to technological implementation and continuance. For example, this faculty member described the shift from the AOSS to ACS servers for e-mail:

> *"... if you have used other systems and you are comfortable with the web, well it is not rocket science ... it also has something to do with how you like to learn new applications, maybe, there are some who react and need a lot of structure even if they have used other applications, they don't immediately see the parallels, and there are others who get three instructions down the road and that's enough, they see the parallels, and they say 'thank you very much' and are independent and do the rest themselves. I remember when I went over to Word Perfect 5.1, and my first frustration was 'what the hell do I do with this blue screen?', and once I had gotten past that it became somewhat intuitive. I am one of those people who jumps into it, and when I can't do something then I go to the help or I buy a detailed help book or something like that. I guess part of the problem ... is that the definition an innovator has changed fairly steadily over the last while, what we would have called an innovator ten years ago where they are going from nothing to something, there are in most cases not many opportunities to go from nothing to something, but there is an expectation, and I have seen people, and I guess it is partly intuitive, where they talk about software being intuitive, and I think in many of these areas, if you have been in some kind of environment, and the Macintosh people had it first, where you are trained to be intuitive, I mean the Mac says follow your instincts, it doesn't say follow the rules, it says follow your instincts, and Windows is a lot closer to that, and if you are used to that when you get into something new, you are not looking around wondering 'what are the ground rules?'"*

In addition to describing learning and coping strategies for dealing with new technologies that appear to like the "progressive problem solving" characteristics of expert-like learners (Bereiter & Scardamalia, 1993), this individual described how the features and capabilities of the technology, the evolving user-centered design of the human-computer interface, can influence how individuals interact with the technology. *"I think what it is, we are starting to learn how, and its at a very low level, to take a risk. When I first got into computing, God I could bring down the computer, I could destroy my data, I mean you took all sorts of* *precautions, you were always concerned about the damage you might do to the machine, of course you couldn't damage the machine, but the damage you could do to the software."*

Past adoption of technology appeared to require more comfort with risk-taking, and greater access to financial resources, than present or future adoption may require. This individual elaborated upon the risk-taking nature and resources needed by EAs ten or fifteen years ago.

> *"The first computer I had, which would have been about 1982 ... was an ordinary IBM PC, but it was also a workstation you could use on mainframes, and I paid I think $19,000 for that, I gave it to myself as a reward ... I think its the comfort level, that 'it is not important what I don't know, I will just move ahead, and when I bump into things that I don't know I will just find out' ... and when you are in that kind of frame of mind, it makes risk-taking comfortable, its risk without damage. The principle thing we risk when we play with computers is loss of time. Rarely do we play with loss of data, loss of computer, anymore. Its like saying, 'feel free to snowboard--guaranteed you won't break any bones', well, what the hell! And when you look at people who take skiing or snowboarding, the people who have the greatest trouble are the people who try to maintain control in a traditional sense of control, 'I must always be in control, in muscular control', and the truth is that occasionally you let gravity do the work for you, where you let the laws of physics take over, and once you let go, and let Newton take over, and the laws of physics says clearly what goes up must come down...."*

It appears that EAs have had to have access to adequate resources, be comfortable giving up a sense of complete control over the technology, and had to develop a sense of trust and comfort that their efforts would not result in complete disaster in order to use technology. The comfort that EAs describe may be akin to "transparency", in that the technology is regarded as a given, a natural part of their landscape.

Integration takes time, there are a number of impediments, and progress often seems painfully slow. Both the faculty member and the institution will require some confirmation that the investment of resources to integrate technology are having some beneficial effect. This individual describes how both faculty and the institution have to become more tolerant of failure when they integrate technology:

> *"If I spend all of my time using technology, but I produce a poor result in my students, no one learns anything, then I have not been successful at teaching even though I have been innovative. I have been innovative to the point of being counter-productive. There is a degree to which our systems of evaluation allow people to fail. And I think that there is a greater openness to tolerance of failure ... it is really*

> *talking about when you develop something new, don't expect to get it right first time, the things we do wrong are an important part of the learning process and anybody that understands the education of children, and watches how children learn, well you learn how to walk by falling down ... In an environment that is geared only to recognize accomplishment, a failure is recognized as a lack of accomplishment."*

So, initial and ongoing attempts to integrate technology may take a long time and several attempts before the investment of time and resources results in beneficial and rewardable outcomes. Tolerance, in the form of institutional recognition and support similar to that required for longitudinal research projects or writing a textbook, may be needed to sustain integration efforts for technology in teaching and learning. Assessment procedures that focus on annual results and accomplishments tend to emphasize, and may inadvertently promote, more conventional teaching and research activities that result in more immediate and reliable benefits and outcomes.

Case 3

This faculty member has more than two decades of experience teaching with and about computers, has been recognized as an "Excellent Teacher" with several awards, and concentrates on technology as a major area of research. Excerpts from the interview transcript will be used to highlight some of the motivators and impediments to integrating technology for both EAs and mainstream faculty.

Knowledge

Early adopters are characterized as having more interest in the technology itself, and many have purchased software and hardware with their own financial resources in order to integrate technology into their teaching. *"Five or six years ago we had software budgets ... now if I want a package to use in a research class ... there is no budget and there is nowhere to get resources. Anything good that I use to demonstrate to my students ... I have had to buy myself. That sort of stuff I should have at least a minor acquisition budget for, but there is no access to funds for it."*

Along with the unwillingness expressed by mainstream faculty to purchase computers and software for instruction, there is a sense that EAs are becoming less willing to invest personal resources in technology for teaching-related tasks. The issues of access and who should pay for hardware and software for teaching, the institution or the individual faculty member, can be a sore point with EAs.

"All staff should have access to the Internet free of charge if we are expected to do work at home, grade assignments, answer e-mail. I answer e-mail from students at home, but I am using a computer that I paid for on my own, I am using a phone line that I pay for out of my own money, I am using debit money out of my account that I paid for ... I think that is the reason that staff get so upset about doing stuff in this area, they know if they develop stuff for conventional scientific mediums, like textbooks and stuff, all of the money is there, the Killam fellowships are there, they can apply for NSERCs, they get all of this support for traditional scholarly work, but for the electronic medium there is very little support."

In addition to the accrued benefits from vendor donations and special pricing policies, it appears that campuses have inadvertently benefited from the past willingness of EAs to outfit themselves with technology both at home and on campus. A technology plan that calls for more widespread adoption of technology for teaching and learning cannot rely on mainstream faculty to have the same enthusiasm for purchasing computers and software as EAs. There appears to be a need to develop funding structures for teaching and research with technology that are similar to those that support more conventional or traditional scholarly work.

Persuasion

Some innovations are readily understood by members of a social system; others are more complicated and will be adopted more slowly (Rogers, 1995). Sometimes the relatively complexity of simply making the technology work as intended hampers faculty efforts to use computers in their teaching. For example, this individual described the many ways that computers and overhead projectors can fail when attempting to do a demonstration with the web, and some of the solutions that can be applied.

"Most people, like inexperienced faculty, wouldn't even know where to look, or how to trouble shoot problems with control settings, and IP addresses. They would just give up, and it is no wonder that faculty say, 'well I am going back to my overhead and chalkboard. I don't need all of these hassles'. People can go through a frustration like this once or twice, and the really committed ones will go on with it and persevere, but people that are just in it to try and experiment with it, will just give up and say its not worth their hassle. If they cannot get the technical support and technical people to figure it out, and here they planned their whole lecture around it, and their whole lecture is canned for an hour because they were planning on using the media and the whole system comes down on them or they can't get into the Internet, it is just not worth it. The systems are still not bulletproof enough

to protect them from that. If they come with a transparency they can still do their own thing."

Integrating technology requires some level of personal skill and facility, in order to have the confidence and ability to troubleshoot problems should the need arise. Even with the advent of graphical user interfaces and more robust networks, computers have earned their reputation as being difficult to understand and use. Innovations that require the adopter to develop new skills and understandings will be adopted more slowly than new ideas that are simple to understand (Rogers, 1995).

A potential solution to increasing faculty member's personal skill and facility with computers is to provide them with hardware and software so they can experiment and learn. Trialability is the degree to which an innovation may be experimented with on a limited basis (Rogers, 1995), and represents less uncertainty to the individual who is considering it for adoption. *"I think every faculty member should have access to guaranteed quality laptops at a reduced price, or should be given to them. ... the money that has been spent to build a central lab facilities, enough money was spent to give every one of the professors here a fairly powerful Pentium notebook or Apple Powerbook, which would encourage them to use it in their office and on the Internet, they could then use it in their teaching, they would have a big enough harddrive that they could develop stuff."*

Instead of regarding such early adopter suggestions as just an attempt to get more technology, those who make resource allocation decisions should take note that "ideas that can be tried on the installment plan will generally be adopted more quickly than innovations that are not divisible" (Rogers, 1995, p. 16).

Decision

An individual's decision to adopt or reject technology for teaching and learning may be influenced by external factors in their research domain that take priority over an internal desire to focus on innovative teaching methods.

"Globally, the extrinsic reward systems have to be there. People at the assistant professor or associate professor level who want to get promoted or get tenure, will find very quickly that unless they are in a Faculty of Education or being sponsored by a Dean or Department Head who has a very strong commitment to quality teaching, they will not get any extrinsic rewards, such as merit pay, tenure, or promotion if they do research of this type ... in chemistry or physics or biology, the pay off is going to be in doing more basic research in their domain, such as NSERC funded research, or MRC funded research ... They make get intrinsic rewards from seeing better quality teaching in themselves, but to get that better quality teaching they have to invest a lot of time and effort, and sometimes their

own money because there are no research dollars sometimes to do the things they want to do, and the payoff is quite minimal."

A recommendation for a campus-wide technology plan may be to find ways to increase the recognition of the value of integrating technology for teaching and learning for the physical as well as for the social sciences. However, a collective effort would also be necessary to lobby and convince external funding agencies, such as NSERC, to support this type of research and teaching.

Implementation

The specific instructional strategies used to integrate a technological innovation in a course are often influenced by events and expectations in the rest of the department. For example, faculty members rarely have complete autonomy when making decisions about large enrollment introductory and core courses.

"Implementation is still an issue ... if you do implement things into your curriculum, who makes the decision that you can do it? For example, in some core courses, especially our undergraduate ones, it is very well standardized what goes into the course, in an undergraduate psychology or undergraduate statistics course, so they can pick a common core text, and they have a common final exam at the end. So, if someone is doing things a bit differently they may disenfranchise their students, they may not get the central support from a group who works and develops that course. And that's the problem with large undergraduate sections, and why we don't see more at work in that area, because some people are seeing no payoff, because they spend all of their time developing this stuff and their colleagues don't use it."

EAs may have the skill, knowledge, interest, and motivation to develop teaching applications for a particular content area, and indeed, many have done so. However, if colleagues who teach similar courses are not interested in the technology, do not believe that the application provides relative advantage, then they will not use it, nor will they provide external support and recognition for the individual who has developed it.

The idea of an early adopter culture and mainstream culture in this situation seems to parallel some of the differences between first- and second-order environments described by Bereiter and Scardamalia (1993). The expert subculture, or second-order environment, embodies ideals and goals which help direct the expert's development, and provide support, cooperation and recognition of success. EAs tend to seek out other EAs who share their interests and can provide support for their continued adoption efforts. The heroic element of the process of expertise captures the development of individual experts who also exist in first-order environments that do not necessarily support or reward the development of expertise (Bereiter & Scardamalia, 1993). Arduous efforts by the expert that benefit others are disproportionate to what others in the individual's first order environment provide in the way of rewards and supports.

Confirmation

There is a sense that mainstream faculty need convincing evidence for the relative advantage of technology-enhanced or technology-delivered teaching and learning methods. Although early adopting faculty may be personally convinced of the efficacy and need for technological innovations in teaching and learning, they too realize the influence of empirical support for these methods, *"Any good software has to be piloted and field tested."* However, conducting experimental research on the integration of technology is rarely straightforward or problem-free because it involves human participants. This individual identified some of the constraints on conducting experimental research on technology for teaching and learning, such as having an experimental and control group, arranging for ethical clearance for human participants from the department, and getting funding from MRC, SSHRC, and NSERC, especially for those in the sciences.

> *"The problems with getting access to actual subjects for piloting and field testing, is again applied, and a lot of people in sciences, doing basic research, for example, have been used to in the past doing research with animals or dealing with lab equipment, and they haven't had to go through ethics review for human subjects. And now, all of a sudden, if they want to collect data, they have to. Even if it's on their own class, a lot of them always felt they had the privilege to collect any information they wanted to on their classes as part of their domain of being the professor of instruction, and now it's quite clear that they need ethics approval. So, I think these issues prevent people from actually following through and actually doing good research on what they have developed."*

One can imagine the impediments to designing an experiment with students; the faculty member would have to obtain informed consent, which would mean providing information about the study; students may feel that one experimental condition is better than the other, which raises issues of fairness and potential appeals; random assignment would be difficult, if not impossible, and so forth. These concerns should not function as an excuse to doing no research at all. However, it is likely that these impediments hamper efforts to provide enough of the type of empirical "evidence" that might convince the mainstream.

It is frustrating for EAs to have developed a level of expertise with the technology and innovative ways to integrate the technology into teaching and learning, and not be consulted or approached when faculty decisions are made.

"Decisions are made completely beyond me, I find out a new lab is being put in from someone else, and I am one of the experts, and probably one of the ones who is using technology the most in my teaching in the whole faculty. I use PowerPoint, I use multimedia, I use teaching applications, I use programs wherever I can, and I am not consulted at all. And the people who are not using it are consulted, they have the ear of the Dean."

Thus, it appears that there are cases where early adopters do not have a great deal of influence on the technology plans in their own faculty or department, even though they have the knowledge, skill, and experience to make valuable contributions to such planning.

In spite of the numerous impediments and disincentives, what motivates an early adopter to continue integrating technology in their teaching and conducting research in this area? In the case of this individual, the reasons have to do with applying a field of interest and expertise to becoming a better teacher.

"This is the area I trained in to do research, this is my area of research and expertise. I think there is a benefit in the sense that, the stuff I have been developing lately is very much related to what I teach. I am developing stuff that makes me a better teacher, I think, and as a result my teacher ratings have gone up, and the students are happier with the course. It doesn't mean all of my course is done that way, but a lot of it is."

This individual described a number of benefits to students, including transfer of skills in future careers, that provide motivation for integrating technology.

"My own motto has been all along that mainframes are a thing of the past, except for maybe communication, and if you can do it on you local computer then do it. And that's why all of my students are learning Office, they are learning PowerPoint and Excel, and they are learning to take the same case study that they run through SPSS for Windows and display it on a spreadsheet and make 2- and 3-dimensional graphs. I want them to learn how to import an Excel graphic into PowerPoint presentation, which isn't that difficult, but the whole idea is we are trying to teach them things they can try on their own in the workplace or at home, and they are not depending on a line to the university. But, that has been difficult, the Internet, because everybody says why don't you use our mainframe or run it on AIX, well it is not what people are going to be doing in five years, and the industry is not doing it now, they are running stand alone systems. They are only going out to the network when they want to get something, but even running off of a server with a standardized package takes a lot longer."

This faculty member has a clear idea of the expected outcomes and benefits from technology, and has many learned lessons about specific instructional strategies that support the learning processes to share with faculty who need help and support in their integration efforts. The development process for technology integration plans for campus-wide adoption could benefit from the expertise possessed by such EAs in the planning and implementation stages.

Case 4

The following faculty member volunteered to participate in an interview after completing the on-line survey. This individual is an early adopter of technology for teaching and learning, and has past experience in the information technology industry. The discussion of this case will include attitudes and beliefs expressed by this faculty member about technology integration plans on campus and elsewhere.

Knowledge

Rogers (1995) describes prior conditions, such as previous practice, perceived needs and problems, and the norms of the social system, as important factors to consider in the innovation-decision process. Thus, a consideration of the diffusion of information technology on campus requires an informed perspective on how this innovation may be received by faculty in light of its impact elsewhere in society. A discussion with this faculty member yielded a perspective of the impact of information technology elsewhere in society, and the potential influence of these events on changing the values and beliefs of faculty members.

> *"When I look at human organizations in North America, information technology has really ... transformed the way that work gets done. Everywhere you go, IT has had this huge impact in terms of both lowering costs and increasing the quality of the customer experience ... everywhere you go, huge changes have occurred except in higher education. What I do today is very similar to what someone in my job would have done in the 60s, and probably the 30s ... what an English professor is doing now is probably really similar to what an English professor did in the 30s, the way they spend their time ... the issues they handle, they write, they teach popular classes, very little change. And, if the information technology wave comes through higher education, it is going to transform higher education as we know it. And I think faculty, particularly older faculty, are scared to death of this transformation. One of the elements of information technology is that you can deliver a higher quality of service to more customers with fewer staff, in many*

cases. And the provinces and the states are very clear about this; that is why they are so into distance learning ... because you can deliver a class to 5000 people instead of 500 or 50 with one person giving a lecture. That's a tremendous economy of scale ... and it means you can get by with many, many fewer professors. And this has professors completely freaked out, with good reason. Just like you had all kinds of strikes in the auto industry when this kind of thing came through, its very disruptive for these academic types, its very frightening, its very threatening, their place in society is threatened, their livelihood is threatened, and so on. I think the model we are seeing is classical resistance to change because the change is going to happen and have big impacts on the existing people."

One should not underestimate the potential impact of such awareness-knowledge about societal changes as a result of technology on the formation of favorable or unfavorable attitudes toward the innovation. Faculty are heavy users of technology for professional and research tasks, but their adoption of technology for teaching and learning seems to come much later than training applications in the private sector. An explanation for later adoption of technology for teaching may be found, for at least some faculty and administrators, in their resistance to potential changes in previous practice and the norms of their social system.

"You will see professors arguing against technological change, they have a very clear interest in the matter, they are not arguing in a disinterested fashion at all about their field of study, they are arguing about the future of their jobs ... a lot of professors are technology have-nots, they are very uncomfortable with it, they are threatened by it, they just don't understand it, they don't have the skill of learning how to use a computer, or the skill of learning how to use the software, so its kind of curious to them. And you throw all of that together, and there is a lot of fear. And I think there is going to be a large levels of resistance, rational and irrational at that level."

If a university's culture either implicitly or explicitly promotes the use of technology as an expensive add-on or profit-driven initiative at the expense of individual faculty, then important questions about teaching and learning will remain unasked and unexplored. Faculty, quite naturally, will resist integration efforts that threaten their livelihood, or demonstrate little relative advantage to scholarship and teaching over present practices. On the other hand, if more stakeholders on campus are willing to fundamentally rethink teaching and learning, and question and explore new approaches to writing, communication, and research, then there will be less chance that fear and resistance will covertly undermine integration efforts.

Assuming that there is a level of fear and/or resistance to technology among some faculty, how might an institution provide the support and training to help these individuals develop a comfort level with technology? *"Teaching technology-phobic individuals to be facile with technology is a big mystery to me. Certainly for some of the older faculty, many of whom don't have PCs on their desk now, to expect them to become facile with these things is asking a lot."*

This individual suggested that there is a type of how-to knowledge that is needed when approaching technology:

> *"I think the most important general skill is the ability to sit down with a piece of software you haven't seen before and be able to figure it out. We are not very good at that. Our students take the point of view, 'well, if you want me to use software you have to train me how to use it'. There is a lab/lecture in this course where you get training in software. Again, I think a benefit of standardization is that we get a much higher level of informal training. The most important piece of software support is not training classes, it's not the help desk, it's not the web site, it's somebody physically near you who can answer your pressing question instantly. That's what I see in the labs, I spend a lot of time in our computer labs ... when students bump into a question, they just ask whoever is near them."*

It is unlikely that there is a large cohort of faculty or administrators who are technophobic in the clinical sense. Also, research suggests there is no relationship between technophobia and age (Rosen & Maguire, 1990). However, the training and support needs of the mainstream are clearly different from those required by earlier adopters. Campus-wide plans for providing support and training to faculty members who are "have-nots" with technology may benefit from an emphasis on general coping strategies for dealing with a variety of software, and some method for providing informal, personal, on-going support while faculty experiment with the technology.

Persuasion

This individual offered some observations about the relative advantage and compatibility of certain tool applications, such as word processing and PowerPoint.

> *"We type our course notes in a word processor, print them out and give students copies ... when we are giving a lecture, instead being human Xerox machines and writing on the chalkboard, and students being human Xerox machines and transferring our chalkboard notes into their notes, we print them, put transparencies up, and then instead of copying the transparency, they can write down their own notes to remind themselves about the discussion ... So, instead of them sketching out this decision tree, the tree is drawn and they can just write down their notes*

about what is going on and what is important. The next step would be from electronic form convert these into PowerPoint or something, and project them directly off the computer ... what I am finding is that that doesn't work very well at all. It is actually a counter-productive use of the computer for that, for several reasons. First, computers are inherently less flexible than transparencies. If a student asks a question, I can just say, 'we did that five pages ago', snag a transparency and throw it back up for a second, and then put it back down. With PowerPoint, and clicking through slides trying to find the right place, well, it's less flexible. Second, the other big difference is that I can draw on transparencies. It sounds very silly, but it is a huge point. If a student asks a question, I can circle where we have addressed that in the notes, or I can just write equations down, or write comments down, or if we are having a discussion, I will write down the student's points on the transparency in a place where it makes sense, which also helps guide them in their own note-taking. And when using PowerPoint presentations I don't have the ability to write anything. There is an interesting thing going on with many faculty who are not early adopters, or innovators, who perceive technology in the classroom as converting their notes into PowerPoint. And, they are reluctant to do that because there really isn't any benefit from that, and they don't see what the benefits are beyond simply taking what is on an overhead projector and projecting it via computer."

This individual's "learned lessons" about PowerPoint seem to be the small points that rarely get addressed when discussing the relative advantage of technology over a conventional teaching strategy. Usually the communication messages about technology emphasize only the benefits. Mainstream faculty need to hear such honest evaluations of the relative advantages and disadvantages of applications that EAs may take for granted.

Decision

Seemingly minor technological glitches may affect faculty member's decision to adopt or reject technology. For example, this individual described infrastructure problems that result in unreliable projection.

