Designing and Developing an Educational Systems Design Model for Technology Integration in Universities

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Acknowledgements

Poets and philosophers have explored the nature of knowledge. About self-knowledge, Kahlil Gibran wrote: "Say not, 'I have found the truth,' but rather, 'I have found a truth.'" This dissertation is the product of much self-reflection and it resonates with the multiple perspectives I have had the pleasure of experiencing as influences. It represents three years of investment in my self and my knowledge.

Family members, friends and colleagues (you know who you are): you made it possible for me to change horses in mid-stream (so to speak), to take a break from an excellent life and dive into a new way of doing and thinking. I appreciate your confidence in me, and your unwavering support. Thank you Richard and Patrick.

In particular I want to acknowledge the members of my committee: Bob Bernard, Gary Boyd and Steven Shaw, whose interest in and support for my research project helped me see it through in a timely manner. I especially want to thank Dennis Dicks, my supervisor, for his wise counsel and constant encouragement.

To my classmates from the Second Cup Corner: together we struggled to master the basic knowledge of the field while we supported each other's learning processes. We explored the benefits of participating in a learning community, and I believe we are all stronger for having shared the experience.

Abstract

Designing and Developing an Educational Systems Design
Model for Technology Integration in Universities

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This study was inspired by the challenges of integrating educational technologies into universities. Beginning with a discussion of economic, political, social, technical and cultural forces for and against technology-enhanced learning, the study aimed to find appropriate initiatives in the research and experience of universities that have successfully harnessed teaching and learning technologies. The objective of the research was to use multiple methods and an emergent design to identify and describe the factors affecting successful institution-wide technology integration efforts with a view to informing more effective policy.

The investigation was conducted using a variety of sources, beginning with an analysis and synthesis of recent research on technology-supported postsecondary teaching and learning. A systematic literature search resulted in more than 300 descriptive and interpretive reports published since 1995. These studies employed various combinations of qualitative and quantitative designs to study technology use in a wide variety of disciplines and many different campus contexts. A broad analysis of the literature suggests that critical success factors are organisation-dependent, related to variables such as organisational mission, goals, culture and practices, as well as faculty and student perspectives.

In the second part of the study three types of university models were explored (planning, design and implementation), using two case studies to learn about one model in more depth. The models were then analysed with respect to their ability to address the factors that emerged in the literature review. A new model for designing and integrating technologies for teaching and learning emerged from the analysis and synthesis of research literature and models. Based on a modified form of educational systems design, this model offers a systemic and multiple shareholder approach to institution-wide planning, design, implementation and evaluation of learning technologies. Focused on learning as the core business of the university, the model offers an alternative to strategic planning approaches. The potential usefulness of the model was evaluated by comparing it with existing technology plans available on the websites of three Canadian universities, selected to be representative of the sector.

The thesis concludes that a multiple perspective, participative approach is necessary to successful integration of technology across the university.

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Chapter I - CONTEXT

Introduction and Methodology

The Problem

The power of technology as an instrument of change deeply influences all sectors of society. Managing technology-induced change is one challenge affecting leaders of all organisations. Technological change, together with the quasi-religious belief in its primacy, transforms organisational culture and behaviour in all sectors. Educational institutions, for example, respond to pressures in their environments by turning to information and communications technologies in the hope of solving a variety of business and academic problems. The technology-based "solutions" bring their own problems, often intensifying the uncertainty. As a result these technologies are changing all aspects of university life. Although there are differences of opinion about the value and impact of these changes in the academy, there is widespread recognition both externally and internally that they cannot be ignored. Governments, the popular press and educational researchers are exploring the impact of uses of educational technologies on teaching and learning activities. Most research suggests that the broad range of learning technologies has potential to deal with several factors that threaten traditional post-secondary education. These factors include: (a) learner demands for anytime, anywhere access to instructional resources; (b) challenges brought on by the convergence of distance and on-campus learning; (c) urgent business need for computer-based, cognitive and social skills in graduates; (d) quickly outdated content and the need for effective updating processes; (e) competition between individual institutions in a global educational marketplace; (f) instructional focus that does not address learner needs for collaboration and relevance; and (g) tradition and inertia, and the unwillingness or inability of individuals and institutions to adapt to ever-changing social needs. The pervasiveness and urgency of these pressures is inescapable.

Widespread and easy access to the