"There are days when I cannot read the screen from five feet in front of it, and there has never been a day when a student in the back row can read it ... instructors need to spend a lot of time harnessing resources, I spend hours with technicians talking about cables, which is ridiculous, I shouldn't be dabbling in that, 'you can get a 60-foot cable instead of a 40-foot cable maybe you can do this' ... the people who own the computer hardware in Comm-media, the people who control the software in our ITS group, and the people who control the budget in the Dean's office don't work

together nearly as well as we would like, they all have their narrow focus, they are all resource constrained ... when somebody shows up and says 'let's do some innovative stuff' it is just a lot of work and hassle for them."

This individual suggests that increased standardization across the campus would reduce support and training issues, and increase more widespread adoption by avoiding many of the technical glitches.

"The solution with computer technology if you are resource constrained is that you try to standardize as much as possible. And you avoid innovation as much as possible because it is very expensive ... The core issue for the university, I think, is that professors don't like standards. Mac users want to use their Macs, and so on, ... but the benefits in terms of costs and in terms of capabilities of standardization are immense ... suddenly Comm-Media is managing one projector, or maybe two ... they plug one computer into the back of the thing instead of the dozens they have now."

This individual described an integration plan at a private American college that accomplished standardization with academics by imposing it.

"What they did was they issued one of these computers to everyone. They didn't force them to use one. But their strategy was to make it really, really easy for people to use one. So, if you used the standard you got all kinds of great support, you got a help desk, you get plug and play network access anywhere, you get to take your computer to any classroom and plug it in and use it, so e-mail became effortless and so forth. And if you don't use their standard, then you were on your own. So the odd Mac user out there was on their own, trying to configure their computers to email and stuff ... The key to their strategy was making it extremely convenient for people to use it ... if somebody wanted a bigger monitor or a full size keyboard, or whatever, they just gave it to them. No hassles, no budget justifications, no memo wars, just 'you want a keyboard - here is a keyboard, you want a big monitor - here is a big monitor'. They recognized that all of those little extras were less than 1% of the overall program cost. On an individual by individual basis, it had a huge impact on people's willingness to accept it."

Faculty members were provided with computers by the college in this case. However, the private institution accomplished standardization by raising tuition $3000 US per year, which may not be palatable or marketable to the average Canadian student.

Implementation

Faculty members are more likely to participate in gradual change rather than making a sudden, diametrically opposite choices (Gilbert, 1996). This individual openly discussed some of the issues surrounding the proposed changes to an entire undergraduate program in her/his faculty.

> *"The focus right now is that the Dean wants to see computers in the classroom in the Fall. The Dean's term also expires (soon), so if s/he can get computers into place by the Fall, s/he has got a great big thing to stick on her/his resume because s/he is going to be looking for a job ... there may be a real conflict of interest going on as well, when people are just starting to be willing to talk about those issues ... But, if we launch this thing in the Fall, and we fail, we will hear the screams in Florida. At the front line teaching level there is a great deal of concern around resources to do it, and the sensibility of trying to rush it ... This thing could blow up if we rush it."*

Even if a technology integration plan has relative advantages for the faculty, if administration attempts to force a seemingly political agenda, the plan is likely to fail. Faculty will become cynical, feel unjustifiably pressured, and not listened to. Focus will shift from the teaching and learning issues, to discussions about the perceived agenda. Faculty may seek to undermine the innovation by actively or passively rejecting the proposal. Another constituency that will be affected by top-down decision making is the student body.

> *"Some students, particularly those who understand the issues, are vehemently opposed. Their incensed that tuition has doubled in the last five years, and they are looking at another doubling to pay for these computers. Student leaders are very aggressive in opposition to us ... we need to deal with those concerns ... we need to deal with the fact that students have an installed base of hardware that they have bought, invested substantial amounts of time and money in, and now we are going to now say its obsolete."*

A number of issues must be considered when proposing technology plans that have far reaching implications for both faculty and students: the norms of the social system, the impact on faculty and students, and the costs and benefits, and the agenda for change. There is a critical difference between "proposing" solutions, and "imposing" solutions.

The individual was asked to consider how change agents, or individuals in positions of power, should approach planning and communication for the wide-scale implementation of technology in a core undergraduate program.

> *"We have a very centralized, top-down management system, and senior administration doesn't have very good listening skills ... the perception is that on the teaching level, this is being jammed down our throats. My perception is that we have the opportunity on the computing side, but we also have other external*

influences, we have accreditation coming up, and we have to decide whether we go for accreditation again or not. We need to spend 6-12 months in very aggressive planning, and then launch something in a year and half, two years from now, that is a combination of genuinely integrated core course that deals with our accreditation issue, ... and genuinely work the IT stuff into it as well. The key personnel are running flat out just to work on the present course materials. Its a miracle that we can put these courses on ... these folks are all teaching overloads ... we cannot just say we will throw resources at this, because the key resources are the time of particular individual human beings. When we are talking about making changes in terms of computer integration, what we need to do is to get these people's time devoted to figuring out how we do this. We just don't have that. Now, next year we could hire some additional instructors, take the key people, take away half of their teaching responsibilities, so they have half time to do nothing except explore these issues, go to conferences, talk to people, try stuff out on their students or however they experiment, figure out how we are going to integrate, deal with the accreditation issue, craft a genuinely new program, and then go and launch that, and do a trial run in the Spring/Summer session, and then go launch that in 1.5 to 2.5 years from now."

Often, the integration of technology into teaching and learning is like trying to change the tires while the bus is moving. The institution cannot shut its doors for a year while faculty figure out how technology can be meaningfully integrated into the curriculum. However, it is very unlikely that meaningful or effective change will occur if individual faculty are expected to conceptualize and implement full-scale computer-based programs on top of their present teaching and research responsibilities. The integration of technology may require an increased commitment to investing in the on-going professional development of faculty, and a decrease in teaching loads in exchange for focused research and development on technology-enhanced or technology-delivered curriculum and programs.

Confirmation

This individual offered the following comments on gauging the benefits of integration if the university adopts a standard platform with a complete software load.

"So the risk is, if you don't do these things, what happens? If you make a big investment and go with technology, and what are the benefits going to be? Nobody at the private college can articulate what the benefits are. And the students that I talked to would fight to the death before they would give up their computers, but ... they couldn't really say what the benefits were either. And so ... we would basically say to our students, this is going to be expensive, there is some risk

involved, and we cannot really articulate the benefits to you in a concrete way other than to say its going to take you to a higher level ... And its cool! And its the wave of future, and all of these other broad brush, grand pronouncements we can make. My gut feeling is that if we do it, we will be glad that we did. That is my intuition. But I really can't provide concrete examples of the benefits. One argument that I can make is to think about telephone service. With the seamlessness, effortlessness of it, we have instantaneous telephone communication, which is hugely beneficial, we couldn't run our economy without it. If we could do the same thing with computer technology, and the benefits are all on the communication side, not on the computational side, if you have instantaneous, telephone-style web access, and you take your computer, you plug it into a network port anywhere on campus, or anywhere in this building, and you have instantaneous email access, you have instantaneous web access, you have the ability to transfer files reliably, which we cannot do on ACS right now, ... if you standardize that stuff, students have to learn it once somewhere, and then each instructor doesn't have to teach students how to relate to technology in her/his class."

For this instructor, the potential teaching and learning benefits of widespread adoption and integration of technology are related to ubiquitous communication capabilities. The next case profiles an early adopting faculty member who shares the belief that the communication and collaboration capabilities of technology offer relative advantages for both teachers and students.

Case 5

The following faculty member has been integrating technology into classroom teaching for more than two decades. This individual is both a basic and applied researcher, with computers being a primary area of research, and was nominated for an interview by another early adopter.

Knowledge

This faculty member requires undergraduate and graduate students to post their coursework on individual web pages because of the relative advantage of all participants, including the instructor and lab assistants, to have ready access and the ability to contribute to each student or group's on-going work. The rationale for requiring students to publish their work on-line includes increasing the audience for student work, facilitating the peer review process, and encouraging the on-going editing and revising of projects.

"The first time I did this, well I did this with a large course, 150 students, which is the third year (topic) course, this would be 3 or 4 years ago, and there were maybe half a dozen people in the class who had done any HTML at all. And I made each group have a web page, and I told them how to set it up, how to share stuff, how to annotate other people's things, just in the most general terms, and that was it. I didn't even give them a lecture on it, or a lab on it, or anything, which I would do if they were (another discipline) students. But at the end, when it came to the course evaluations, I asked them also, how did you like having everything on the web? And almost everybody without exception said it was much easier, because previous years, each group had about this much (i.e., inches!!) documentation they had to copy, they had to produce three copies of this stuff, and it was costing them a lot, they got beautiful color copies and everything. God knows where they got the money from to do all of this. Now suddenly it is all on the web, it's all accessible to everybody, it is not just one document to share between 12 people, and they could look at it when they liked, they could contribute to different parts, they could see how the whole thing fit together. And, they were unanimously in support of the advantages to them of doing this."

This individual provides how-to knowledge, support, and guidance in the technical aspects of posting work on-line, as well as discussing the learning benefits and advantages of this approach to collaborative work with students. The underlying principles that guide the development of course assignments are to build in progressive levels of difficulty and integrate technology into each task so that students learn and practice the skills that they will need for subsequent tasks as they are engaging with the course content.

"I always use my assignments, especially for undergraduates, which have got multiple purposes, so that you are building up the skills they need to do the next thing, so the next assignment builds on that. They can never skip an assignment. ...so the first assignment, to look at different things that are around, and to surf the web, ... and maybe to use some of the search engines, but don't give them anything that you haven't tried so that you know exactly what is going to happen. So, they have got a whole set of things they have to do, and it can all be there, in e-mail or on the web already, so they only have one URL to go to, and then they have got all of their links and instructions and everything. And then the second assignment can be to write up what they like and what they don't like, what they think is good and what's not in web page design, and the third assignment might be to start a web page of their own, and so on."

This faculty member has integrated web page construction into the primary teaching and learning tasks for the course. Students are required to use the technology for tasks related to the investigation and discussions in lecture. As a result, students acquire the knowledge and skills needed to publish their work on-line as a natural extension of their coursework.

Persuasion

This individual displays a favorable attitude towards the World Wide Web and the relative advantage that this technology offers in a teaching and learning environment. *"To me, the web is probably the most significant thing that has happened to us in recent years in the way of technology for teaching."* Building upon the topic of students posting their coursework to the World Wide Web, this faculty member emphasized the importance of discussing information design principles and guidelines in order to help students select and present information on their web sites.

> *"I used to teach in school once, and we used to have things like, kids would draw a histogram and they would fill in the columns all different colors, and we would say, 'no, you don't do that because it isn't contributing to the information. What you are trying to do is have a color scheme which is consistent with the information you are trying to communicate'. And this is even worse with undergraduate students doing their web pages. They want every fancy last twiddly bit on it, and it doesn't help at all. You want to make it as simple as you can which is consistent with what you are trying to show."*

In the same way that faculty members provide advice and guidelines for conventional academic tasks, such as scholarly writing or conducting scientific research, instructors will need to provide instruction and guidance for students on screen and information design principles as they learn how to publish on the World Wide Web.

One factor that may persuade faculty members to adopt or reject communications technology for instruction is class size. For example, if each student in a class of 100 sent an instructor a question in e-mail each week, the time needed to generate individual responses would be overwhelming. This individual described how they use technology to manage interaction with a large class of students.

> *"Actually, if you encourage students to use a listserver, and put all of their problems on there, you see I don't take questions from individual students unless it's trivial things, if it's anything to do with course material it is on the list, everybody hears the question, everybody hears the answer. Or, other people reply. If you have a listserver, and you put up things like 'these are going to be the questions on the test' or something that will ensure that they will join and read it,*

> *you have got to put up stuff that they cannot do without, you know, they have got to know this."*

The relative advantage of establishing a class listserver includes leveraging the expertise of both the instructor and other experts in the class, providing an additional opportunity to broadcast course information to the entire class, and extending discussion beyond scheduling class meeting times. In order to realize the potential advantages of a listserver, and use this technology as more than an add-on to instruction, instructors need to somehow motivate students to join and actively participate in the discussion. A strategy that has been successful for this instructor is to post crucial course information on the listserver.

Decision

This individual was asked to consider the factors which may influence their academic colleagues' technology adoption or rejection decisions. The following response balances the perceived characteristics of technology, such as compatibility with existing teaching methods, and the barriers that may impede the use of technology in classrooms.

> *"Faculty will do it if they see a need, and if they see a way of working better, working smarter, a way of explaining things more easily, a way to improve their teaching. ...there is stuff on the web you can use to explain stuff much more easily. ... there is the hassle of getting a computer in, and booking a room, and whether you have got the right projection and everything. If they have got to do all that they won't bother. It has got to be easy to do, and its got to be something that really interests them and motivates them within itself. It's got to be something that they find interesting. ...I think the web appeals to everyone because it's a way of accessing things that you cannot in other ways."*

While this early adopter was an advocate for technology in teaching and learning, s/he was also circumspect about technology being a solution for every teaching situation or problem. This individual promotes appropriate use based upon careful consideration of how the integration of technology can provide relative advantage over current instructional methods.

> *"Down the road, say five years down the road, you may have got 90% conversion, or whatever, but I think that it's not that everybody should be doing the same thing, but they should be thinking out whether it's appropriate, whether it can lead to anything, whether technology is beneficial. It's not a universal, it's not something that everybody should be doing all of the time, I don't think for a minute. I just don't believe it."*

This individual believes that the decision to integrate technology should be based upon goodness of fit between the technology and processes used to attain desired outcomes.

"I don't think it's whether we do or don't use technology, I think it's that we don't think out what is really appropriate for the situation. If you have got a room with loads of windows and you cannot block them out, forget taking your laptop, or if you have got a noisy projector, and nobody can hear anything, it's stupid. If you have got to carry your overhead projector around from room to room, yourself, which we did in the early days, people won't use it. It's got to be something that is appropriate to the situation. I think that sometimes it's appropriate just to talk, sometimes it's appropriate to have transparencies, you know there is all sorts of different ways to go."

Therefore, like any other instructional method, the integration of technology has to be evaluated for appropriateness and goodness of fit with learning objectives, and its relative advantage over conventional instructional methods. For example, this individual described reasons for discontinuing the use of computer-based presentation technology for certain lecture-style situations.

"I have almost completely abandoned using PowerPoint on an overhead projector. I don't use it for anything less than an hour long talk these days because it is just not worth it. I might create something in PowerPoint and print it off for transparencies, and then I am only carrying a folder that is this thick rather than carrying two pieces of equipment to a conference.... I gave a talk at (a conference) last summer ... about students putting work on the web and how we are using the web in courses. I had a 10 or 15 minute talk ... and I took overheads with me. When it came to the questions, someone said, 'how come you are talking about all of this stuff, but you are not using it?' So I said, 'Well, I have been to a lot of talks where people have a 15 minute talk but they take 5 minutes messing around getting their stuff to work, and then they cannot find the right thing in the right order, and to me it is a waste of time'. And, the whole room applauded. They had obviously put up with this a lot."

This view is similar to opinions expressed by other early adopters and faculty members; using technology just to prove you are using technology is an insufficient reason for going to the trouble. Setting up a computer and projector in order to display PowerPoint slides may be more appropriate for organizing a longer presentation, such as a 50 minute lecture, than they are for a short talk at a conference.

Implementation

During the interview, this individual was asked about specific instructional methods and strategies used to support educational processes. This early adopter described some of the beneficial features of technology for certain learning outcomes, such as peer review and collaborative writing, as well as specific instructional methods and interactions that are facilitated with technology.

> *"One thing I like about the web is that all of your diagrams can be in color, and color can tell you a lot more than black and white, and your text can be in color. For example, with the (third year) undergraduate class, I have a supplier group and a customer group. The supplier group produces documentation and the customer group annotates it. So, they download the other group's web page, they annotate it in a different color or in a different form, and then they put it back up, so that you see generations of annotations on this, and you can see what it is referring to. ...you can mark student's work like that as well. ... another thing I really like about the web is that, in the past when you did a piece of work, who sees it? You see it, the TA might see it, the instructor sees it, if you are lucky, not always. And now, everybody can see everybody else's work."*

The teaching philosophy that guides this type of work is that the learning process is an on-going and shared activity. Students are encouraged to construct better and better versions of their work, and reconsider their work in light of instructor and peer feedback. The emphasis on collaborative work is facilitated by on-line publishing and review of student work.

> *"I always try to let them have more than one go at things, why should they be expected to get everything right first time? So, give them feedback, either from me or from other people in the class or whatever, after discussion let them update it. If some of that feedback has been posted, as annotation, then they can click some of that stuff if they want to, it is a much simpler job. And also, the last class that I just finished, we were looking at (this topic), each group had identified what they were doing in their area, and then the whole thing had to fit together. Well, there was quite a bit of overlap, so one student took what everybody had done, and then after the discussions of where the overlap was, what we could get rid of, what else we needed, he just pulled it all together and annotated it with what would be an overall framework for the whole, all of the areas together. So, it was so much easier, and it's so practical because you can do so much more with it."*

Another relative advantage of on-line publishing for this individual is the increased discussion and openness about standards and what constitutes high quality academic work. In order to encourage students to freely participate in such an open and constructive learning environment, the instructor must actively build and promote a classroom culture of mutual trust and acceptance.

"Another thing I have been doing with all my graduate students is all of the feedback on their presentations, all the marks, all of their work, has all gone on the listserver. So, you do something, and I am critical of what you have done, but its out there in the open where we can all see it, and other people who come after you can learn from the mistakes you have made. And I think you can only do that if you have generated a supportive environment so that people don't feel threatened, you are there to learn, and not to take it as if you are a terrible person because you didn't do this the very best way, but these are things that you can improve on and you will do it better next time. Not only because of what we have told you, but what we told everybody else as well about what they did, so you see what they did and you see how they were marked."

In addition to establishing a collegial and supportive classroom culture to support on-line collaborative work, this instructor emphasizes the importance of teaching individual students about their roles and responsibilities in group work.

"Another thing that I always insist upon, if you are a joint author on a paper, or if you are a joint author on a piece of work which is an assignment for the course, then you are responsible for all of it, not just the bit that you did. So the whole group has to talk about it, everybody has to be comfortable with the whole document, and then I can mark the whole team with one mark. Its no good you saying to me, 'Oh, well I did this bit and you thought that it was good', or whatever, or 'so-and-so did this bad bit', that is not part of it. The part that you are required to do is be responsible for the whole thing, and understand the whole thing, and be able to present the whole thing if necessary. It doesn't work like that in all disciplines. I know (some disciplines), for example, don't do their papers like that, they split them up and they are each responsible for one little bit. To me that is not the way to go. You shouldn't be putting your name to something that you don't understand ... You have to tell the students that every single one of them has got to be responsible for that piece of work, so you could ask any of them any question about the whole thing, and they will just do it, once they know what your expectations are there is no problem getting them to do it."

In addition to teaching about her/his discipline, this instructor aims to develop knowledge and skills that are highly valued by future employers of graduates, such as the ability to work in teams, the ability to lead teamwork, and the ability to get the best out of other people. The use of the World Wide Web as a collaborative publishing environment, along with instruction, assignments, and requirements for group participation, appears to a catalyst for the development of such teamwork skills.

Confirmation

In order to justify the investment of time and effort, faculty members need to be convinced that their technology integration efforts are having the desired or intended effects on student learning. This individual described some of the reinforcing messages that s/he has received from the community about the integration of technology into her/his courses.

> *"I have had e-mail from people in lots of places saying how they like this course. I have students who have put stuff up for assignments, and then I get e-mail from industry people, people in government, hospitals, all over, who say, 'Oh, what you have been doing is exactly what I need to do for my research project'. I have to write back and say 'this was an undergraduate assignment', or 'I got that out of this textbook', or whatever. They write from all over and say, 'you are obviously a great expert on this and this and this', and it's nothing, it is just stuff I have put up along the way. So, I say to them, 'well, these are the people who have developed this, why don't you talk to them', and the students are really thrilled you know, because I mail it along to the students concerned, and I say talk to these people. ...it makes it all very authentic, because they are not just sharing it with their instructor, they are literally sharing it with other interested people in the world. And our students now do that automatically, they search for other people, and they look for listservers and newsgroups in areas that they have got an interest in, and if they have got a question, technical questions, they ask 'has anybody had this problem, or does anybody have any research material on something or other', and they get all of this stuff coming back and they make contacts."*

In addition to observations and evaluations of the quality of student work throughout the course, this instructor draws upon feedback from sources beyond the institution about the relative advantage and effectiveness of using technology as an on-line publishing environment.

Case 6

The following faculty member has over twenty years of experience as a member of an academic staff, and has integrated technology into teaching and learning for over five years. This individual has been awarded "Excellence in Teaching" awards on campus, currently uses the World Wide Web as a supplement to their on-campus teaching, and was nominated for an interview by another early adopting faculty member.

Knowledge

This faculty member designs, constructs, and maintains web sites that present extensive course-based materials and previous student work to accompany on-campus instruction.

> *"I am very adamant that the web sites are complementary to the standard classroom activities, an adjunctive to classroom activities. There are a couple of things that are really, really interesting. The getting started is no big deal, just how to use the Web, and the standard course outline, with standard stuff, like getting in touch with the TA. But things get interesting when I lecture, and I suppose this is another technology, I use two overheads. On one of them I put up an outline of the lecture that I am giving, just sort of the topics, organized in an indented form, and the students seem to really like this because it gives some structure to the lecture, and gives them something to structure their notes to. But then once I had them up to make overheads of them, I had them on the computer, it didn't take much to get to the point where what I could do was I could put the lecture notes themselves up on the Internet."*

This faculty member regards the integration of technology as an extension of classroom instruction, not a replacement for faculty-student interaction. The rationale for creating a web site to build and extend upon classroom instruction is based partially on a desire for students to make a contribution to the course materials and extend the lecture notes.

> *"One of the things I do in the course is that I ask that the project for the course is that each student has to prepare what I call a learning resource, where they have to take part of the course material and in as creative a way as they can, or in as interesting or effective way as they possibly can, the student has to prepare a learning module that could potentially end up on the Web. Now what this is beginning to provide is a really interesting learning resource for the students ... the nice thing about it is that it's a student side perspective, it's written by a student for a student, rather than by me for them. However, I have also written a text for this course so that is part of the course, too. So, I present that in class and talk about it, so in addition to the student modules they have these other overheads that I put up, they might be tables of data or various kinds of things. What these lecture notes are evolving toward is to become a rather interesting way to look at course topics, this is something about (this topic), and more student work on the topic. What it is then is an enriching process for the students, if they want it ... I have always treated the Internet as optional mostly because I am concerned about access. Although we have a pretty good lab here, I still don't feel right forcing the students to use it."*

In this case, technology is used as an extension of the course rather than a requirement for participation. Students are motivated to create quality learning materials based upon course content, and some of these modules are published on the web for future students.

Persuasion

The use of technology by this instructor appears to be compatible with existing or prior teaching methods. The driving force for developing the course web site was to address an instructional need, rather than a specific desire to integrate technology itself.

> *"Once I had the lecture notes up on overheads, and had them in computer files, I just sort of said ... why should the students, what I used to do was post them out here, because about half the students really wanted to have them before class, and so I was posting them out on the bulletin board, and I said this is silly, why can't I just put them somewhere where they can all get them. So I initially thought about putting them on our regular server so the kids could go in and get it, print it out. Basically, when I asked about doing that, I learned about this magnificent new thing called the Web. Because it really wasn't well known at the time, we didn't even have a web site, actually a web server at the time. And then, one thing led to another. So it was sort of the technology just, what I was doing wasn't led by the technology it was really led by the student's request for what I was presenting, my lecture material."*

For this instructor, technology offered a solution to an existing problem.

> *"I was really lucky when I think about the development of the course web site and use of the internet for teaching. When the need presented itself, when I said, geez, I don't like forcing the kids to Xerox this, you know I kind of got into a moral dilemma with it because I posted things out on the bulletin board and then some unethical student would come along and just take it ... and basically, I was really lucky because what I did was I went down to our technical people and said, look I have this problem, what can I do about it? One of the guys said, 'look there is this thing called the Internet, why don't you try it?' So, it was luck. A lot of it probably has to do with opportunity, with the hardware being available, the software being available, the expertise, because most people, unless they are the real techies, you know, the computer nerds, and of course there are some around, most people will tend to approach it the way that I do, on an 'as needed' basis, and ... if it is not there you will go do something else, and I suppose in retrospect you could look like a technophobe. If I had come to this need for the Internet a few years earlier, before the Internet existed, I might have abandoned the idea of distributing lecture notes on the Web, and I could have been living happily ever after, I don't know. But, in that*

particular instance, it really was an issue of my being fortunate enough to have support, and I suppose in part being able to recognize the potential once I got a vague idea of what was going on and building on it once I knew the technology."

One of the reasons for building the course web site was to increase access to the instructor's course materials and previous students' work on course topics. This individual explained that some students are especially motivated by the opportunity to create a learning resource that may be selected for publication on the web site.

"And it's all there on the Internet too, so. That's to me, from a teaching perspective I think, that is one of the particularly interesting applications of this technology, as an enricher, as something for those students who are willing to go the extra mile, two miles, however much. And it really is the good students that really benefit from this, the ones who care, and who spend time looking at that stuff. So it's kind of a nice technology in that, you are almost certain that kids, in undergraduate classes you have some kids that would just as soon be somewhere else, 'just tell me what I have to do, and I'm going do it, and I'm going get out of here and go home', and that's fine, I'm happy to service those students and give them what it is they need to go home. But the other ones, the ones that have that interest beyond ... this is a wonderful technology because it serves their interests. Now the interesting thing about this is that, the project, which is outlined in living detail under assignments (on the Web site) and what they have to do for the project, there is all kinds of stuff, about suggested ideas, and all sorts of other stuff they can have if they want. ... what the motivator is all of a sudden you are not just writing in a project for the professor. They are writing something that is possibly going to be seen by the world ... all of a sudden the students are taking this incredibly seriously. They have had tiffs about it, and one girl this past year she got upset because she thought someone was going to steal her ideas. Which is sad, you know, but on the other hand this is the kind of pride and ownership that the kids are starting to take, and it turns out to motivate students. I have never seen anything like this for projects, its just like a house on fire. Students going right out, and really quickly doing the work."

This instructor is motivated to integrate technology to provide a publishing opportunity for students that goes beyond conventional paper-based methods because of the observed impact on student motivation to produce quality work.

Decision

It has been established elsewhere in this dissertation that a variety of factors (i.e., incentives and barriers) may influence a faculty member's decision to adopt or reject technology for teaching and learning. This individual offered the following opinion about factors that may prevent some faculty from integrating technology into their classrooms.

> *"I think that 'time' or lack of time is an excuse, personally. If you want to do it, you do it. It is just like anything else. I know that there has been a tremendous resistance to using technology among some of my peers because they think Ralph (i.e., Ralph Klein, the current provincial premier) is staring over their shoulders looking for a way to get rid of them. You know, there is a very real sense that you could be working yourself out of a job. That is not a problem for me because I can see the light at the end of the tunnel, but some of the younger professors, who think if they do something like what I have done here, will it be long before somebody comes along and says, 'well, what do you need the lectures for?' Now, the way that I have constructed my stuff, there is no way anybody could say that, without the lectures the whole thing would fall apart. I think that some of the resistance has been a sense, it is not really an overt, luddite kind of 'damn technology' thing, so much as just a little bit of a hesitancy, thinking a bit like you are shooting yourself in the foot, that kind of thing. Also, we have one (person) here who still handwrites everything. Now, if (s/he) started complaining, if (s/he) started telling you that (s/he) didn't want to use technology because it takes too much time, (s/he) couldn't justify that position because the technology would save (her/him) so much time it is a joke. The problem is, that when I first switched over from handwriting to writing on a keyboard, I did lose about three months, before I could write up to this style and with the same facility that I could write with by hand. And some people's careers might be such that they cannot take that three months off, and for some it may be more than three months ... one of the sad things we do here is have a merit review on an annual basis, so what that means is that you are really shooting yourself in the foot if you let go of something for six months to learn something new, because I mean your little queue of accountables is a red light, and they will get on your case for not being productive. I am full professor, and I've been around the block so it really doesn't bother me, but it really does bother some of the other faculty."*

In addition to addressing workload concerns about the time needed to learn about and integrate technology, the potential threats to employment security, and the possible influence of the annual review process, this individual discussed the possibility that some faculty are concerned about putting their lack of skill with technology on display.

> *"Another part of it I think is just plain competencies, old fashioned technology skill. Knowledge and skill, and sometimes an unwillingness to look stupid, I mean that is*

one of the things that you have to recognize when learning a new technology is you have got to become a fool for awhile. Some of my colleagues have difficulty doing that, I don't, I never have, but that is another part of the resistance."

This individual also elaborated on some of the factors that motivate them to integrate web-based course materials into their teaching methods.

"I am incredibly comfortable with technology. It certainly has resolved some teaching concerns that I had, and indeed, I think that my concerns predated the availability of the technology, and then the horse started to drive the cart a little bit, in that once I realized how effective this was I started pushing for us having decent computer facilities which we didn't have when I got started with this stuff, myself and couple of others started pushing and eventually the administration gave us a new lab."

At this time, the instructor is personally formatting student work for publishing on the web site, which s/he admitted was a time intensive task.

"When they submit their project, they have to submit the project itself plus an essay that describes why they did what they did, a rationale, and all that stuff. So they get a grade on that, and while I am grading them I make the editorial decision about whether they get on or not, and I'd say about 1 in 5 get on the Web site, so that's why they are pretty good actually."

Even though the time involved in publishing materials on the web site is substantial, this individual believes that there are relative advantages and learning benefits for students.

"It takes a lot of time, but so does preparing good lectures, so does everything else, I mean time is time. So yes, it is a big investment of time. We have pretty good technical support here, which helps. But it is something that I started to believe in as I started to see the lights come on in some of the students that you regularly wouldn't even notice."

This individual believes that the web site serves as a valuable adjunct to classroom activities because course information and other learning materials, both instructor and student created, are organized and available from a central place which provides a valuable instructional and learning benefit for students.

"Giving people the structure of the various learning resources, by putting it up on the web and having it available in this way, it allows people to move beyond. I mean, the information is there, you don't have to collect it first, and then try to figure out what it means. You can move on to the figuring out what it means, and working through it, that much faster. And after all, I can't think of a better use for technology myself. So, I honestly don't think technology makes it so we

necessarily learn anything faster. All it does is that it allows you to shift the emphasis from that mind-numbing finding of the stuff, to the working with it. And I think that all of the stuff that I have done here can be thought of in this way."

For this faculty member, the decision to adopt or reject technology was influenced by the relative advantages and observable student learning and motivation benefits.

Implementation

In addition to integration methods already mentioned, this instructor involved graduate students in preparing additional learning materials for publication on the web.

"What we have is a series of labs associated with the course, so what I have done is write a fairly detailed lab manual, myself and some of my graduate students, and we have put the whole thing on the web, again voluntary if they want to, and what it tells them is about the manual, and the work. And then it goes to each project, there is an overview of each project if you want to get right into the details of it, you find what its about, what is learning objectives are, the resources that are included, and then stuff about the written assignment, it tells them about it. ... also, links to previous student's work, who have agreed to do it. And basically what it does is communicate to students precisely what it is that they are asked to do, and the quality of the work is good because they are working from almost templates, and it allows them to get over the anxiety of including everything, and they start playing with the ideas much sooner than they would regularly because all of the busywork is done for them."

Examples of undergraduate student work are accompanied by detailed explanations of the rationale and expectations for each assignment. By publishing learning instructions and examples in a central place, this instructor is increasing student access to prior student work and providing an instructional springboard for their current academic work.

Confirmation

This faculty member seems to be convinced that their investment of time and effort into technology integration is having the desired or intended effects on student learning. This individual conducts an on-going evaluation of student satisfaction with the integration of technology into her/his courses, and the ways in which students interact with on-line materials.

"The comments I get about this stuff are outrageously good from students, in fact if you wanted to see some of those ... I have them under current course information ... I have been doing evaluations of the Web, and you get an idea of what the students think. Student comments on the web site, and its a summary of different kinds of things, like how much they used it."

For this instructor, technology facilitates the accomplishment of valued instructional goals, rather than being an instructional goal in itself. Technology tools, such as e-mail and the web, have also enabled this instructor to communicate more effectively with individual students in large lecture sections.

> *"The really nice thing for me, speaking as a teacher, is that once I turned the students loose, and said look I am not looking for a standard essay ... if you like writing creatively, or have some special background in something else, like supposing you are doing a philosophy degree and are taking a psychology course or something, bring it in. And, the student response has been just amazing. When you give these students a chance to be what they really want to be, creative, engaged, doing something that is theirs rather than something that is the professors, a twinkle comes in their eyes that I haven't seen in undergraduate students in awhile, because you know our classes are huge, they are so crowded. And I have found that I have been able to break down some of those big barriers, people come in and we will have a chat, and I can encourage to try and do something. And so its from that perspective as well, it has been very time consuming, but it has had a tremendous impact on my teaching, and in particular my teacher ratings."*

It is important to emphasize that in this case, as well as other cases described in this chapter, that early adopting faculty members tend to actively reflect upon the appropriate role for technology and constantly evaluate and consider whether technological tools offer a viable instructional advantage for teaching and learning.

> *"So I guess my own perspective on technology is that under certain circumstances I will be the first person to use it, and then under others I find that it really does get in the way, and it is something that I wouldn't mind getting rid of, but to an extent I have to deal with masses of students as well."*

The final case to be described in this chapter illustrates the design and delivery of a web-based course for distance education.

Case 7

The following faculty member has won "Excellent Teaching" awards on campus, has used technology for teaching and learning for more than a decade. This individual has developed and taught a technology-delivered course using the World Wide Web. What follows is an abridged version of the interview session about the instructor's role in developing and offering a web-based course.

Knowledge

The length of time required to develop and offer a web-based course will probably vary depending upon the course content, the length of the course, and the instructor's technological experience and how-to knowledge. This individual was asked about the time it took to construct their web-based course.

> *"I should have kept a log, and I didn't, but what I can tell you is that I had a half course release to work on the course from, starting in January . I had some of the web materials up already before January . The course ran from mid-May to the end of June. It was a six-week half course running in the Spring Session. Essentially, all of my time, except for the time I spent on the other half course I was teaching from January to April, was spent, between January and the end of June working on development of the web site. ...I tried to keep it to 40 hours. And when I went outside of 40 hours in the Spring session it was doing the teaching of the course, because there was a listserv as well as the web site. But I reckon 40 hours a week between mid-May and the end of June, and probably something like 30 hours a week between January and the start of the course. But I might be overestimating in that period because I had other administrative responsibilities and so on. ... it is a tremendous investment of time. But, I mean one of the things that is true about this technology-delivered course, which may not necessarily be true of others, is that there is the equivalent of a full textbook on the web. I am essentially authoring a textbook at the same time that I am preparing to teach a course. So, how much time do people put into authoring a textbook? Unless it is an assembled collection of articles, or unless it's based on existing course materials, it is quite a long time to author a textbook."*

Not only was this faculty member the content expert for the development of this course, but s/he served as the instructional designer and did some of the HTML coding. Administration and multi-disciplinary faculty teams have to be aware of and factor in the extensive development time needed for course construction and on-going maintenance when designing and drafting technology integration plans for distance education using the World Wide Web and other delivery technologies.

Persuasion

The web-based course was developed to teach about a particular language. While demonstrating parts of the web site developed for the course, the instructor described some of the events that let up to the eventual conversion of this course for delivery on the web.

> *" ...there is reading about (the language), and study of, in that way, of (the language) grammar and pronunciation, and things like that. And readings of*

particular (the language) texts, and ... they are arranged as a glossed text so that you click on any word and the word comes up to the bottom of the window and you get a definition and a grammatical description. This is what actually got me started on the course in the first place. I have been working for about 7 years on a CD-ROM project just recently published, on an electronic edition of (a text) using this same type of technology to provide a glossary of the text. I am just so impressed with how much more efficient it is than giving students a book where they look at the word on the page, they have to flip to the glossary, they have to find the word in the glossary which is not an easy task given that there are some unfamiliar elements in the alphabet, and given that students are not necessary expert at knowing whether or not you can make slight adjustments to the word to find the head word in the glossary. This is a faster, less confusing, and gives you the information that you want right on the same screen as what you are trying to understand."

According to this instructor, the computer-based delivery environment offered both compatibility with existing teaching methods, as well as relative advantage and improvements on ways that students tend to interact with the learning materials. The idea for the design and delivery of web-based course was a few years in the making.

"...parts of this idea came 7 years ago and other parts were added as my work went on. So that, 7 years ago the most central thing that I thought I was doing was taking different versions, manuscript versions, of (this) text and putting them together on the same screen. And as technology improved, and I thought about it more, this idea of the edition of the glossary that you can click on, the idea of really good quality photographs of the manuscripts, the idea of assembling, as I started to work on (the CD-ROM version of a text) with the source text that (the author) had used ... and of providing translations for those, for the idea of having explanatory notes in another part of the screen so that those explanations would be there, the whole elaborate hypertext edition idea grew, but the sort of central idea of having a divided screen and texts that were in relation to one another as a better way of doing it for the edition was the first thing that I started. It was only later that I started to realize that it was better for students as well as scholars in that we could add sound and we could add images and all that. Well anyway, this is technologically not very exciting but it works better."

This instructor's original motivation to convert some of the course content was to provide a more efficacious method for interacting with the material. The faculty member's own observations of student and colleague enthusiasm and success with this type of interaction seems to have provided the motivation to ultimately convert these materials for multimedia distance delivery using the web.

Decision

This early adopter was asked to comment on institutional or personal factors that influenced her/his decision to adopt technology and convert course materials for web-based delivery. It is important to recognize that this instructor is familiar with potential applications of technology for teaching and learning, is interested in developing applications, and has procedural knowledge and skill with authoring programs.

> *"I had a lot of experience with the technology, let's not forget that. I had been working in an electronic delivery kind of environment on the CD-ROM project since 1990, so I had learned a lot during that period that I could simply transfer to the course. I say simply, but of course it wasn't easy. But it was simple in the sense that I started with a clear vision of what the technology could do. I knew of things that were implementable. When it came to JAVA-based exercises, I could say to the person who actually did the programming, 'well, let's get these things working, and if we have more time we will get this other set of things working' kind of thing. Not everyone is equipped to have that kind of conversation with a programmer. I knew what a web page could do. I knew HTML backwards and forwards, and had in fact constructed web pages of the kind I was going to be using in the course. All of that, obviously, was important in making the transition to teaching a full course over the web easy for me."*

Based upon years of experience and an interest in how technology could be used to accomplish certain learning tasks, this individual found the transition to offering a web-based course to be an easy one. However, it would be naive to assume that mainstream faculty, who may have less experience with and interest in the technology itself, and little or no procedural knowledge and skill with authoring or programming, to make such a smooth transition from local to distance teaching environments. This faculty member described a potential strategy for encouraging other faculty to experiment with publishing web-based materials in manageable steps.

> *"So, it seems to me that what we need to do if more faculty are going to be involved is to give them more of those early experiences, such as making their own web page for a course, just a single page of the course outline on it, that kind of thing, and move on from there. Because, the fact is that most of it is pretty easy, its just a matter of some hard work along the way. I think one of the things that we maybe need to be thinking about, in making the step to the web easy, people do know how to construct documents and it's not difficult to add visual materials to documents,*

and it's not difficult to link documents together. All of those things are much easier with the modern web editing tools, programs like PageMill or FrontPage, or even the publishing programs that have web output capability, like PageMaker or Quark does this as well. Get people through that move, and not worry about trying to get them to learn the guts of HTML or how to program an applet or anything like that."

If the goal is to persuade more faculty members to become involved in designing and delivering web-based courses, then technology integration plans must include realistic expectations for mainstream faculty members who may be interested but may not know where to start. It may be unrealistic to expect mainstream faculty to be able to articulate design expectations and system requirements to web page programmers as fluently as an early adopter. It is likely that training and support that builds on previous word processing and graphics experience would be an effective and comfortable starting point for a large number of faculty members.

Technology integration plans should make provisions for a team approach to course development. Instead of (unrealistically) expecting a faculty member to construct a course entirely on their own, supportive and productive development teams might include the faculty member as the content expert, an instructional designer familiar with screen and information design on the web, a programmer who is skilled with the technical tools, and a media specialist to create graphics, audio and video segments.

Implementation

This early adopting faculty member was asked to elaborate on how the course was implemented on the web, how students participated, and the nature of on-line activities, assignments.

"The course schedule, the way the course was set up, students were in charge of scheduling their own work in the course. There were certain tasks that had to be done by a particular deadline. ... Things that had to be in on that day were particular translation assignments, and by the end of the course everything was due. So there were credit exercises throughout the course and suggested dates for doing them, but students were not required to do them on those dates, some students left them all to the end, some students did them faithfully on the suggested dates, and it was up to them. So the students who left them all to the end, they formed a kind of final examination for the course. They were credit exercises, grammar exercises, and the idea was that if the students kept up with the schedule of learning that went with the exercises they would be in good shape to do the other tasks in the course. So it was scheduled as a series of readings from (the language) text, as a series of particular learning tasks, particularly grammatical learning tasks, and a series of lessons. My

sense is that for most students, the sequence of lessons was what structured the course for them, rather than the readings in particular or the exercises and tasks in particular."

It appears that while students are provided with structure and deadlines for certain tasks, they have a great deal of freedom to participate in the course in ways that are meaningful or appropriate for them individually.

This particular course web site includes a number of links to outside sites that relate to the disciplinary topic. The instructor was asked about the process of finding and evaluating other web sites for inclusion on the course web pages, as well as the design and delivery activities s/he participated in before and during the course.

"As the pacing of this turned out, the finding of associated web sites was not before the course started. As it turned out, the lesson pages were things that I was writing the day before students were scheduled to interact with that lesson. I was lucky not to have any real keeners among the students who would want to go ahead to the next lesson before it was ready, because that wouldn't have worked for them. ...So, I was actually doing a lot of web searching in between kind of authoring HTML, replying to the listserv, and dealing with people's technical problems and so on. I designed the course site and I wrote most of the pages, and I supervised the work of people who wrote other pages. But, in general, I am kind of the author of most of it. ...I didn't write the JAVA, another person wrote the JAVA, he had taken the (language) course, actually. ...I was kind of marginally involved in the coding, but I wasn't directly involved in the coding. I just told the programmer how I wanted it to work at a program level, and how I wanted it to work on the screen. ...I wanted to be able to reuse the applets, so I had to put particular constraints on both the file type, both the program type, in that I wanted the executable separate from a file into which you could put just about anything and the file structure because there was existing material that I wanted to adapt this to."

This individual is describing the development process that preceded and accompanied the first time offering of this web-based course. In a similar way to conventional course preparation, planning, and delivery, an instructor has some flexibility during a web-based distance course to add new materials (or link to new URLs) as they become available, and delete or discontinue materials (or URLs) that are no longer relevant. Because of the dynamic nature of the World Wide Web, an instructor has to monitor and check links to other web sites in case links become broken, or web sites are moved to other servers.

The instructor set up a listserv to facilitate class discussion about the course, and made it a graded requirement for students to participate on the listserv. Students were required to make three contributions to the listserv discussion each week for the duration of the six week course. A quick calculation of the expected activity for 18 students is approximately 324 messages on the listserv. The instructor reported that the actual listserv activity resulted in almost 600 messages being exchanged by the students.

> *"And the listserv means that anyone can ask a question whenever the question occurs to them. And the problem with the classroom setting is that the classroom doesn't account for what goes on in the course. In fact, a lot of the time that people put into a course they are putting in outside the classroom, so they don't have any access to the instructor. Plus, it doesn't always have to be the professor. And there was a lot that went on during this course, with students asking questions and other students answering those questions. I would often hang back just to give students a chance to answer questions. And it really happened a lot. It was, they were helpful to each other, it was a really cooperative feeling for students in the course. At least one, two or three people said, that it was the most faculty-student interaction, and the most student-to-student interaction that they had had in a University of Calgary course. Which is possibly true, if you think about what they mean by faculty-student interaction, not just listening to the professor in the classroom, but getting to converse, and have questions, and get those questions answered."*

One of the perceptions or concerns often expressed about computer-based distance education is that faculty and student interaction may become impersonal, sporadic, and a be a poor imitation of face-to-face interaction in a classroom. It appears that in this web-based course, faculty-student and student-student interaction was actually facilitated using a listserver for conversations about the course and for addressing questions and concerns.

The instructor was asked to comment on how student submitted coursework and completed exercises on-line, how grading was managed, and potential concerns about security.

> *"The credit exercises were, they work as a web page that is basically JAVA script based, and interacts via CGI with a PERL script on the server. They were developed from a model, and the programmer worked it so that there is a countdown timer. Students load the page, they have 20 minutes to answer all of the questions, and if they are still hesitating the page submits itself. And they score what they have done in 20 minutes. The security concerns surrounding this were tremendous, and occupied a lot of our time figuring out how to prevent them from subverting the clock, and how to prevent them from getting a hold of the page before they, before the time that they got the page, had a major impact on development. I don't think we ever solved all of those problems, although it is a*

> *pretty good system. I wouldn't want to use it in a course where a lot of students think they can make money by passing the course. It is probably fine for (this course) because the competition to get this qualification in (the language) is relatively limited by comparison."*

This instructor suggests that a consideration of security issues must also include an analysis of student motivation for academic misconduct. In a high stakes assessment situation, such as a certification or licensing examination, or in courses where one student's success depends upon another student's failure, the security concerns may be very different from a course where collaborative learning and teamwork are encouraged and expected.

Confirmation

After teaching a web-based course for the first time, how does an instructor know whether the investment of time and effort has resulted in the desired outcomes? This individual described some of the motivators and impediments to teaching a web-based course that impact her/his evaluation of the relative advantages of continuance or discontinuance. One of the motivators for offering this course again is the interest expressed by geographically dispersed students who want to participate.

> *"There has been a lot of interest in the course since it has been offered, from people in often very remote places who are interested in the subject matter, but sometimes surprisingly unremote (sic) places. I got an e-mail from somebody in Los Angeles, who wanted to take the course via the web in Calgary, presumably because it would be more convenient to do that than to get to, I presume they do have universities in Los Angeles somewhere, along the interstate. But, I have also had inquiries from people in New Zealand, and one in Turkey."*

The instructor was asked to comment on off-campus student registration procedures for the course, tuition fees and the nature of classifications, such as part-time and/or unclassified.

> *"I don't have an answer for that now that will last for all time. The University will have to rule on this soon, and make a decision about how it is going to work. The last run of this course, in Spring 1997, originally when the student from Texas and the student from Massachusetts expressed interest in registering in the course, they were told by our Registrar's office that they would have to pay international student's fees, which is double our Canadian rate, and that they would also have to pay for Student's Union membership, for athletic facilities, for health services, all of the supplementary fees. And it took quite a series of back and forth e-mails before the Vice-President of Financing Services ruled that they could go for the Canadian fees without having to pay for their towel and locker, and all that. The reason that this is probably not an answer for all time is that there are also problems*

with that solution. ...there is an inequity created if students who are registered in the course from off-campus are paying less than students who are registered in the course on-campus. Is it better to move to Winnipeg and take University of Calgary courses, than to live in Calgary and take UofC courses? And so, my guess is that some other solution will be the final solution. But not at much of a higher price, because I think that the University can make money by marketing faculty expertise here to places that do not have it."

It appears that there are some institutional impediments that will have to be overcome to accommodate off-campus student participation in web-based course offerings at the University of Calgary.

The faculty member commented on measuring outcomes, determining student satisfaction, and impediments to delivering a web-based course.

"Many students were initially quite excited about the idea of taking a course via the Internet. It solved a lot of scheduling problems for students, which was probably the main thing, but people also liked the idea of experimenting with learning through the technology. The scheduling problems were of various kinds, students took the course who were working full time through the summer. I had one student who had a two year old at home and was eight months pregnant, and would have had great difficulty making it in to a scheduled campus class. There were also the distance problems, students who lived in Red Deer (Alberta) wouldn't have had access to this instruction unless they moved here to do this. People were also quite apprehensive at the beginning of the course. Some of their apprehensions turned out to be true. Mainly, there were technological problems for a lot of students, mostly with their own set-up. We weren't trying to exclude people, but we were also trying to use the most effective and more recent web technologies. So, stuff like RealAudio, which demands it's own plug-in, and stuff like frames and tables in Netscape, JAVA script and JAVA limitations. So, for each one of those things, something particular has to be true about your system. You have to have a certain version of Netscape in order to deal with frames and tables, you have to have the plug-in for RealAudio, you have to have a very recent version of Netscape and have your little box ticked or JAVA won't work, and JAVA script doesn't work with other browsers the way it does with Netscape, and so on. And there were hardware problems as well. So we had all of those problems!"

The instructor described some of the activities and features of the web-based course that seemed to appeal to students.

> *"I think there were lots of elements of this course that the students really liked. They really liked the audio. They really liked the exercises, particularly the fact that you could do the exercises over and over again until you got it. There was one kind of exercise ... that was just a flash-card exercise, with a JAVA applet. It showed you a (language) word, and when you were ready you click, and it showed you the translation, or the grammatical category, or things like that. It showed up in different lessons in different ways. And they loved that one."*

In addition to her/his own observations about student reactions to the course, the instructor drew upon anecdotal student comments about the relative benefits of this style of instruction and course participation.

> *"My feeling is that it works. My feeling is that it actually worked better for the students that were taking the course. They learned more of the subject matter, and had more depth of knowledge of the subject matter, than students who took the course in a classroom setting. I think that the classroom is not the best arena for this kind of material. One of the students had actually taken a prior (language) course, and said that she thought she had learned more in the first two weeks of my course than she had ever learned in the course that she took in the classroom setting."*

This instructor plans to analyze and report on the archived listserver discussions to further explore the nature of student interactions in the course, as well as teaching the web-based course again to further evaluate the efficacy of this distance education medium.

Summary

This case-by-case analysis of seven interviews with early adopting faculty members who are expert teachers represents a first attempt to model Sternberg's (1997) framework for documenting and profiling teaching excellence. The seven cases presented here provide some insight into the development of expertise, experiences, dispositions, decision making, and motivation for technology integration efforts of early adopting faculty members who are also excellent teachers. The outcomes of this research provide useful accounts of the individual experience with technology integration, as well as insight into the beliefs and values of individual faculty members, their expectations for outcomes and benefits from using technology for teaching and learning, and a variety of instructional strategies they use to support educational processes. There is some consistency in what the individual faculty regard as important and valuable instructional goals, and also diversity in the characteristics of instructors and their specific instructional methods for integrating technology into teaching and learning. Case 1 and Case 3 allow readers to compare and contrast the characteristics and teaching methods of a faculty member who is relatively new to technology integration and a faculty member who has used technology in teaching and learning for over twenty years. Case 2 and Case 4 present two perspectives on the administrative and cross-campus issues involved in widespread adoption of technology. Cases 5, 6 and 7 allow readers to compare and contrast the experiences of three faculty members who have designed teaching and learning activities that involve the World Wide Web. A goal that was accomplished with this research was the generation of descriptive accounts that provide interested faculty members with a means for drawing parallels and contrasts between the early adopter profiles and their own educational practice.

The seven cases presented here were reconstructed from interviews using a constant comparison method, and depended upon the individual's retrospective analysis of their technology integration efforts and teaching philosophies. Future research that attempts to profile early adopting faculty who are excellent teachers could also employ a longitudinal observation and interview methodology to be more informative. Although it was not a goal of the present investigation, future research of this kind may also choose to profile excellent teachers who do not integrate technology into their teaching and learning to facilitate a comparison with the early adopter cases presented here.

Chapter Six
DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

> One of the greatest pains to human nature is the pain of a new idea. It ... makes you think that after all, your favorite notions may be wrong, your firmest beliefs ill-founded.... Naturally, therefore, common men hate a new idea, and are disposed more or less to ill-treat the original man who brings it.
>
> Walter Bagehot (1873), Physics and Politics
> (Rogers, 1995, p. 335)

The mixed-method research design employed in this study yielded quantitative and qualitative data that was distinct but complementary about adoption patterns and respondent characteristics. The survey, open-ended response, and interview data gathered provided information about why integrating technology is so appealing to some faculty members, but not to others. This chapter begins with a discussion of the results of this investigation with regard to the research question, and using an on-line research methodology. The findings in this investigation both confirm expectations from previous research, as well as uncover some surprising results that nevertheless make sense when viewed from Rogers' (1995) theoretical framework. The second section of this chapter will discuss the implications of these results, and make suggestions for future research. There are some limitations to generalizing the results of the present investigation, and areas that require and deserve further study. Finally, this chapter concludes with recommendations for individual faculty and institutional leaders for technology integration plans that may address the gap between early adopters and mainstream faculty, as well as promote a culture of inquiry into fundamental teaching and learning issues.

Contribution to Knowledge

The survey instrument used in this investigation was designed and constructed by the present researcher based upon a review of the literature and expert judgement. Although some of the measures have been successfully used and validated in previous investigations, such as the patterns of computer use, generalized self-efficacy scale, and Hadley and Sheingold's (1993) measures, the arrangement and presentation of the entire collection of instruments was new, and therefore, untested. This study contributed to the validation of Hadley and Sheingold's (1993) subscales, changes to teaching and learning, incentives, and barriers, with a post-secondary teaching sample. This study also provided additional evidence for the unidimensionality, reliability, and validity of the Generalized Self-Efficacy Scale when administered in an on-line, web-based environment with post-secondary teachers. The following section will bring together the survey and interview results of this investigation with regard to the research question, and discuss the application and validation of the on-line research methodology.

Answers to the Research Question

The primary research question and purpose of this exploratory study was to better understand why the integration of technology for teaching and learning is so appealing to some faculty, and not to others. The survey data corroborates Rogers' (1995) theory in that, based upon adoption patterns and faculty innovativeness, there are statistically significant differences between early adopting faculty and mainstream faculty on several variables. The survey data also provided information about trends, issues, and concerns about technology integration by post-secondary instructors. Qualitative data from open-ended responses and interviews contributes corroborative evidence for Rogers' (1995) theory by providing additional insight into the incentives and motivations for adoption, and the similarities and differences between EAs. These methodologies also provided in-depth descriptions of instructional strategies, expected outcomes and methods for evaluating the integration of technology for teaching and learning. The rich qualitative data collected from open-ended responses complements and facilitates further interpretation of the results provided by the survey data, corroborates Rogers' (1995) innovation-decision process, and provided a forum for the open discussion of ideas by both earlier adopters and mainstream faculty. Together, the survey and interview information demonstrated that EAs and MF experience different motivators and impediments to integrating technology.

Early Adopter Characteristics

Early adopters are more likely to have first used computers on campus as a student, and use computers for more hours per day than mainstream faculty. However, an unexpected result was that EAs have similar computer ownership patterns to MF for personal/home and professional use. The hypothesis here is that early adopters are more likely to have first used powerful mainframe computers because of their higher relative advantage which may have affected, that is, delayed and moderated, their desktop computer purchasing decisions. As expected, EAs report higher levels of expertise than MF for 38 (86%) of the 44 types of computer software and tools, and earlier use in teaching for 27 of the 44 types of measured types of instructional technology. This result provides evidence for the breadth of EAs' relatively higher *innovativeness*; they are earlier in adopting many forms of technology than other members of the social system for both personal use and for use in teaching. Technology seems to hold a high, intrinsic attraction for early adopting faculty who view technology as fun and challenging. It is interesting to note that EAs tend to teach more students per semester than mainstream faculty (i.e., 125 vs. 75). This finding suggests that EAs are integrating technology beyond the pilot projects, beyond the smaller classes with more “experienced” students. With regard to changes to teaching and learning, EAs identified in this study tend to believe they are better able to tailor students' work to their individual needs and that they spend less time with the whole class practicing or reviewing material. EAs are confident that they can effectively integrate computers into instruction, and rate computers as compatible with the course or curriculum that they teach.

Evidence was also found that EAs integrate technology into their teaching earlier than MF. EAs used 27 of the 44 types of software and tools sooner than MF. EAs have used tools such as UNIX, desktop publishing, spreadsheets, databases, newsgroups, FTP, Gopher, WWW browsing and searching, WWW page creation, graphics and presentation software, on-line video and audio, Hypercard, HyperStudio, and other types of instructional software earlier in their teaching than mainstream (Appendix G). However, a somewhat surprising result was that there were no differences for EAs and MF for word processing and e-mail, the two most widely diffused applications for teaching and learning. It appears that the relative advantage and compatibility of these two tools is relatively high for both groups, perhaps because of the nature of academic work.

Some initial evidence for the higher self-efficacy of EAs versus MF was found in this study. EAs believe in their ability to solve difficult problems if they try hard enough and invest the necessary effort, and are confident about their ability to deal efficiently with unexpected events. These findings corroborate Rogers’ (1995) descriptions of the early adopter, as well as Weil and Rosen’s (1997) description of the eager adopter who expects to have problems with technology and are convinced that an answer is close at hand. In fact, Weil and Rosen’s (1997) eager adopters find personal fulfillment and satisfaction in solving problems with technology. However, these results should not be interpreted as evidence that mainstream faculty have low self-efficacy; in fact, results from the entire sample suggest that participants in this study have relatively high self-efficacy overall.

EAs tend to prefer certain methods for learning about computers more than MF. In terms of help or assistance with using computers, EAs ranked experienced graduate students as more important than MF. The EAs’ self-confidence with the technology, and greater enjoyment figuring out how to use computers effectively for a variety of teaching situations probably contributes to the value they place on graduate students who share this interest, speak their language, and may contribute to further building and extending their current knowledge and skills. This hypothesis finds further support in the higher importance that early adopters place on innovative graduate students for keeping abreast of changes/innovations in the area of computers.

It is likely that early adopting faculty and graduate students who are attracted to technology are homophilous and tend to develop stronger communication relationships with each other than those who are heterophilous (i.e., not alike on the categorical variable of interest). The hypothesis here is that the homophilous communication relationship represents an expert subculture, or informal network, that embodies the ideals and goals which help direct the early adopter's on-going development, and provides support, cooperation and recognition of success. Bereiter and Scardamalia (1993) described the expert's second-order environment, in which each expert's advance in technology, strategy, or contribution to knowledge, sets a new standard which others try to surpass. Individual experts do not merely adapt to constant change; instead, they adapt to changes that keep raising the ante, by setting a higher standard of performance, by reformulating problems at more complex levels, and/or by increasing the knowledge that is presupposed.

The early adopter's second-order environment, or expert subculture, may also explain why EAs in this study rate popular computer magazines, refereed computer journals, conferences, demonstrations and workshops, on-line computer newsgroups and websites as more important sources of information for keeping abreast of changes and innovations in the area of computers than MF. The communication channels for information about the innovation chosen by the EA as important tend to be homophilous in nature, although "diffusion demands that at least some degree of heterophily be present or there is no new information to be exchanged" (Rogers, 1995, p. 19). Publications by and meetings with other EAs give the individual EA an opportunity to build and extend their knowledge base and skills. The EAs more heterophilous MF peers may find these sources of information to be ineffective for their learning needs, or quite literally, to be in a different language.

The results from interviews with EAs suggest that there is a relationship between early adoption, motivation, and excellent teaching. The motivation to integrate technology in their teaching tends to be located in some EAs beliefs about excellent teaching. Many of those interviewed described ways in which technology enables them to be a better teacher, provide enriched learning opportunities and access to information, and improve communication with students. EAs seem to exhibit characteristics of expert-like learning, such as progressive problem solving, belonging to second-order environments, and flow. They often describe or refer to their extensive experience and knowledge about the technology as a given, *"it is not rocket science,"* which suggests they take for granted their greater literacy and fluency with computers, but might also be a sign of indifference or lack of awareness about how others struggle with the technology. However, it must also be said that most of the EAs interviewed, who have first hand experience with the unreliability of computers and anticipate problems, demonstrate empathy for colleagues who encounter bottlenecks or problems with the technology.

EAs appear to regard technology knowledge and skills as one type of expertise, and pedagogical skills as another type of expertise. Some EAs cringe at the awkward and ineffective uses of technology by their peers, and are convinced that technology cannot improve poor teaching. EAs interviewed in this study seem to be constantly changing teaching and learning processes, reformulating and pushing the edges of the problem, creating and designing alternate solutions, and seem to be more content with risk-taking than the status quo. Not only do EAs appear to have the self-confidence in using technology for teaching and learning, EAs have intrinsic motivation and a belief structure that integrating technology into their teaching is the right thing to do. An individual early adopter explained in an interview that they apply technology in their teaching because it is the solution to her/his problems, not a solution looking for a problem.

EAs are concerned about student evaluations of their teaching, and student access and equity issues, but many continue to integrate technology because of their enduring beliefs about the relative advantage, and the potential benefits and value of computers for students. EAs described some of the same impediments that other faculty highlighted, such as equipment and software failures, poorly designed classrooms, and slow and clumsy Internet connections. However, a subtle difference was that these difficulties seem to be expected, the EAs locate the problem in the technology rather than themselves, and do not appear to be deterred by these impediments.

Because of their different levels of computer use and years of experience, each EA appeared to have a unique innovation-decision cycle. For example, most of the EAs used the WWW for demonstrations in their classroom, some of them published information to the web, and only a few required their students post work on the web. Only one described the development and delivery of a web-based course. One EA was convinced of the benefits of web-delivered instruction, while another only considers the web as an enhancement to face-to-face instruction. These differences are consistent with Rogers' (1995) suggestion that the same innovation may be desirable to one early adopter in one situation, but undesirable for an early adopter in another situation. Some of the EAs described events that have lead to their current adoption patterns, and others described factors that may lead to future adoption, discontinuance, or rejection. Current fiscal realities are impacting the EAs as well as the mainstream. Some EAs purchase software using personal resources, even though funding is not available on campus, because they believe the application is important for instructional goals and students' learning processes. The adoption of presentation software is undesirable to some EAs, not because of lack of skill, but because there appears to be little relative advantage; the impediments include poor lighting and unreliable equipment, and interactivity is perceived to be low.

EAs described their frustration with the annual review process and funding agencies that seem to undervalue their teaching and technology integration efforts. Further, for many EAs, who are working at the edge of their fields and developing new teaching and learning environments, it is disheartening to be evaluated by department heads and peers who may not share the same belief structure and often fail to understand the significance of and motivation for their work. EAs also describe frustration with the "insufficient evidence" argument put forth by peers who do not share their beliefs about the benefits of this type of research and teaching. Two EAs described the difficulty of doing experimental research on the benefits of technology integration with students because of equity concerns about the control group who does not get the technology intervention.

There were clear signals that some EAs feel left out of the current planning and decision-making processes in their faculties or departments. Two individuals described situations in which their opinions and expertise were not been called upon by committees when major technology planning was being done and decisions were being made about the acquisition of technology for teaching and learning.

EAs offered some solutions for bridging the gap between themselves and MF. One faculty member described the potential trialability and reduced complexity benefits of giving each faculty member their own laptop computers, while another described a campus example where even gifts of computers did not encourage all faculty to adopt. Another EA suggested providing training and support to increase the comfort level and how-to knowledge of other faculty so they can approach any piece of software and figure it out (i.e., perhaps to become more like an early adopter?). One individual called for increased standardization of hardware, software, and networking in order to make it very convenient for faculty and students to use the technology, and increase the amount of "just in time" training and support by building more critical mass technology skill and knowledge on campus. Another proposed solution from an EA was to give experienced faculty members course reductions so that they can invest time creating and developing technology-enhanced curricula that can be standardized throughout a department or faculty.

In some cases, EAs had strong opinions about why mainstream faculty do not adopt technology that may be inaccurate and not supported by research, such as other faculty are too old and fearful about their jobs to adopt. However, the one characteristic that all EAs appeared to have in common was a willingness to share their knowledge and expertise in some way to encourage further adoption of technology by peers.

The interviews proved to be a valuable way to gather in-depth information from and about EAs. Rogers (1995) calls for more diffusion research into the "why" or motivations for adopting an innovation, and interviews with EAs extended our understanding of and provided insight into the EAs motivation to integrate technology. A comparison of the interviews reveals that EAs have both common and unique: (1) values, beliefs and characteristics, (2) expectations about outcomes and benefits from integrating computer technology, (3) integration processes to attain outcomes, (4) specific instructional strategies that support educational processes, and (5) motivators and impediments to integrating computer technology.

Patterns of Computer Use

Evidence was not found in this study to support the perception that mainstream faculty members are hesitant or fearful about using computers. Instead, over 90% of respondents use computers for their research and professional tasks, and close to 85% say they have used computers in some way for their teaching tasks. It is important to interpret the teaching result with caution because it does not reflect incidences of rejection or discontinuance. Over 90% of respondents own a computer for personal/home use, and close to 85% own a computer for professional use. Over 60% of respondents have owned more than 5 computers since buying their first one, and over 30% have owned 6 or more computers. Respondents are generally quite heavy computer users, with approximately one-third using computers up to 3 hours per day, almost 45% percent using computers from 3 to 5 hours per day, and one-fifth of faculty using a computer for more than 5 hours per day. Thus, for the majority of these respondents, computers are an everyday part of their work lives.

Overall Faculty Expertise

Based upon measures of faculty expertise, survey data collected in this study provides evidence for widespread diffusion of over half of the different types of software and tools into the late majority, and diffusion of almost one-quarter of the software into the early majority. The four software types that show the greatest Total Adoption by these faculty respondents are word processing, e-mail, WWW searching and browsing, and on-line databases or library catalogues.

Evidence for the Total Adoption of technology tools that support writing, research, and communication tasks is not surprising given the nature of academic work. Rogers (1995) predicts that the higher degree of compatibility between the innovation and current values and beliefs, the faster the rate of adoption. Findings comparing faculty respondent's expertise with the year that individuals first used the software or tool in their teaching provide evidence that faculty tend to develop a level of personal expertise with a particular computer technology before attempting to integrate it into their teaching. This finding is hardly surprising, but it does suggest that respondents in this study have sufficient awareness and how-to knowledge with a wide range of technologies to make informed decisions about the further integration of these tools into the classroom. The innovation-decision period is the length of time required for an individual or organization to pass through the innovation-decision process (Rogers, 1995). The rate of awareness-knowledge for an innovation is more rapid than its rate of adoption.

One explanation for slower adoption of computers for classroom use may be found in access; nearly one in five respondents (18.4%) indicated that ready and convenient access to computers and/or software for teaching tasks was inadequate or inconsistent. Other explanations may be found in the changes to classrooms, incentives, and barriers to integrating technology for teaching and learning, which will be discussed in a subsequent section. What appears to be lacking for many faculty respondents who have yet to adopt technology for classroom use is a *compelling reason* to integrate technology, and sufficient evidence about the *relative advantages* of doing so.

Classroom Use

This study provides evidence that the diffusion of technology for classroom use seems to have increased over the last few years. Of the 44 types of computer software and tools measured in this study, 29 have been used in the classroom by more than 16% of respondents and thus, have exceeded critical mass. Three types of software have diffused into the late majority, which means that more than 50% of the respondents in this study have used word processing, e-mail, and the World Wide Web in some way for teaching and learning. Again, it is important to be cautious when interpreting the adoption for teaching results as they do not reflect incidences of discontinuance or rejection.

It is particularly interesting to look at the different innovation-decision periods for word processing, e-mail, and the World Wide Web. For example, let us assume that word processing became widely available for classroom use in 1975, even though it was probably available even earlier. Faculty adoption of word processing for classroom use took 11 or 12 years to reach critical mass between 1986 and 1987, and took another 6 or 7 years to diffuse into the late majority by 1992. Assuming that e-mail was available in 1975, faculty adoption for classroom use took 16 or 17 years to exceed the critical mass stage between 1991 and 1992, but only 4 years to diffuse into the late majority by 1995. This result may be explained by increased network capacity, reduced complexity, and increased access for all students on campus. The WWW became available around 1990, faculty adoption for classroom use took 3 or 4 years to reach the critical mass stage between 1993 and 1994, and took 3 or 4 years to diffuse into the late majority by 1997. To be sure, the shorter innovation-decision cycle after reaching critical mass of the WWW and e-mail compared to word processing is probably related to greater network access and facilities on campus, the lower price and greater availability of desktop computers, and the reduced complexity of graphical user interfaces. The qualitative data collected in this study provides evidence that faculty also attributed greater relative advantage and more observable benefits to integrating the WWW and e-mail for teaching and learning faster than they did for word processing.

There appears to be tremendous potential for the Internet and the Web to enhance traditional modes of education for teaching, student-centered learning, and research activities at the university. Landauer (1995) described poor design as one of the biggest troubles with computers, and suggested that "... we need to make computers into much better tools for work, both for the work of individuals and for the work of organizations" (p. 136). Companies like Netscape and Microsoft, seeing the commercial opportunities in Internet-based distance education, have begun to develop integrated distributed learning environments which combine powerful Internet-based collaboration tools such as e-mail, synchronous and asynchronous discussion, shared work spaces, Internet-based computer and video-conferencing and access to the WWW into common easier-to-use browser applications that can be used for education and training delivery. So, the compatibility between computers and teachers may be increasing as tools are developed specifically for educational uses. Respondents described many examples of how they are using Internet tools for teaching and learning, from e-mail to on-line databases, and for web-enhanced and web-delivered instruction. However, the learning curve for utilizing electronic networks and the Web for teaching and learning is still steep, even for some EAs, and can make full-fledged adoption for classroom use seem like a complex task, for both teacher and student. The technology itself may be becoming somewhat easier to use, but the pedagogical applications and implications are not always clear.

The perceived characteristics of the innovation, such as relative advantage, compatibility, complexity, and observability, impact the innovation-decision periods of potential adopters (Rogers, 1995). Evidence was found in this study that suggests that later technologies, such as Macintosh, Windows 95, e-mail and the World Wide Web, are adopted faster by more members of the faculty social system. Rogers' (1995) concept of interrelatedness provides an explanation for these shorter innovation-decision periods. Interrelatedness suggests that an adopter's experience with one innovation usually influences their perception of the next innovation in a technology cluster to diffuse through their social system. Early computer technology was harder to use, harder to learn, more expensive, unreliable, and in the case of mainframe instructional software, showed limited gains for production time; in short, earlier technology was complex with little relative advantage. In contrast, current technology is somewhat easier to use with graphical interfaces and point-and-click interaction, easier to learn, less expensive, more reliable, and there are better applications designed specifically for educational applications and delivery. As the perceived characteristics of technology change, and there is increased relative advantage, more compatibility, reduced complexity, and observable gains for teaching and learning, then more MF may be motivated to adopt and integrate technology.

Changes to Teaching and Learning

Respondents agreed with most of the statements about changes to teaching and learning, which suggests that faculty hold similar beliefs about the results of integrating technology as do K-12 teachers (Hadley & Sheingold, 1993). While most of these statements describe direct benefits to student learning, it is clear that respondents are aware that it takes more time to prepare materials and resources when they integrate technology. Most of the faculty responses mentioned the increased time spent developing and preparing for instruction, learning to use technology, deal with technical problems, and many discussed how provisions must be made for student access and training with the technology. Earlier adopting faculty may have more effective strategies for applying previously learned technology skills than do mainstream faculty, and as a result enjoy some return on their investment of time. Only a few respondents predicted or described a pay-off for this investment of time, so the perceived relative advantage of integrating technology is not clearly related to time savings for MF. For many respondents, the jury is still out on whether there are great gains, or any at all, to be made from investments of time and resources to integrate technology into teaching and learning on campus.

In addition to concerns about greater demands upon limited time resources, some respondents are clearly frustrated that their greater “just in time” training and support needs are not being met, and worse, that when they try to get assistance, the helpers seem to speak a different language. There appear to be heterophilous communication barriers between service and instructional staff, and also between EAs and MF. Gilbert (1995) predicted the cultural challenge of facilitating communication between the “techies” who like to tinker with technology, and the “teachies” who regard technology as a possible solution to a teaching and learning problem. MF will not feel confident making the leap to integrating computers in their classrooms when they cannot seem to get the type of help and training they want for professional and research tasks.

Respondents appear to be split on the relative benefits and drawbacks of changes as a result of integrating technology into teaching and learning. A number of respondents are enthusiastic about the benefits of using the WWW, e-mail, and tool applications in their classrooms. Among the learning benefits described are accessing shared resources on the Internet, on-line publishing, interaction and communication through e-mail, better writing and presentation skills, and improved learning of difficult subject matter. It seems that technology can support a shift from a primarily transfer mode of instruction to a more knowledge-construction emphasis, but not all faculty consider the changing teacher and student roles to be a relative advantage. Some faculty *and* students prefer traditional approaches to instruction. Some of the negative changes that seem to accompany the integration of technology are problems with student access and equity, different levels of student's prior computer experience, the relative appeal of technology to students, and the increased need to provide computer skills training. Some respondents believe that the shift to technology will ultimately impoverish students and reduce the value of their post-secondary education. As a result, there is a gap between faculty who are experiencing success with their integration efforts, faculty who are discouraged by the limited returns on time invested, and those who believe that technology is simply not the answer.

Motivators and Impediments

Some of the incentives and barriers that both EAs and MF experience with technology have become clear through previous discussion. Faculty members do not operate in isolation, and are necessarily affected by external factors in their environment and social system. The following section brings together results from the incentives and barriers subscales, as well as open-ended and interview data, to summarize the common motivators and impediments that faculty encounter when they are making the decision to adopt or reject technology for teaching and learning.

The highest rated incentive for integrating technology into teaching and learning is the intrinsic gratification that respondents get from learning new computer knowledge and skills. Both EAs and MF seem to enjoy learning new things about computers. However, the greater enjoyment that EAs experience may be related to the incremental amount of time needed to add to their existing repertoire of computer knowledge and skills, and the greater success they experience integrating technology into their teaching. It is likely that MF have to invest more time developing a repertoire of computer knowledge and skills, as well as investing time figuring out how to integrate technology into their teaching. Therefore, the greater amount of time needed by some MF for these two tasks may not translate into the same intrinsic enjoyment and relative advantage that EAs experience using technology.

The most common incentives to integrate technology include providing enriched learning opportunities for students, increasing student satisfaction, the change from being a lecturer to a facilitator, the informal recognition and support from colleagues, and the time saving and efficiency benefits of using technological tools for creating presentations, calculating grades, demonstrating complex content, and communicating with others. Some faculty have realized personal benefits of using computers and want to extend these to their students. The incentives of "becoming a better teacher" and the shift towards more "student-centered instruction" with technology are very important to some faculty, but less important to others. Many respondents believe, and rightly so, that they can become excellent teachers and design student-centered instruction without technology. Some faculty are motivated to integrate technology in effective ways to provide models for others who they believe are using technology ineffectively.

Respondents described conditions that would provide a more motivating environment for integrating technology in their teaching, such as release time for training and course development, better student access to technology, grants and financial support, technical support, inexpensive and convenient training, and evidence that technology adds value to student learning over conventional methods.

Many of these desired incentives are related to the barriers that faculty describe that influence their decision to adopt or reject technology. Respondents agreed with most statements about barriers, which suggests that faculty at all stages hold similar beliefs about impediments to integrating technology as do K-12 teachers (Hadley & Sheingold, 1993). The five barriers that respondents agreed with most strongly are a lack of time, problems scheduling computer time and resources, too few computers for students, inadequate financial support from administration, and the lack of a reward structure that recognizes faculty for integrating computers for teaching and learning. Faculty members elaborated upon infrastructure barriers, administrative barriers, and the lack of evidence for learning gains over conventional methods in open-ended responses and interviews.

The communication and collegiality gap perceived by MF between themselves and EAs may be related in some way to the limited time resources of all faculty. It is unlikely that EAs do not want to help others, and probably spend a great deal of their time sharing knowledge and skills with their MF peers. However, EAs also have research, teaching and service responsibilities of their own, and cannot be expected to take on the one-on-one training of novice peers over and above their present workloads. This gap may also be related to the homophilous second-order environment enjoyed by EAs that may exclude MF. EAs probably do speak a different language, and conferences and workshops about high-end applications of technology are far beyond what the MF member wants or needs in order to integrate technology in their classroom.

There is clearly a gap between the convinced and unconvinced with regard to the observability of benefits that technology adds to the classroom. While some respondents are convinced that technology enhances specific learning outcomes, others want conclusive evidence that integrating technology is superior to what they are doing now. The "insufficient data" gap appears to be one-sided, and may be related to who has first hand knowledge of what technology *can* contribute to specific teaching methods and learning outcomes, and who does not. Thus, the incentive for some respondents, their belief that technology adds value to instruction, is a barrier to others who fail to see any relative advantage from integrating technology for teaching and learning.

When The Rubber Hits the Road

Eloquently summarized by Bagehot (1873), and noted at the outset of this chapter, there may be hesitance or resistance to accept technology because it represents a fundamental change, and those who bring the message of change will not necessarily be welcome. Some faculty members have observed increased resistance to technology in the classroom that replaces a previous attitude of indifference. Others have discussed the status quo, and the goal of some members of a social system to enjoy and to actively preserve the lifestyle and career conditions they have achieved. It seems to be human nature for some people to want to enjoy established ways, rather than attempting to change them, or take part in the changes around them without strong evidence of the relative advantage of doing so. The individual who is interested in preserving the status quo may not be receptive to a change agent who promotes new ideas. Because we are talking about the changes to teaching and learning that technology can demand and require, let us use the analogy of a school bus in an attempt to sort out some of the different attitudes and dispositions in a faculty social system.

Before computers became widespread, and their potential influence on many aspects of society was unclear, faculty members were able to ignore technology without worrying about its impact on them personally. However, now that the rubber has hit the road, and there is clear evidence that computers have become an essential part of our lives and will not go away, we cannot expect all faculty members to immediately get on the same school bus and go in the same direction at the same time, especially if administration is driving. Innovators and early adopters will get on the bus, eager for adventure, will not need a clear map about where the bus is going, but will be convinced that the trip will be exciting and worthwhile. A few will prefer to design and build a new bus, point it in some direction, and start driving. A number of mainstreamers will get on the bus, if they are provided with a clear map of where the trip will take them, given a list of supplies to bring, told when they will get there, how they will know when they have arrived, and offered training on what to do while they are there. Some will attempt to shoot out the tires on the bus, and others will argue that they do not have time to go on the trip. If widespread adoption is the goal, then the question is, who should drive the bus? Is it essential that there be only one kind of bus, or can the university accommodate a number of buses going different directions?

Both individual early adopters and institutions have to be aware of the resistance to new ideas, especially those to do with technology because of the perceived characteristics of this innovation by the mainstream: computers are complex, they do not offer readily observable relative advantage, computers may not be compatible with present ideas about teaching and learning, and without some support, computers cannot be experimented with on a limited basis. Although EAs are more comfortable with the risks involved with technology, there is uncertainty, by both EAs and MF, that technology can represent a superior alternative to the previous practice that it might replace. Recommendations for technology integration plans cannot be based upon the assumption that the adoption of technology is a desirable option for every faculty member.

On-line Research Methodology

The on-line survey methodology used in this study presents a new way of looking at an old problem. Findings in the present study suggest that the Internet is a very promising method of conducting psychological research. Almost three-quarters of respondents chose to participate using the web-based survey compared to a conventional method of participation. In the present study, the unidimensionality of the Generalized Self-Efficacy Scale was confirmed using factor analyses which replicates previous findings for an Internet survey method (Schwarzer, Mueller, & Greenglass, 1998). In the present study, estimates of the internal consistency of five subscales yielded coefficient alphas ranging from .88 to .93, which are relatively high ratings of item homogeneity and indicates that faculty responded consistently across items. The web-based survey proved to be a feasible method for collecting both quantitative data using scaled, selected-response items and qualitative data using open-ended response items. A majority of faculty took advantage of the opportunity to respond and provided rich, qualitative data; the average length of faculty responses ranged from 34 to 55 words.

Method of Survey Participation

The purpose of piloting a web-based version of the survey was to examine whether this method of data collection would yield equivalent results to conventional paper-based method. A comparison of the survey data based upon method of participation showed that there were statistically significant differences between the electronic and paper respondents for 1 out of 5 items. Differences for the two parts of the computer experience subscale were negligible, which suggests that faculty expertise and faculty innovativeness are not strong influences on whether respondents chose to participate using a web-based or paper-based method.

Overall, the electronic and paper groups differed on 6 of the same variables that EAs and MF differed upon. Both electronic respondents and EAs are more likely to have first used computers on campus as a graduate student, to have used WWW page creation and editing earlier in their teaching, enjoy figuring out how to use computers effectively in teaching more, and regard computer journals, conferences, and on-line newsgroups and websites as more important sources of innovation information than the mainstream and paper respondents. It is likely that respondents who access the Internet often, to author webpages and to seek out newsgroups and websites, regarded their participation in a web-based survey as a natural extension of their habitual patterns of computer use. Ready access an Internet-capable computer may also make the web-based survey more appealing.

The electronic respondents were likely to be younger, have fewer years of experience as a faculty member, and have first used computers for personal, professional academic tasks approximately 4 years earlier than the paper respondents. These findings are similar to the characteristics of earlier adopting faculty reported by Anderson, Varnhagen, and Campbell (1997). Those who participated using the web-based survey were more satisfied with the support and training on campus for teaching tasks and were more positive about current campus investment plans to acquire computers for teaching and learning activities. The electronic participants rated media center support staff as more important in terms of help or assistance using computers, as well as publications from major computer vendors as more important sources of information about changes/innovations in the area of computers.

Those who used the web-based method of participation indicated higher levels of agreement with more than half of the incentive items. Electronic respondents agree more strongly than paper respondents that computers: (a) help them to make a subject more interesting, (b) enable them to communicate more with students, (c) provide a means to expand and apply what has been taught, and (d) appeal to a variety of learning styles. The higher agreement expressed by the electronic respondents may be an indication of their relative success at integrating technology into teaching and learning for these purposes. Web-based participants also agree more than conventional participants that by integrating technology they are helping students to acquire the basic computer education they will need for future careers, and that students are enthusiastic about subject for which they use computers. Again, these findings may be an indication of the electronic respondents' own greater enjoyment, and possibly greater success, at figuring out ways to use computers effectively for a variety of teaching situations. Indeed, for the learning about technology items, the electronic respondents rated the more independent and self-structured learning methods as more important than the paper respondents. It is possible that participants who responded using the paper method simply do not know, or are reserving judgement about the incentives for integrating technology that are related to specific learning outcomes.

The electronic respondents expressed statistically higher levels of agreement for four of the barriers than the paper respondents. Web-based participants, more than paper-based participants, believe that there are too few computers for students, there are problems scheduling enough computer time for different faculty members' classes, and that the reward structure does not recognize faculty for integrating computers for teaching and learning. These differences may reflect the greater enthusiasm of the web-based participants for using computers for teaching and learning, and thus, greater dissatisfaction with access issues. It is difficult to speculate about reasons for the higher agreement expressed by the electronic respondents that there is less control over classroom instruction when using computers. One cannot conclude whether less control is a desired or undesired learning outcome. Certainly, one can speculate that with a shift from teacher-directed to more student-centered learning, less control may be a desired learning outcome.

To conclude, the findings reported here suggest that the web-based method of survey participation currently may be more appealing to a different, but not necessarily early adopting, segment of the faculty population than paper-based methods. There are some characteristics that are shared by electronic respondents and early adopters, and this study cannot decisively conclude whether there is a relationship between method of participation and early adoption. It seems safe to conclude that the two survey methods are fairly equivalent, and that a majority of faculty members will find the web-based method of participation appealing. Faculty are adopting e-mail and the WWW at faster rates than computer applications that have been available for longer periods of time, such as tutorials and simulations. Although it is likely that web-based research methods will be an increasingly viable means to collect data from an entire faculty population in the future, a researcher must also carefully consider who may be excluded from their chosen sample if exclusively web-based survey methods are used for an investigation.

Limitations of Present Study

This exploratory investigation used both survey and interview methodologies in order to better understand why the adoption of technology for teaching and learning is so appealing to some faculty and not to others. Although this study has made progress in answering this research question, the results should be interpreted with an awareness of the methodological limitations of this study. The methodological limitations relate to: (1) sample size and selection, (2) generalizability, (3) the variables selected for investigation, and (4) the interview methodology. The following is a description and comment on each of these limitations.

Sample Size and Selection

One limitation of the present study is the small sample size. Despite using a variety of means to invite participation in this study, the researcher achieved a small return rate from the University of Calgary (12.8%) and the University of Alberta (3%). Previous successful research that surveyed academic staff about the adoption of technology for teaching achieved a return rate of 37% in response to a paper-based survey (Anderson, Varnhagen, & Campbell, 1997). A possible explanation for the small return rate may be found in the time of year the study was conducted. Data collection started at the beginning of the winter 1998 semester at the same time that Faculty Annual Reports were due. Sample size may have been increased had the initial invitation to participate been broadcast to the entire academic staff at the University of Calgary, rather than a sample of 500, and if similar sampling procedures were used at the University of Alberta. Although the length of the survey did not appear to contaminate the results, it may have influenced the decision to participate.

The survey relied upon volunteers in groups collectively asked to take part. It is possible that participants who took the time to complete the survey were predisposed to be more positive towards integrating technology for teaching and learning. There is a general sense that there may be more early adopters in the present sample than would be found in the general population. Almost 30% of this sample indicated they taught computer courses; as a result, approximately two-thirds of this sample could be described as technology "users", and one-third as the "techies" who teach about technology. Additionally, awareness-knowledge in the innovation-decision process is influenced by predispositions such as selective exposure and perception. Some faculty may have felt excluded by the very nature and content of the survey. Individuals who do not use technology for teaching may have perceived the survey as a communication message about this innovation, and this awareness may have influenced the individual to not participate in the study. The items themselves may have made some potential participants feel uncomfortable, pressured, or inadequate because they could not answer many in the positive. Therefore, the reported levels of Total Adoption may be over-representative of the population as a whole, and thus their views about barriers more compelling.

This potential sampling bias could be construed as a weakness of the study. However, it could also be argued that those who participated in the study had the best understanding of both the positive and negative aspects of integrating technology, have the most knowledge and experience to contribute to the research question, and have the most to contribute to understanding why the integration of technology is so appealing to some and not to others.

Generalizability

Because the results of this study are based upon a small sample, it is not appropriate to generalize the overall survey results to a larger, potentially dissimilar population. The samples were drawn from two Canadian research universities that have academic staff’s of approximately 1500 to 2500 individuals. Although both institutions have made large investments to acquire technology for a variety of purposes, neither institution requires or provides a computer to every student, nor provides each faculty member with a computer. It would not be appropriate to compare this sample to academic staff from an institution that provides each student and faculty member with a computer (i.e., Acadia, Wake Forest), or uncritically generalize overall results from this study to much smaller or much larger North American institutions.

However, sample size should not be regarded as a complete limitation. More individuals participated in the present investigation than would be feasible to include in a face-to-face, technology roundtable discussion about integrating technology in teaching and learning. Thus, for the purpose of making recommendations for technology plans, the sample can be regarded as adequate. Also, the generalizability of the interview results may not limited by sample size. Previous successful research into teaching excellence only solicited the participation of a small group of participants (Andrews, Garrison, & Magnusson, 1996).

Time of Adoption Variable

A potential limitation of this study is the measurement of time of adoption for teaching and learning without gathering information about rejection or discontinuance. Faculty were asked to indicate “year first used for teaching” for types of computer software and tools, but no quantitative data was collected about subsequent rejection of technology or discontinued use. Qualitative data provided some insight into methods of integration and impediments to adoption, from which discontinuance and rejection can be inferred. However, it is important to be cautious when interpreting the time of adoption for teaching results as they do not quantify incidences of discontinuance or rejection, and may be an overestimate of the current integration of technology on campus.

Single Interview Sessions

A potential limitation of moving the present case profiles of early adopters into instructional practice is that each case is a retrospective analysis and interpretation of one person's end result based upon one interview session. One can expect that these profiles leave a great deal of the early adopter's initial experience out, and therefore may be limited as a primary data source for examining the development of expertise in teaching with technology. Because an expert's processing is largely preconscious and automatic until they encounter novel situations or problems that require analysis (Berliner, 1992; Sternberg & Frensch, 1992), the expert may not be able to provide a full account of what it is that they do and how they think. The more competent domain experts become, the less able they are to describe the knowledge they use to solve problems (Ford & Adams-Webber, 1992). Also, the development process does not unfold in a vacuum (Finnegan, 1997). These first person accounts offer some descriptions of the interrelated factors (i.e., personal goals, motivations, and career choices, other individuals, institutional, systematic) and decisions (i.e., institutional appointment, research and teaching program) that have influenced their adoption of technology, and represent descriptive accounts of some of the early adopter's experiences and views.

However, these case studies are a one-time, snap-shot view from which inferences about the underlying cognitive processes, and the incremental knowledge responsible for evolving them beyond a competent practitioner, are difficult, if not impossible. Therefore, a clear description of the developmental process that leads to expertise in teaching with technology in higher education was not found in this study. Future attempts to describe the motivational aspects of excellent teaching and early adoption of technology should apply the innovation-decision process described by Rogers (1995), research on the development of expertise (Bereiter & Scardamalia, 1993), and employ a longitudinal observation and interview methodology to be informative. Also, each of the present cases concentrates on continued adoption, rather than considering non-adoption or rejection of the innovation. Future research of this type may want to include those who have not adopted technology and are excellent teachers for the purpose of comparing these cases to early adopters, as well as to examine whether their non-adoption of technology constitutes potential later adoption or active rejection.

Despite these limitations, this study made significant contributions to new knowledge by providing additional evidence in support of Rogers' (1995) theory of the diffusion of innovations, evidence that goes beyond the theory, and tested the application of a new research methodology. This study made significant progress in documenting and understanding the adoption of technology patterns of faculty across disciplines, the common trends, issues, and concerns about integrating technology into teaching and learning, and the characteristics of early adopters. Future studies can utilize the methodology, instruments developed, and the results of this exploratory study to further advance understanding of the adoption of technology by faculty for teaching and learning.

Future Research Directions

This exploratory investigation uncovered some questions and areas that require and deserve further study. The present investigation is point-in-time diffusion research that documents a stage in the process of adopting technology for teaching and learning on campus. Because the diffusion process is still underway on campus, it would be useful to gather data at two or more points to measure the changes over time.

The survey instrument used in this investigation was designed and constructed by the present researcher based upon a review of the literature and expert judgement. Future applications of the survey, or individual subscales, would be useful to further examine the psychometric properties of the instrument using both paper and web-based forms. Many issues of survey design were not investigated in this study. It would be useful to conduct experimental research on different ways to design and present survey items and scales using a web-based instrument. For example, do participants responded differently to survey items when rating scales are presented using pull-down, or pop-up, menus of options as opposed to more conventional left-to-right checkboxes? When presenting survey scales of options, should the default response in a pull-down menu be a non-scoring option, such as “select answer”, or should the default response be one of the scaled responses, such as “strongly agree”? An experimental research design that randomly presented participants with Form A or Form B of a web-based survey could begin to address these questions.

This investigation explored the possible relationship between characteristics of expertise and the motivation for early adopters to become expert at integrating technology for teaching and learning. Future research of this type may want to emphasize an ethnographic or case study methodology that includes observations and interviews over a period of time to profile early adopters who are also excellent teachers. To address both adoption and rejection, future research should also profile faculty members who have not adopted technology and who are excellent teachers in order to examine whether this constitutes later adoption or active rejection. Additional study is also needed to further explore the hypothesis that the homophilous communication relationships among early adopters represents an expert subculture, or second order environment (Bereiter & Scardamalia, 1993), that embodies the ideals and goals which help direct the early adopter's on-going development, and provides support, cooperation and recognition of success.

A future study may want to examine the difference between early mainframe and early desktop use to examine whether it is true that early adopter access to university mainframe computers affected their desktop computer purchasing decisions and related desktop computer usage patterns. More study is also needed to examine the hypothesis that earlier adoption of technology for teaching is related to the more user-friendly characteristics of graphical user interfaces.

Future empirical research on faculty adoption patterns may want to build and extend upon Rogers' (1995) innovation-decision process and adopter categories to more accurately reflect and describe faculty innovativeness with technology (i.e., reflective observers rather than late majority; conscientious objectors rather than laggards). For example, there is a different kind of adopter in the field of educational technology: one who brings words of caution and criticism rather than wholesale, unqualified evangelism and enthusiasm.

Bridging the Gap Between Early Adopters and Mainstream Faculty

The intent of this section is to present recommendations for technology adoption and integration plans that do not succumb to the individual-blame versus system-blame biases that often appear in diffusion research. Rogers (1995) defines individual-blame as the tendency to hold an individual totally responsible for non-adoption rather than the system of which the individual is a part; conversely, system-blame is the tendency to hold a system responsible for the slow or limited adoption of individual members. Findings here suggest that both internal and external factors make the integration of technology more appealing to some faculty respondents than others. The first part of this section contrasts individual-blame and system-blame, and how higher education must get beyond blame in order to bridge the gap between early adopters and mainstream faculty. The second part of this section will present recommendations two ways: (1) Recommendations will be made for what EAs and MF might do to encourage further adoption and integration of technology efforts on campus, and (2) Recommendations will be made for what institutions might do to promote instructional technology as a way to fundamentally rethink teaching and learning.

Implications for Higher Education

Blaming Faculty

Previous explanations for why the majority of faculty do not readily adopt technology for teaching and learning focused on blame. Faculty were blamed for being stuck in traditional methods of course delivery, were labeled as resistors and charged with negative attitudes towards technology (Gordon, 1983). Faculty who express concerns about the shifting culture and mood that seems to emphasize the technology over teaching and learning are shamed by commercial and administrative bodies whose interests may be profit-driven rather than pedagogical. Accusations such as, "...faculty are the problem, ... don't want the technology ... are stuck in traditional approaches ... are behind the times...", are tolerated in a culture based upon faulty assumptions and often inaccurate explanations, "...students have no trouble with technology...want to use technology ... prefer technology ... etc., and so on." Previous explanations for limited adoption that blamed faculty were based on a poor understanding of the difference between faculty who readily adopt technology for teaching, and those who do not. Administration and management, sometimes the early adopters themselves, wondered why mainstreamers were not jumping on board and getting with the technology program.

The results of the present investigation provide evidence that these faculty respondents are using computers extensively for their professional and research tasks, and that there are encouraging levels of adoption for teaching and learning. Respondents also describe a number of impediments that may discourage student adoption: access, experience, changing roles in classrooms, and relative appeal. In some cases, students do not want remote participation. For example, when given the choice between on-campus and distance participation in a psychology course, 49 students chose the face-to-face course, and 4 chose the televised course with a computer-based module (Savenye, 1998).

Rogers' (1995) bell curve holds true; most of these respondents are not early adopters. Most faculty will not be the first adopters of a new technology. The majority of faculty will be "reflective practitioners" who may be willing to use a new tool if it is perceived as worth the effort in instructional value, not just budgetary value. Early adopters and administrative change agents need to respect faculty who are slower to change, yet are still willing to learn (Wilson, 1998).

Unfortunately, the term *luddite* has become synonymous with those opposed to any technology that may replace human labor, and has negative connotations. In fact, individuals often apologize in advance for expressing views that appear to criticize the adoption of technology for certain tasks, or for making appeals for cautious adoption rather than uncritical and enthusiastic acceptance. If the goal is to promote an institutional culture that explores fundamental teaching and learning issues, rather than emphasizing the adoption of technology for technology sake, then it is important to solicit and include views from both advocates and critics about the relative advantages of technology for teaching and learning.

The right to support or oppose the integration of technology for teaching and learning is related to academic freedom, and is important within the liberal conception of a university because universities are not only purveyors of the known, but creators and disseminators of the new (Schrank, 1993). To fulfill this crucial creative role, universities require openness, the free exchange of ideas, controversy, ferment, dissent, even heresy. Schrank (1993) believes a component of academic freedom is tolerance, and that participating in the university environment may sometimes involve accepting a fair measure of intellectual discomfort.

The negative connotation of the word *luddite*, and its association with individuals who are opposed to technology, may be linked to the assumption that existing teaching and learning practices are so inferior that they need not be considered at all in light of technological innovations. The appropriate response to such arrogant technocracy, is speech that refutes those ideas. For example, Clifford Stoll (1995), one of the pioneers of the Internet, offers the following sobering thoughts on the relative benefits of the information highway: “...a computer network is, indeed, a community. But what an impoverished community! One without a church, cafe, art gallery, theater, or tavern. Plenty of human contact, but no humanity. Cybersex, cybersluts, and cybersleaze, but no genuine, lusty, roll-in-the-hay sex. And no birds sing.” (p. 43). There is an new generation of educational technology researchers and writers, like Stoll, who are cautious about overselling technology, and call for more serious reflection on what benefits that technology can offer to teaching and learning.

The opinions of faculty and others who do not see the relative advantages of technology for their teaching, or call for more critical and reflective evaluation of technology’s impact, must be included in a discussion of campus-wide adoption. In order to promote a culture of openness, honest evaluations of the benefits and drawbacks of technology and intended outcomes are needed. Judging from the sheer volume of books (for example, Andre & Frost, 1997; Bess, 1997; Cahn, 1978; Ellis, 1993; Flood & Moll, 1990; Johnson, 1995; Jones, 1995; Kimball, 1988; McKeachie, 1978; Sternberg, 1997) and journal articles published on teaching excellence in higher education, the majority of faculty are highly motivated and committed to improving instructional quality. If the integration of technology can be shown to improve instructional quality, then professors may be more willing to adopt technology for their teaching tasks.

Blaming Institutions

Faculty are just as guilty of blaming the institution for limited adoption of technology for teaching and learning. Institutions, faculties, and departments are accused of paying more attention to and investing capital to build the technological infrastructure rather than investing operating funds to train and support the human infrastructure. Academic staff members are frustrated with integrating technology for teaching and learning in a university climate that has provided little or no external recognition or incentive for either excellent teaching or technology implementation. Many faculty respondents believe there is inadequate training and support for using computers in teaching and learning, and are also dissatisfied with the annual review process that often fails to recognize innovative teaching as part of the merit system, with or without technology. For those who invest long-term development time creating computer-based teaching materials, there may be little reward for the final product, and the developer may have to share or give copyright of software products to the institution. Respondents accuse administration of paying lip service to using technology for better teaching and learning, and believe that the decision makers often do not have a clue what “the effective use of technology for teaching and learning” means, as distinct from hopes for budgetary economies and increased tuition revenue.

The collective efforts of individual faculty are needed to balance the apparent mismatch between administrative, cost-conscious objectives, and faculty level teaching and learning and research goals. Those in higher education *should* be concerned about links with business that appear to constrain or direct the teaching and research agenda. Partnerships with the computing industry should be mutually beneficial, and should be evaluated for their potential impact on student learning, not merely whether they address budgetary constraints or provide financial advantages.

Getting Beyond Blame

The challenge for faculty and administration is not to assign blame nor to attempt to “fix” faculty attitudes. Academics are trained to be critical (in the best sense of the word) and may be expected to make demands for justification of resource allocation (Noblitt, 1997). Because of their independent nature, academics might be skeptical when technicians rather than faculty direct the use of educational technology (Gilbert, 1995), or when leaders make sweeping pronouncements about the institutional mandate without consulting faculty. The challenge instead is to draft integration plans and design new educational systems within the logic and meaning of the emerging paradigms that are informed by our growing understanding of the complexity and interconnectedness of faculty social systems, communication channels, and patterns of diffusion.

Administrative types have to be convinced to let go of the infrastructure-driven "if you build it, they will come" approach to technology integration on campus that may have appealed to early adopters who are more interested in the technology itself, but will not encourage mainstream faculty who are more concerned about teaching content and learning processes. Faculty and administration have a deep mutual dependency. Institutions need convincing evidence to justify large investments in technology in a resource constrained climate, and mainstream faculty need a well-conceived and reliable working environment for successful implementation of technology. Mainstream faculty want convincing exemplars and evidence of successful strategies to be convinced of the relative advantages that technology may bring to teaching and learning. Change agents in administration (from the president, to deans, to directors of service units), and opinion leaders (i.e., early adopters) and mainstream faculty, must all contribute to planning and honestly discussing strategies for bridging the gap.

Recommendations for Individual Faculty

Technology appears to be widely diffused in among faculty respondents for professional and research tasks, and is becoming more visible on campus for teaching and learning. Results from this investigation provide evidence that some types of computer software and tools have diffused into the mainstream for teaching and learning tasks. Findings from the faculty expertise subscale suggest that many participants have sufficient awareness and how-to knowledge with a wide range of technologies to make informed decisions about the further integration of these tools into the classroom. It has also been established that there are incentives that appeal more to EAs than MF, barriers that constrain MF as well as EAs, and changes to classrooms as a result of integrating technology. What appears to be lacking for many faculty respondents is a *compelling reason* to integrate technology, and sufficient evidence about the *relative advantages* of doing so. Diffusion scholars have found relative advantage to be one of the best predictors of an innovation's rate of adoption (Rogers, 1995). The following recommendations are directed at increasing mainstream faculty's perceptions of the relative advantage of technology by increasing the awareness knowledge about effective strategies for integrating technology in teaching and learning, and addressing the concerns of the unconvinced.

The first recommendation is for individual faculty to focus on strategies for increasing the awareness and how-to knowledge about successful strategies for teaching and learning with technology. The bias of this investigation is that faculty are the most appropriate persons to decide how to integrate technology in their own classes. Mainstream faculty may be reluctant to make decisions about the use of technology in their teaching because they are unfamiliar with it, they may feel inadequate to assess the potential impact the technology will have on the teaching and learning environment, and they are not convinced it offers relative advantage over what they are doing now. Not every faculty member can or will become a technology expert. In order to increase the awareness and how-to knowledge of mainstream faculty who are reluctant to adopt technology or have no means of thinking about technology in the context of their own teaching, some method has to be found to share the experience, skills and knowledge of the early adopters, their “learned lessons”, with the mainstream. Mainstream faculty need to understand what the technology can do, and be provided with evidence about the benefits, but they do not necessarily have to have procedural-knowledge about computers before evaluating the relative advantage of an innovation in their own teaching situation.

Brown and Kerr (1998) describe a Multimedia Teaching Strategies project that has potential application for increasing the awareness and how-to knowledge of mainstream faculty in post-secondary education. Brown and Kerr (1998) have designed a web-based resource for K-12 teachers that contains successful strategies for exploiting technology in the classroom. Material for the site was gathered by interviewing experienced teachers who have integrated technology in their classrooms. The site is divided into five interrelated sections: pedagogy, equipment, projects, resources, and skills. Rather than being prescriptive, the content in each section is anecdotal in nature, highlights the elements of successful integration experiences, and draws from the expertise in different schools throughout the division. Brown and Kerr (1998) have attempted to capture the underlying philosophy, knowledge, skill, and resource requirements, and successes and demands of each teaching strategy. They believe that classroom teachers should not have to construct technological solutions before their can think about integrating technology into their teaching. Their goal in creating the Multimedia Teaching Strategies web-site is to give teachers appropriate teaching models and support so they can look beyond the technology and instead think about how the classroom can be changed and determine what activities are now available.

A potential solution for bridging the awareness and how-to knowledge gap between early adopters and mainstream faculty, as well as addressing “insufficient data” concerns, is to create an analogous *Post-Secondary Teaching Strategies* web-site that brings together first-hand knowledge and learned lessons about effective and successful technology integration from a particular campus. Mainstream faculty would be able to examine the current teaching strategies that are being used effectively at their institution by early adopters from across disciplines, determine what equipment and resources are needed for a particular idea, and using e-mail or sneakernet, would be able to contact their early adopter colleagues for information about developing and applying needed skills. This strategy would be a useful and valuable application of findings from case study research with early adopters who are excellent teachers, and would formalize the early adopter's second-order environment.

Commercial web sites have been designed to help faculty learn about instructional technology. For example, The Faculty Connection (Creative Analytics, Inc., 1998) provides links to articles, other relevant web-sites, and technology tutorials, and can be a comprehensive starting point for mainstream faculty who want to use technology in their classroom. While such sites are valuable as mass media communication channels, Rogers (1995) suggests that interpersonal networks are more effective to persuade members of a social system to adopt.

Thus, a Post-Secondary Teaching Strategies Website that highlights examples and experts from a faculty member's own campus may have more of an impact on bridging the gap between early adopters and mainstream than a commercial web-site. Faculty did rate on-line computer newsgroups and websites as an important source of information for keeping abreast of changes and innovations in the area of computers. Therefore, the hypothesis here is that the website approach to sharing information about effective teaching and learning strategies for integrating technology would be an effective way to leverage the knowledge, skills, and experiences of early adopters across campus. Promising steps have been taken towards this knowledge sharing goal: a team of researchers at the University of Calgary have designed an academic web site that publishes evaluations of technology integration projects across campus (Lessons Learned Home, 1998).

A second recommendation is to increase the observability and trialability of technology integration on campus. Observability is the degree to which the results of an innovation are visible to others (Rogers, 1995). Perhaps if early adopters modeled or demonstrated strategies for successful uses of technology one-on-one or with small groups of their mainstream peers then the gap between the convinced and unconvinced would begin to be addressed. The personal trying-out of an innovation is a way to give meaning to an innovation, to find out how it works under one's own conditions, and tends to dispel uncertainty about the new idea (Rogers, 1995). Early adopters can act as a kind of vicarious trial for mainstream faculty by modeling and demonstrating successful uses of technology for teaching and learning, and reducing uncertainty about this innovation.

Teaching is a social science, not a physical science, and as such, cannot always be evaluated by the quantitative methods that are suitable for measuring physical processes. It should be emphasized that "insufficient evidence" does not usually mean that there is "data that is inconclusive", but that "there is no data" either way. Faculty were neutral about mass media publications like refereed computer journals for learning more about technology. Instead, qualitative assessments and the opinions of early adopting colleagues about the learning gains that are more social and behavioral in nature may be more suited to helping mainstream faculty evaluate the impact of technology. The research evidence for relative advantage should also be published on a shared information source, for example the Post-Secondary Teaching Strategies Website, so others can evaluate the real outcomes of integration.

A third recommendation for individual early adopting faculty is to help promote a culture of inquiry into teaching and learning with technology that begins with incremental steps rather than huge leaps into a maelstrom of options. A frequently mentioned incentive to further adoption of technology, "give me more time", and the highest rated barrier to integrating technology, "faculty lack the time to develop instruction that uses computers", may be related to the exponential rate with which new hardware and software tools are being developed. The steady rate with which new technologies become available leads to shorter and shorter innovation cycles, and therefore a continuous training and professional development requirement. This shortens the innovation-decision period, and when faced with the onslaught and never-ending cycle of new technologies, some faculty may just throw up their hands and give up, "I just cannot keep up." Those in the fields of computer science, or engineering, where technology is the subject of study, may accept the constant development of new tools and technological processes as the nature of things, and are probably not as overwhelmed by the sheer number of innovations they face. Those in other fields, however, may regard the ever changing nature of technological tools and software as a chaotic stream that they do not wish to jump into for fear of drowning.

Because of the ever changing field of technology, and the vast number of tools, applications, and innovative pedagogical methods, no one instructor can hope to become an immediate expert in all areas. Later adopting faculty may justifiably feel overwhelmed by the vast array of applications and tools to learn, and new teaching methods to understand and apply. However, early adopters can contribute to a culture that promotes the idea that integrating technology is much like planning for financial freedom, "it is never to early to begin, and its not too late to start". Early adopters have developed impressive knowledge and skill integrating technology for teaching and learning, and each would likely admit that they still have a lot to learn, and often find themselves flying by the seat of their pants while trying unproved and innovative teaching methods. EAs who are interested in being role models have much to offer to the newer adopter who wants to just get started by helping to change the perception that technology adoption and integration for teaching comes easily to them. Instead, shared commiseration about this barrier-ridden, and often time-consuming process may help to bridge heterophilous communication channels, and increase a more homophilous exchange of ideas about appropriate strategies for starting to integrate technology in manageable steps, as well as reducing the potential and real uncertainty about outcomes.

A fourth recommendation for early adopters who are excellent teachers is to conduct and widely disseminate applied educational research on the changing roles of teacher and student, and the shift from more behaviorist methods to more constructivist methods that have been facilitated by technology. An innovation's incompatibility with cultural values can block its adoption (Rogers, 1995). A cultural incompatibility, related to the norms of the academic social system, appears to be related to academic skepticism about the relative value of soft versus hard science for explaining the outcomes of using technology. Another example of the cultural incompatibility related to the integration of technology for teaching and learning results from the origin of this innovation. Technology was originally designed for use in one culture, math and science, but it has now spread to a different culture, teaching and learning, with different cultural values. Excellence in teaching does not depend upon technology. Many faculty members have philosophical and pedagogical beliefs that do not open a space for technology.

Old ideas are the main mental tools that individuals utilize to assess new ideas (Rogers, 1995). One cannot deal with an innovation except on the basis of the familiar, with what is known. Previous practice provides a familiar standard against which an innovation can be interpreted, thus decreasing uncertainty. In the case of mainstream faculty applying technology in ways that are compatible with their previous teaching practices, this perceived compatibility of technology with previous experience may lead mainstream faculty to incorrectly utilize the technology (i.e., recall the LOGO example of faulty implementation using behaviorist rather than the intended constructivist methods). A strong belief in the relative advantages of integrating technology may lead early adopters to assume that existing teaching practices are so inferior that they need not be considered at all. Hence, the emphasis in the present investigation on excellent teaching. Almost every innovation is evaluated by potential adopters in terms of their prior experience with something similar (Rogers, 1995). The analogy of "new wine being poured into old bottles" provides a clear image of the innovation being considered through an adopter's existing perceptions. This view is insufficient if institutions, faculty, and students are to optimize the potential for technology to facilitate changed teaching and learning environments. Understanding mainstream faculty member's perceptions about the efficacy of current teaching practices, and the potential role of technology, is important when considering the further adoption rates of technology. The goal is *quality* integration, not quantity and ill-conceived and awkward integration. Therefore, additional educational research is needed on the relationship between integrating technology and a shift from teacher-directed to more student-constructed learning environments in order to provide images of new pedagogical methods, and decrease uncertainty about these changes.

Recommendations for Institutions

Social system, or environmental, behavior frequently involves a conflict between what is best for the system and what the individual would prefer to do (Rogers, 1995). For example, distance learning technologies increase the potential tuition revenues for an institution, however, many faculty members may prefer to teach face-to-face. Faculty members may prefer that the institution buys them computers for professional, research, and teaching tasks, but the institution is resource constrained and the cost of such an incentive would be prohibitive. The institution may want a standardized solution for hardware and software, but a significant proportion of individual faculty members and students want to keep their present systems. The following recommendations are made in the attempt to find a balance between what is good for the university, and what is known about the differences between early adopters and mainstream faculty.

The first recommendation for institutions is to focus technology integration plans on increasing critical mass by investing in the professional development of faculty members. To make the products or results of early adopter efforts more widespread and their results used more comprehensively, incentives, training, support and reward structures from administration are needed to build a strong human infrastructure that supports the integration of technology for teaching and learning. Administration also has to address teaching and course release time, software ownership issues, research and development grants, and funding in order to encourage more inquiry into teaching and learning with technology. The key to diffusion will be training and support. Without investment in the human infrastructure nothing of sustainable value will be achieved (Foa, 1993).

Institutions can do little to stem the exponential rate at which hardware and software tools are being developed. However, they may play a greater role in providing the necessary training and support with these tools as faculty face shorter and shorter innovation-decision cycles. A large number of respondents are currently dissatisfied with the support and training on campus. A majority of respondents indicate that their range of computer knowledge and skills are primarily as a result of self-teaching or a combination of self-teaching and formal courses. Mainstream faculty who are dissatisfied with current support and training prefer other methods for learning about computers, and feel abandoned when they have to struggle alone. Faculty seem to prefer getting help from colleagues and graduate students, and want one-one-one assistance, rather than relying on other sources of help or assistance when learning about computers.

The most successful professional development may be to arrange for just-in-time, one-on-one access to colleagues and experienced graduate students when one runs run into trouble experimenting and playing around with new technologies. Wake Forest College has the STARS program which redirects funds to provide skilled undergraduate students with financial incentives to provide faculty support and training (Burg & Thomas, 1998). Gilbert (1996) also described the deployment of student assistants who can help increase the use of information technology for teaching and learning, and alleviate some of the financial and human resource costs of support units, resulting in a win-win situation for the institution, faculty, and students. However, Anderson, Varnhagen, and Campbell (1997) suggest that an age gap may present a barrier to this strategy. Therefore, perhaps experienced graduate students would be less threatening sources of training and support than early adopting peers or undergraduate students.

Faculty also rated media center support staff and telephone assistance as important sources of help and assistance, however, these services cannot be staffed exclusively with “techie” individuals who do not understand teaching and learning concerns. Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. Diffusion scholars have found that the complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption (Rogers, 1995). Early adopters tend to be technology hobbyists, are attracted to the technology, like using it, get personal satisfaction from figuring out new ways to use and apply the technology. Therefore, early adopters of technology do not consider computers to be complex. Mainstream faculty, on the other hand, do not have high levels of computer expertise, experience greater frustration learning how to use computers, regard the technology as fallible, difficult to use, tend to internalize technology failures (Weil and Rosen, 1997), and get little help from technical support staff who appear to speak a different language of technological jargon. If a mainstream faculty member feels a lack of support and access to technological expertise, it may be hard to provide that support, but there is simply no other way (Wilson, 1998). Therefore, leaders and decision makers should review the staffing of support units and evaluate how changes can be made that would facilitate the efforts of mainstream faculty who are more interested in the instructional outcomes of using technology rather than being motivated by the technology itself. Support and training should focus on the how-to knowledge needed for the integration of technology for teaching and learning, as well as support and training for basic technology skills.

A specific concern expressed by some faculty was the apparent shift in focus from content to the tool. This may be a sign of the growing pains associated with first adopting technology. The development of any type of competence or expertise involves a growth process; there is a period where more attention has to be invested in learning the new way or developing a base of knowledge, and skills have to be practiced until they become more automatic, more fluent. Faculty, who are used to being experts in their domain, may struggle with and tend to avoid the symptoms of being a non-trained novice in using technology for teaching (i.e., postulant experts, Berliner, 1992). Mainstream faculty are not intrinsically interested in the technology itself, seem to want proven applications with a low risk of failure, and expect to see immediate results from their investment of time and resources. It is likely that mainstream faculty want to skip the messy and frustrating experimental learning stage and might prefer clear, step-by-step examples and strategies for integrating technology into their teaching tasks. Mainstream faculty do not necessarily have the early adopter's patience and faith that all of their efforts will pay off. All faculty have to decide how to allocate their time among teaching, research and service responsibilities. Mainstream faculty, who are not at all interested in "new hobbies" nor in technology for its own sake (Anderson, Varnhagen, & Campbell, 1997), are likely to be less motivated to invest their limited time in figuring out ways to use technology in their teaching.

On the other hand, earlier adopters embrace the experimental nature of figuring out how to integrate new technological methods and solutions, enjoy learning about computers, have developed impressive levels of expertise, like working on the edge of their expertise, have faith that they are doing something that will be beneficial. EAs are more comfortable with situations where there is not an immediate solution to a problem, and expect to encounter problems with the technology. Earlier adopters are supported by a "second-order" environment, often of their own making. They seek out a personal network of other earlier adopters and technology enthusiasts who share their interest in technology, provide support, exchange ideas, and always up the ante. Early adopters tend to gravitate towards conferences, demonstrations, symposia given by their early adopting peers to continually add to their knowledge and skills.

Institutions should investigate ways to make early adopter communication about technology less homophilous and more heterophilous. Early adopters have to be motivated to continue their focus on innovation and re-invention of technology, and exploring new ways to use model-less technology. Therefore, belonging to an informal network of other EAs who will push the edges of their knowledge and skill is important for motivation and continued growth. At the same time, incentives need to be provided that encourage EAs to publish findings on benefits and outcomes for a more mainstream audience, describe uses and provide models for technology integration, provide workshops, demonstrations, and symposia for mainstream "teachie" audiences, in addition to sharing their knowledge and skill with a converted "techie" audience. Institutions should explore strategies for accomplishing this goal by encouraging EAs to give technology away, like expert psychology professors give psychology away.

The second recommendation for institutions is based upon the need for a technological infrastructure (i.e., networks, hardware and software) to encourage adoption and integration. IT investments for teaching have to be closer to what is the state of the art in the world of work, as higher education prepares for the future. These ever-new investments cannot be left to uncoordinated departmental or individual initiatives, as they often exceed respective budgets (Bull, et al., 1994). Ownership of computers for personal/home and professional use is almost completely diffused among these respondents. Therefore, although many faculty are probably dissatisfied that the institution did not provide them with a computer, there does not appear to be a present need for campus investment plans to acquire computers for individual faculty. Instead, resources may be better invested acquiring hardware and software, and networking capabilities, for teaching and learning. Over 75% of respondents were dissatisfied with current campus investment in computer technology for teaching and learning. The most promising uses of technology for teaching and learning seem to be for communication, accessing and exchanging shared resources and information on-line, and faculty and student publishing on the web. Campus acquisition plans should direct resources to upgrading the infrastructure to accommodate more technology integration in all classrooms; adjustable lighting, adequate projection systems, and built-in network connectivity. Infrastructure also includes providing adequate funding for support and technical units that ensure that the technological infrastructure is available and reliable for classroom use.

The third recommendation for institutions is to find ways to reward that which they purport to value. Administration must recognize that in order to drive change they will have to be aware of the culture they promote, and emphasize excellent teaching in their technology integration plans. In order to realize the benefits and value of investing in technology, a university's culture should explicitly and intentionally promote instructional technology as a way to fundamentally rethink teaching and learning, and as a way to question and explore new approaches to writing, communication, and research.

The main function of an incentive is to increase the relative advantage of adopting the innovation (Rogers, 1995). Diffusion research includes a high proportion of marketing studies that are concerned with how to launch new products successfully, influence purchasing behavior for commercial advantage, and match consumer's needs and wants with commercial products and services. The link between providing incentives and marketing research often leads to a pro-innovation bias. Rogers (1995) has found that incentives may increase the quantity of adopters of an innovation, but the quality of such adoption decisions may be relatively low, limiting the intended consequences of adoption. Hence, faculty using technology as an add-on, rather than as a vehicle for fundamental change. Institutions should consciously avoid the pro-innovation nature of incentives, and instead of rewarding the adoption of technology for adoption sake, encourage and reward better teaching and learning with technology. Incentives should not be linked to the technology per se, but should be linked to providing enhanced learning benefits for students, and conducting research that examines fundamental teaching and learning issues.

Brown and Kerr (1998) warn institutions that they run the risk of fostering the belief that the technology is all-important; that as long as students have technologically advanced material and equipment, they have also advanced their learning. Promoted simply by profit-driven commercial and administrative interests, this culture may create a false sense that the learning environment has improved. That is, instead of being a vehicle for change, the technology will become the change. Rewards and incentives, such as release time, start-up grants, and research funding, should be closely linked to using technology in the exploration of fundamental and applied teaching and learning issues.

A <u>fourth</u> recommendation for institutions is to create a different support infrastructure for mainstream faculty that leverages the knowledge and skill of the early adopters. It appears that system-wide changes will be needed in the reward system and training for faculty members in order to encourage broader diffusion of instructional technology in the mainstream. Further, a different support infrastructure is clearly needed for mainstream faculty than that which sufficed for early adopters. Proportionally more support and training services will be needed for the 80% or so of faculty members who are mainstream users of technology. Recognizing that mainstream faculty have different characteristics, and therefore needs, does not suggest that there is no role for early adopters in developing long-term plans for campus-wide adoption. Quite the opposite. Early adopters have discovered and overcome many barriers in their attempt to integrate this innovation, and have developed and contributed to a collective knowledge base concerning instructional technology. Change agencies must capitalize on this valuable human resource that exists on campus.

Those in leadership positions on campus, administration, deans, department heads, should perhaps focus support and training efforts on developing competent performers (Berliner, 1992) rather than striving to create a whole cadre of experts across campus. Berliner (1992) argues that, as in every complex endeavor, the number of people who achieve expert status will be small, and believes that professional development ought to focus on the development and maintenance of competence, not expertise. The small number of faculty who have become expert can be models for new faculty adopters, with the most articulate of them becoming mentors and providing the scaffolding needed to move the novice or advanced beginner to the competent level. Only a few faculty will attain the level of expert at integrating technology in teaching and learning, and these faculty members may be able to provide role models and mentorship for others. Although perhaps less satisfying than a "campus-wide vision", this strategy may be a workable solution.

The fifth recommendation for institutions is find ways to include both early adopters and mainstream faculty in campus-wide decisions about integrating technology. Results in this study demonstrated that early adopting and mainstream faculty have strong and varied opinions about the changes to classrooms, incentives, barriers, and methods for evaluating integration. Wilson (1998) describes approaches to technology adoption and integration by different learning communities. A key feature of a learning community is to draw on expertise distributed throughout the group. Other features are the shared decision making, collaborative work, and interactive discussions among its members. In such environments, coercion and mandated obedience to group norms are rarely used effectively to achieve group ends. Diversity among members can be a strength that results in more creative outcomes. The views, beliefs, suggested solutions, and opinions of both advocates and critics should be elicited and included in the development of campus-wide technology integration plans.

Institutions presently have strategies for dealing with homophilous and heterophilous communication channels on campus between and among diverse faculties and departments. Similar strategies should be employed in order to move discussions about integrating technology beyond the early adopters and perceived "techno-cliques", and into the mainstream by promoting interaction and collaboration among and between faculties and departments. Groups that include their diverse members in decision making tend to be more inclusive and reflective of people's interests and needs, which in turn makes the change process more successful and less traumatic (Wilson, 1998). One method that has proved to be effective in getting cross-campus faculty members to communicate and work with heterophilous individuals in other departments and institutions has been to link project funding to the interdisciplinary nature of the investigation; for example, more governmental agencies are making it a qualifying criteria that more than one institution or faculty is involved in a funded project.

The sixth recommendation for institutions, faculties, and departments is to resist being autocratic in drafting plans for bridging the gap between early adopters and mainstream faculty. Change is hard work. While the administration may find it more expedient to lay down the law and declare that everyone will use computers, this strategy is likely to yield bitter fruit (Wilson, 1998). Faculty may become cynical, feel abused, and not listened to. Taking the major portion of the responsibility for instructional decisions out of the hands of faculty is a serious step. Faculty will, in turn, seek to undermine the technology agenda through passive resistance, disengagement, and covert sabotage, which means more work in the long run for an authoritarian solution (Wilson, 1998). A more difficult and time consuming, but potentially more effective, strategy would be to elicit and include both EAs and MF in technology discussions, plans for acquisitions, and decisions about implementation. Administrative proclamations, press releases, pressure from software companies, and other forms of covert harassment will not train and support faculty members in their integration efforts, nor will these win faculty support for an agenda that they do not support.

Technology should never be used as a weapon upon faculty, or as a threat to unwilling participants (Wilson, 1998). Some faculty members cannot be expected to embrace the uncertainty of technology, nor should they be forced to integrate technology in their teaching if they believe there is no relative advantage to themselves or their students. Institutions have to accept that it is not desirable for every faculty member to adopt technology for teaching and learning, and that many faculty will reject technology. Instead of trying to get those who are hesitant or resistant to adopt, campus investments of time and resources, strategic discussions, and technology plans should focus on the new or potential adopters who are willing to try technology, and leave the non-adopters alone.

A <u>seventh</u> recommendation for institutions is to put mechanisms in place that allow for cyclical and iterative development and assessment of technology in teaching and learning. Tolerance has to be build into the system for time lags, unexpected barriers, and longer innovation-decision periods. Technology integration constitutes a major change in people's lives. Such change does not happen quickly or easily. Even in the best of circumstances, teachers and students need high levels of support, training, and access to technology. While technology can open up new possibilities in teaching and learning environments, care should be taken to make sure that the technology fits the core values and goals of higher education, and not the other way around. Strategies to encourage EAs to share their expertise with the mainstream might include changes to the reward structure, release time for training, forging links with Teaching Development units, creation of training materials, and supporting symposia and conferences.

A <u>final</u> recommendation for institutions is to resist re-inventing the wheel. A number of system-wide initiatives have been implemented at various higher education institutions (see Burg & Thomas, 1998, Communications of the ACM special issue on campus-wide computing) which provide models for encouraging wider diffusion of technology for teaching and learning, and bridging the gap between early adopter success and more mainstream adoption. An institutional mandate of standardization of computer hardware, software, and peripheral devices on campus is a “mechanism through which the system exerts pressure on the individual to recognize the relative advantage of an innovation” (Rogers, 1995, p. 233). This sounds dark and manipulative, however, a mandate for adoption can be a positive way to achieve relative advantages for the many, even if it may be at the expense of a few. For example, strategies for ubiquitous computing and standardization policies have been put in place at institutions to provide each student and faculty member with ready access to computers, and enables the institution, faculty members, and students to realize benefits of economies of scale (Brown, Burg, & Dominick, 1998; MacDougall, 1998). A technology integration plan that focused on standardization would address the following managerial challenges: (1) providing training and support for both faculty and students, (2) support units dealing with thousands of combinations of hardware and software, (3) file exchanges and networking, and (4) resisting the tendency to reinvent the wheel. The most important and critical form of support is having a colleague or support person physically nearby who can instantly answer a small, urgent question; this may be facilitated by standardization. Support and training benefits are realized by faculty, students, and support units. However, to address the tension between innovation and stability, strategies for ubiquitous computing must provide and support standardized platforms for general use, while also allowing diverse self-supported platforms for experienced and experimental users (Brown, Burg, & Dominick, 1998).

A potential problem with standardization of technology on campus is that there is an established base of technology with both students and faculty, and convincing these individuals to throw away their current technology for the new standard platform will be incredibly difficult, and ultimately, undesirable. Instead, a plan for standardization has to also provide mechanisms to support those who own and prefer to use different platforms.

Conclusion

The results presented in this investigation have both theoretical and practical significance. Additional evidence has been found to support Rogers’ (1995) theory of the diffusion of innovations. Documenting the adoption patterns and characteristics of faculty who integrate instructional technology using diffusion theory has provided information that can be used by those interested in campus-wide integration of technology for teaching and learning. Identifying the unique concerns that can shape the mainstreams faculty member's decisions to adopt led to the understanding that a different support infrastructure is needed for mainstream faculty to integrate technology for teaching and learning. If campus-wide integration plans are developed on the assumption that everyone will naturally use computers as readily and easily as the early adopter, then they are bound to fail. The outcomes of this study identify the need for campus-wide planning and investment in the "human infrastructure" by providing training and support, encouraging heterophilous communication channels, providing a technological infrastructure, and capitalizing on the opinion leadership and evangelistic qualities of early adopters to promote further adoption by the mainstream. Strategies are needed to promote more widespread dissemination of learned lessons, successful strategies, and ways to improve teaching and learning using technology.

There is still a great deal to learn about early adopters of instructional technology as a subgroup of the faculty population. There is a need for more in-depth case study research that profiles individual early adopters of instructional technology who are also excellent teachers. Early adopters who are excellent teachers can provide role models and guidance in this innovative, constantly changing, and exciting area. A prototypical model of the exemplar of this category is needed against which one can compare individual early adopters and better understand their commonalities and differences. A promising application of such research is the development of web-based resources that may help bridge the gap between early adopter knowledge, skills, and experience and mainstream faculty members' training needs.

This dissertation only provides an opening wedge to the complex and interesting pedagogical concerns related to integrating technology into teaching and learning, about which many books have been written (Heermann, 1988; Laurillard, 1993; Roblyer, Edwards, and Havriluk, 1997). However, discussion did yield examples of the changes to teaching and learning that an adopter can expect, as well as specific strategies for successful use of technology. An outcome of this study is a set of recommendations that will be useful for developing guidelines for the design of professional development initiatives for mainstream faculty who are beginning to integrate computer technology into their post-secondary teaching.

Developing increased awareness that the adoption of information technology for teaching and learning is a complex, barrier-ridden, and time-consuming process will help institutions understand that expectations for campus-wide technology integration will not materialize overnight. It has been argued that technology integration plans must allow for a cyclical and recursive implementation and evaluation process. A long-term strategy for technology integration is needed rather than focusing on quick results and rapid adoption. Faculty support in the form of incentives, rewards, time, access, training, and additional personnel in support units (i.e., campus computing and media centers, library system) will be necessary to improve chances of success, excellence, and efficiency. Early adopters are the exception, rather than the rule. However, we can learn from exceptions and unique experiences, and take from these an understanding of the necessary strategies to encourage mainstream adoption and scaling up from the pilot projects and individual cases.

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APPENDIX A. SURVEY INSTRUMENT

Teaching and Learning with Technology In Higher Education

Patterns of Computer Technology Use

The following 18 questions gather information about individual computer use patterns. Please write or select the response that best represents your experience, situation, or opinion.

1. In what university role did you first USE computers on campus?
   - ❑ as an undergraduate student
   - ❑ as a graduate student
   - ❑ as a new faculty member
   - ❑ as an experienced faculty member
   - ❑ have not used at all
   - ❑ other, please specify: _______________

2. In what YEAR did you first use a computer for your personal, professional academic tasks (i.e., writing, e-mail, grade sheets, etc.)?

3. In what YEAR did you first use a computer for research tasks (i.e., data collection, statistical analysis, etc.)?

4. In what YEAR did you first use a computer for teaching tasks (i.e., demonstration, modeling, instructional, etc.)?

5. In what YEAR did you BUY your first computer for PERSONAL/HOME use?

6. In what YEAR did you BUY your first computer for PROFESSIONAL use?

7. How many computers have you owned since buying your first computer?

8. Do you have exclusive access to a computer for professional use?
   - ❑ yes
   - ❑ no
   - ❑ sometimes

9. Do you have ready and convenient access to computers, software and needed equipment for teaching tasks?
   - ❑ yes
   - ❑ no
   - ❑ sometimes

10. How satisfied are you with SUPPORT made available to you on campus for computer-related TEACHING tasks?
    - ❑ 1. very satisfied
    - ❑ 2. satisfied
    - ❑ 3. neutral
    - ❑ 4. unsatisfied
    - ❑ 5. very unsatisfied

11. How satisfied are you with TRAINING made available to you on campus for computer-related TEACHING tasks?
    - ❑ 1. very satisfied
    - ❑ 2. satisfied
    - ❑ 3. neutral
    - ❑ 4. unsatisfied
    - ❑ 5. very unsatisfied

12. How satisfied are you with current campus investment plans (i.e., professional development funds) with regard to the acquisition of computer technology by INDIVIDUAL faculty?
    - ❑ 1. very satisfied
    - ❑ 2. satisfied
    - ❑ 3. neutral
    - ❑ 4. unsatisfied
    - ❑ 5. very unsatisfied

13. How satisfied are you with current campus investment plans with regard to acquiring computer technology for TEACHING and LEARNING activities:
    - ❑ 1. very satisfied
    - ❑ 2. satisfied
    - ❑ 3. neutral
    - ❑ 4. unsatisfied
    - ❑ 5. very unsatisfied

14. How did you acquire your INITIAL computer skills?
    - ❑ self-taught
    - ❑ formal courses
    - ❑ self-teaching and formal courses
    - ❑ from a colleague
    - ❑ from a graduate student
    - ❑ from support staff
    - ❑ other, please specify: _______________

15. Overall, your range of computer knowledge and skills are primarily the result of:
    - ❑ self-teaching
    - ❑ formal courses
    - ❑ both self-teaching and formal courses
    - ❑ colleague teaching and support
    - ❑ support staff assistance
    - ❑ other, please specify: _______________

16. Do you teach computer courses (or have you ever)?
    - ❑ yes
    - ❑ no

17. If you DO/DID teach computer courses, what is/was the typical course level?
    - ❑ pre high school
    - ❑ high school
    - ❑ undergraduate
    - ❑ graduate
    - ❑ other, please specify: _______________

18. On average, how many hours do you spend using a computer per day?
    - ❑ less than one hour
    - ❑ 1 to 3 hours
    - ❑ 3 to 5 hours
    - ❑ more than 5 hours

Computer Experience

For each of the following 44 examples of computer software and tools, please indicate:
(a) your current level of expertise, and
(b) the year in which you first used this software/tool (if ever) in a course you taught.

Level of Expertise: (0) None (1) A little (2) Fair (3) Substantial (4) Extensive

Software and Tools:

1. Any programming language (i.e., Logo, Basic, C, Fortran, etc.)

Operating Systems:

2. Apple
3. Macintosh
4. UNIX
5. PC-DOS
6. Win 3.x, NT
7. Win 95
8. Sun

Tool Applications:

9. Text editing
10. Word processing
11. Desktop publishing
12. Database
13. Spreadsheets
14. Charting-graphing
15. Statistics package
16. Grading package
17. Music Composition

Graphics Software:

18. Presentation package
19. Drawing program
20. Paint program
21. Clipart
22. Drafting, CAD

Communications Software:

23. Electronic mail
24. Newsgroups
25. Listservs, BBS
26. FTP (upload, download files)
27. Gopher
28. World Wide Web browsing, searching
29. On-line databases (and/or library catalogues)
30. On-line video, audio

Authoring:

31. HyperCard
32. Toolbook
33. Linkway
34. HyperStudio

Instructional Courseware:

35. Tutorials
36. Drill & Practice
37. Simulations
38. Integrated Learning System
39. Games

Variety:

40. CD-ROM materials
41. Videodisk
42. Robotics
43. Virtual Reality
44. WWW page creation/editing

Generalized Self Efficacy

Please read each statement below, and mark an answer from 1-4 to indicate how well you feel the statement describes you.

1	2	3	4
Not at all true	Sometimes true	Often true	Almost always true

1. I can always manage to solve difficult problems if I try hard enough.
2. If someone opposes me, I can find means and ways to get what I want.
3. It is easy for me to stick to my aims and accomplish my goals.
4. I am confident that I could deal efficiently with unexpected events.
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.
6. I can solve most problems if I invest the necessary effort.
7. I can remain calm when facing difficulties because I can rely on my coping abilities.
8. When I am confronted with a problem, I can usually find several solutions.
9. If I am in trouble, I can usually think of something to do.
10. No matter what comes my way, I'm usually able to handle it.

Participant Information

The intent of this section is to obtain some information about individuals who respond to this survey. Information gathered about participants will be treated confidentially, and only GROUP data will be reported as an outcome of this research.

1. What is your age (years)?

2. What is your gender?
   - ❑ male
   - ❑ female

3. What is your academic rank?
   - ❑ Assistant professor
   - ❑ Associate professor
   - ❑ Professor
   - ❑ Senior Instructor
   - ❑ Instructor I
   - ❑ Instructor II
   - ❑ Sessional Instructor
   - ❑ Lecturer

4. What is the type of your appointment?
   - ❑ Limited/Contingent Term Contract
   - ❑ Sessional Contract
   - ❑ Leading to tenure
   - ❑ Tenured

5. How many years (in TOTAL) have you been a member of an academic staff?

6. In which Faculty/Department do you hold your appointment?

7. How many years (in TOTAL) have you been teaching undergraduate/graduate students?

8. What is the average number of undergraduate/graduate students that you teach in one semester?

9. What is the number of graduate students that you currently supervise?

10. At which institution are you a member of an academic staff?
    - ❑ University of Calgary
    - ❑ University of Alberta

I. Changes to Teaching and Learning (Selected response)

Some research has indicated that significant changes take place as teachers integrate computers into instruction (Hadley & Sheingold, 1993). Some of the changes that are said to occur as a result of using computers are listed below.

Please read each of the following statements, and then indicate the level of your agreement as to how the integration and use of technology for teaching and learning changes the post-secondary classroom environment.

(1) Strongly Agree (2) Agree (3) Neutral (4) Disagree (5) Strongly disagree

1. Faculty can expect more from students in terms of their pursuing and editing their work.
2. Faculty can spend more time with individual students.
3. Faculty can be more comfortable with students working independently.
4. Faculty are better able to present more complex material to students.
5. Faculty are better able to tailor students' work to their individual needs.
6. Faculty spends less time lecturing to the entire class.
7. Faculty spends more time working with smaller groups who are pursuing project-based work.
8. Faculty will spend more time acting as a guide and facilitator with individual students.
9. Faculty spend less time with the whole class practicing or reviewing material.
10. Faculty will spend more time preparing materials and resources for instruction.

II. Changes to Teaching and Learning (Open-Ended response)

One of the goals of the current research project is to gather additional information about the nature of changes that occur when technology is used for POST-SECONDARY teaching and learning.

Please take the time to elaborate on the nature of changes that you have observed in **faculty teaching** and in **student learning** as a result of integrating and using technology for instruction.

1. I have observed the following changes to teaching as a result of integrating technology:

2. I have observed the following changes in student learning as a result of integrating technology:

I. Incentives to Integrate Technology for Teaching and Learning (Selected response)

Given the time and effort required to integrate technology into teaching, different reasons tend to motivate and keep faculty engaged with this task. Some incentives seem to be more important in encouraging faculty members to integrate and use technology in their teaching (Hadley & Sheingold, 1993).

Please indicate the extent to which you agree or disagree that the following statements represent important incentives and motivators.

(1) Strongly Agree, a major incentive (2) Agree (3) Neutral (4) Disagree (5) Strongly disagree, not an incentive

1. Computers are a tool that help students with learning tasks, such as writing, analyzing data, or solving problems.
2. Students are enthusiastic about the subjects for which they use computers.
3. Computers enable me to make a subject more interesting.
4. Technology tools enable me to better diagnose learning problems.
5. I get personal gratification from learning new computer knowledge and skills.
6. Computers provide a means of expanding and applying what has been taught.
7. Computer tools enable me to communicate and interact more with students.
8. By integrating technology, I am helping students to acquire the basic computer education they will need for future careers.
9. I enjoy figuring out how to use computers effectively for a variety of teaching situations.
10. Computers provide more opportunities for gifted students.
11. Technology tools enable students to help each other and cooperate on projects.
12. Computers provide an environment that appeals to a variety of learning styles.

II. Incentives to Integrate Technology for Teaching and Learning (Open-ended response)

One of the goals of the current research project is to gather additional information about the intrinsic motivators, and extrinsic incentives, that may encourage faculty members to integrate and use technology in their teaching tasks.

In addition to those listed in the previous section, please elaborate on the nature of what motivates you to integrate and use technology in your teaching on campus, and the incentives that encourage you to engage in this task.

1. The following reasons motivate me to integrate technology into teaching and learning:

2. The following are incentives to integrate technology into teaching and learning:

I. Barriers to Integrating Technology for Teaching and Learning (Selected response)

Many faculty are highly motivated to integrate computers for teaching and learning. Although faculty members have developed impressive expertise in using computers in their classrooms, to a greater or lesser extent all faculty experience barriers when they attempt to use and integrate computers in their teaching.
In your opinion, how significant is each of the following barriers, as identified in previous research (Hadley & Sheingold, 1993), to the use of computers for teaching and learning in the campus environment?

(1) Strongly Agree, a major barrier (2) Agree (3) Neutral (4) Disagree (5) Strongly disagree, not an barrier

1. Faculty members lack enough time to develop instruction that uses computers.
2. There are problems scheduling enough computer time and/or resources for different faculty members' classes.
3. Hardware is unstable and always breaking down.
4. The reward structure does not recognize faculty members for integrating computers for teaching and learning.
5. There are too few computers for the number of students.
6. There are too few computers for individual faculty.
7. There is a scarcity of printers and/or other peripherals in order to effectively use computers for teaching and learning.
8. There is not enough time in the course schedule for computer related instruction.
9. There is limited research literature that shows significant improvements in learning as a result of computer integration.
10. Financial support for computer integration from administration is inadequate.
11. There is not enough support for supervising student computer use.
12. There is inadequate financial support for the development of instructional uses of computers.
13. Faculty members are not interested in using computers for instruction.
14. I am unsure how to effectively integrate computers into instruction.
15. Available software is not adaptable to my instructional needs.
16. Computer manuals and materials are inadequate and unhelpful.
17. There are too few training opportunities for faculty members to acquire new computer knowledge and skills.
18. There is less control over classroom instruction when using computers.
19. Computers do not fit the course or curriculum that I teach.
20. There is no recognition for using computers for post-secondary teaching and learning.

II. Barriers to Integrating Technology for Teaching and Learning (Open-Ended response)

One of the goals of the current research project is to gather additional information about the barriers that may prevent or discourage faculty members from integrating and using technology in their teaching tasks. In addition to those listed above, please elaborate on the nature of barriers that you believe limit the integration of technology by faculty members for teaching and learning.

1. The following barriers may prevent faculty members from using and/or integrating technology into teaching and learning:

Learning About Technology

Individuals tend to have preferred methods for learning more about technology. In the following three questions, please indicate the importance of each of the following methods to you for learning about technology, getting support, and accessing information about innovations.

(1) Very Important (2) Important (3) Neutral (4) Not Important

1. In terms of media and methods for acquiring NEW computer application skills and knowledge, how important are the following to you?

    a. on-line manuals
    b. hardcopy materials (books, etc.)
    c. hands-on experimenting & trouble shooting
    d. mixture of manuals and hands-on
    e. workshops and presentations
    f. structured courses and guidance

2. In terms of HELP or ASSISTANCE with using computers, how important are each of the following sources of support to you?

    a. experienced graduate student(s)
    b. colleague(s) on campus
    c. colleague(s) at another institution
    d. outside professionals trained in technology use
    e. media center support staff
    f. hot-line, or telephone assistance
    g. one-on-one assistance

3. How important are the following sources of information to you for keeping abreast of changes/innovations in the area of computers?

    a. Informal network of friends and family
    b. Colleague(s) on campus
    c. Colleague(s) at another institution
    d. department chair
    e. university administration
    f. innovative graduate students
    g. popular newspapers and television
    h. popular computer magazines
    I. refereed computer journals
    j. conferences, demonstrations and workshops
    k. on-line computer newsgroups & websites
    l. on-line computer journals
    m. publications from major computer vendors
    n. hardware and software catalogues and brochures
    o. hardware and software stores, vendors, suppliers

Methods for Using and Integrating Technology in Teaching and Learning

One of the goals of the current research project is to gather information about the "learned lessons" or methods that have been effective for post-secondary teaching and learning using technology.

Please elaborate on some of the methods that you have used in order to integrate technology in your teaching.

1. The following are ways in which I have used and integrated technology into my teaching:

2. Additional comments:

Evaluating the Outcomes of Using Technology for Teaching and Learning

How does a faculty member determine whether the use and integration of technology is having the intended/desired effects? How do you "know" when using technology has "worked", and when it has not?

Please elaborate on the ways in which you evaluate the outcomes of using technology in your teaching.

1. The following are ways in which I evaluate the outcomes of using technology into my teaching:

2. Additional comments:

Concluding Remarks

I invite you to use the remaining space or a separate sheet to comment about any item in this questionnaire about which you would like to elaborate on your responses or positions.

APPENDIX B. LETTER TO UNIVERSITY OF CALGARY DEPARTMENTS

January 14, 1998

Dear Department Staff:

As part of my doctoral research in educational psychology, I have designed a survey for academic staff in order to collect information about current adoption patterns of computer technology for post-secondary teaching and learning.

Faculty are encouraged to participate in this investigation by accessing the on-line WWW version of the survey at the following URL:

http://www.acs.ucalgary.ca/~dmjacobs/phd/

To assist me with my attempt to gain the participation of all academic staff in this research, I would greatly appreciate your help with the following information:

1. Distribute the enclosed letters to each academic staff member in their department mail boxes,
2. Make available to academic staff copies of the enclosed "Teaching and Learning with Technology in Higher Education" survey by placing it close to the department mail boxes, and
3. To meet possible demand for the paper version of this survey, please copy additional survey forms for academic staff. Alternatively, please contact me and I will quickly send additional copies of the "Teaching and Learning with Technology in Higher Education" survey to your department.

If you have additional questions about this investigation, please contact me by phone or by email, my supervisor John Mueller at 220 - 5664 or by email (mueller@acs.ucalgary.ca), the Office of the Chair, Faculty of Education Joint Ethics Review Committee at 220 - 5626, or the Office of the Vice-President (Research) at 220 - 3381.

Thank you very much for your valuable assistance with my doctoral research.

Sincerely,

D. Michele Jacobsen
Doctoral Candidate, Educational Psychology
302 Education Tower
dmjacobs@acs.ucalgary.ca
220-3605, (H) 282-3013

APPENDIX C. LETTER TO UNIVERSITY OF CALGARY FACULTY

Dear University of Calgary Academic Staff Member:

As part of my doctoral research in educational psychology, I have designed a survey to collect information about adoption patterns of computer technology for post-secondary teaching and learning.

Results from this investigation will be used to inform and educate the general post-secondary community about the adoption of educational technology by academic staff, resulting changes to the teaching and learning process, the incentives and barriers to integrating technology, and methods for evaluating the outcomes of integration.

A goal of the present research is to develop recommendations for teaching practice with regard to the training, support, and resource needs on campus. This plan may contribute to the future design of professional development opportunities and incentives for faculty who wish to integrate computer technology into their post-secondary teaching. However, this independent research project is unrelated to current information technology plans on our campus.

Invitation to Participate:

Your participation and contribution to this research is very important. The views and opinions of faculty who have, and have not, integrated technology for teaching and learning will provide valuable information. Please select one of the following two methods to participate in this investigation, and take the time to return survey results by February 18, 1998. The survey will take approximately 30 to 45 minutes to complete, your responses will be kept in the strictest confidence and only group results will be presented in any published reports.

1. Online World Wide Web (WWW) Survey

Faculty are encouraged to participate in this investigation by accessing the on-line WWW version of the survey at the following URL:

http://www.acs.ucalgary.ca/~dmjacobs/phd/

2. Printed Survey

a. A limited number of paper copies of this survey have been provided for each department on campus. Please obtain a copy of my survey, entitled “Teaching and Learning with Technology in Higher Education”, from the administrative staff in your department.

b. Faculty members can also obtain a copy of this survey by contacting me directly by phone (220-3506 or 282-3013) or by email (dmjacobs@acs.ucalgary.ca).

If you have additional questions about this investigation, please contact me by phone or by email, my supervisor John Mueller at 220 - 5664 or by email (mueller@acs.ucalgary.ca), the Office of the Chair, Faculty of Education Joint Ethics Review Committee at 220 - 5626, or the Office of the Vice-President (Research) at 220 - 3381. Thank-you very much for your participation.

Sincerely,

APPENDIX D. BOOK DRAW AND REQUEST FOR RESULTS

Book Draw!!
for Research Participants

TechnoStress:
Coping With Technology @WORK @HOME @PLAY

Michelle M. Weil, Ph.D. and Larry D. Rosen, Ph.D.
http://www.technostress.com/

> Modern technology was designed to empower us and set us free. So why do we often feel more like its slaves than its masters? In this "must-have" book, psychologist Michelle Weil and educator Larry Rosen explain why technology often makes people feel under the gun -- and how to preserve your humanity and sanity in a digital world.

Tear off and return this form with your completed survey to enter a draw for this book! *Participants who complete this survey using the WWW form have a chance to enter this draw online*. Identifying information will be kept confidential, and will only be used for the purpose of entering the draw for TechnoStress. Your email address (and/or Name and Office location) will not be associated with or linked in any way to the data you provided in this study.

Research Results

If you wish to receive information about the results of this survey (available after March 1998), please provide your e-mail address (and/or Name and Office location) in the space provided below. Identifying information will be kept confidential, and will only be used for the purpose of returning aggregate results. Your email address (or name and office location) will not be associated with or linked in any way to the data you provided in this study.

Please Return to:

D. Michele Jacobsen
Doctoral Candidate, Educational Psychology
302 Education Tower

❑ Please enter my name in the draw for TechnoStress

❑ Please forward the results of this survey to me.

Name: ________________________________ Office: ____________________

AND/OR

E-mail Address: ________________________________

APPENDIX E. EMAIL LETTER TO EDUCATIONAL LISTSERV AT THE UNIVERSITY OF ALBERTA

****
TEACHING AND LEARNING WITH TECHNOLOGY IN HIGHER EDUCATION
****

Online World Wide Web (WWW) Survey of Academic Staff
http://www.acs.ucalgary.ca/~dmjacobs/phd/

My name in Michele Jacobsen, and as part of my doctoral research in educational psychology at the University of Calgary, I have designed a survey to collect information about adoption patterns of computer technology for post-secondary teaching and learning.

Results from this investigation will be used to inform and educate the general post-secondary community about the adoption of educational technology by academic staff, resulting changes to the teaching and learning process, the incentives and barriers to integrating technology, and methods for evaluating the outcomes of integration.

A goal of the present research is to develop recommendations for teaching practice with regard to the campus training, support, and resource needs. This plan may contribute to the future design of professional development opportunities and incentives for faculty who wish to integrate computer technology into their post-secondary teaching. However, this independent research project is unrelated to current information technology plans on any particular campus.

Invitation to Participate:

Your participation and contribution to this research is very important. The views and opinions of faculty who have, and have not, integrated technology for teaching and learning will provide valuable information. Please take the time to return survey results by February 18, 1998. The survey will take approximately 30 to 45 minutes to complete, your responses will be kept in the strictest confidence and only group results will be presented in any published reports.

Online World Wide Web (WWW) Survey

Faculty are encouraged to participate in this investigation by accessing the on-line WWW version of the survey at the following URL:

http://www.acs.ucalgary.ca/~dmjacobs/phd/

If you have additional questions about this investigation, please contact me (dmjacobs@acs.ucalgary.ca) or my supervisor John Mueller (mueller@acs.ucalgary.ca). Thank-you very much for your participation.

Michele Jacobsen
Doctoral Student
Educational Psychology
University of Calgary

APPENDIX F - FREQUENCY DATA FOR FIRST COMPUTER PURCHASE

Item 5. In what YEAR did you BUY your first computer for PERSONAL/HOME use?

Year	Frequency	Percent	Cumulative Percent
< 1980	8	10.5	10.5
1981	2	2.6	13.2
1982	2	2.6	15.8
1983	7	9.2	25.0
1984	6	7.9	32.9
1985	9	11.8	44.7
1986	3	3.9	48.7
1987	7	9.2	57.9
1988	4	5.3	63.2
1989	3	3.9	67.1
1990	7	9.2	76.3
1991	3	3.9	80.3
1992	6	7.9	88.2
1993	1	1.3	89.5
1995	1	1.3	90.8
1996	1	1.3	92.1
1997	1	1.3	93.4
Do not own	5	6.6	100.0

Item 6. In what YEAR did you BUY your first computer for PROFESSIONAL use?

Year	Frequency	Percent	Cumulative Percent
< 1980	6	7.9	7.9
1981	3	3.9	11.8
1982	4	5.3	17.1
1983	3	3.9	21.1
1984	7	9.2	30.3
1985	4	5.3	35.5
1986	7	9.2	44.7
1987	4	5.3	50.0
1988	3	3.9	53.9
1989	3	3.9	57.9
1990	4	5.3	63.2
1991	2	2.6	65.8
1992	4	5.3	71.1
1993	4	5.3	76.3
1995	3	3.9	80.3
1996	1	1.3	81.6
1997	3	3.9	85.5
Do not own	11	14.5	100.0

APPENDIX G - 27 STATISTICALLY SIGNIFICANT DIFFERENCES FOR YEAR FIRST USED 44 TYPES OF COMPUTER SOFTWARE AND TOOLS FOR EARLY ADOPTERS VERSUS MAINSTREAM FACULTY

Early adopters used the following 27 types of computer software and tools earlier in their teaching than did Mainstream faculty.

Software and Tools	t	df	p <
Gopher	4.86	74	.001
Drill & Practice	4.42	74	.001
HyperStudio	4.29	74	.001
Newsgroups	4.19	74	.001
Tutorials	4.15	74	.001
Integrated Learning System	3.94	74	.001
HyperCard	3.46	74	.010
Linkway	3.33	74	.010
Drawing program	3.23	74	.010
FTP (upload, download files)	3.20	74	.010
Paint program	3.09	74	.010
Clipart	3.07	74	.010
Robotics	2.99	74	.010
Presentation package	2.81	74	.010
Simulations	2.64	74	.010
Drafting, CAD	2.39	74	.010
Desktop Publishing	2.56	74	.050
World Wide Web browsing and searching	2.51	74	.050
Spreadsheets	2.43	74	.050
Database	2.40	74	.050
CD-ROM materials	2.38	74	.050
WWW page creation/editing	2.33	74	.050
Music Composition	2.26	74	.050
Virtual Reality	2.26	74	.050
UNIX	2.15	74	.050
On-line video, audio	2.14	74	.050
Charting-graphing	2.05	74	.050

Note: The 17 types of computer software and tools for which there was no statistical difference between EAs and MF for year first used:

Any programming language (i.e., Logo,Basic,C,Fortran, etc.)
Apple
Macintosh
PC-DOS
Win 3.x, NT
Win 95
Sun
Text editing
Word processing
Statistics package
Grading package

Electronic Mail
Listservs, BBS
On-line databases
Toolbook
Games
Videodisk

APPENDIX H - A SAMPLE OF ON-LINE RESEARCH PROJECTS AT THE UNIVERSITY OF CALGARY AND ELSEWHERE.

1. "Affective and academic results of computer programming experience"
   John Mueller and Michele Jacobsen
   Educational Psychology
   [On-line] Available: http://www.acs.ucalgary.ca/~mueller/tai-consent.html

2. “Neuroscience and Education"
   Simon McCrea and John Mueller
   Educational Psychology
   [On-line] Available: http://www.acs.ucalgary.ca/~mueller/neuro.html

3. “The effects of differing attitudes on the Internet, and the resulting behaviours”
   Barbara Marcolin and Carol Pollard
   The Faculty of Management
   [On-line] Available: http://www.acs.ucalgary.ca/~intsum96

4. Personality Test
   Liam Healy & Associates
   Work and Organizational Psychologists, http://www.occpsy.demon.co.uk/index.htm
   [On-line] Available: http://www.psychometrics.co.uk/

APPENDIX I - UNIVERSITY OF CALGARY ASSESSMENT CRITERIA PERTAINING TO TEACHING AND RESEARCH PERFORMANCE AND COMPUTER-ASSISTED LEARNING TECHNIQUES

Criteria for Evaluation

6.7.7.5 The development, testing, and application of computer-assisted learning techniques and software shall be deemed to be innovative teaching when the techniques or software have been successfully integrated into the teaching of University course offerings and the usefulness of the activity has been acknowledged by informed peers in a manner similar to the peer review of materials submitted for publication. [APD 3.2.2]

6.7.8.4 The development of software and the creation of data bases or the creation or entry of information into data bases or contributions to program libraries shall normally be considered equivalent to research publication only if the results have been subjected to informed peer review or appropriate refereeing. [APD 3.3.5]

Sources

The University of Calgary (1996, November). Manual of Policies and Procedures for the Annual Assessment of Academic Staff (Increments and Promotions).

The University of Calgary (1997, June). Procedures Pertaining to Appointment, Promotion and Dismissal of Academic Staff, as established and approved by: The General Faculties Council and The Board of Governors.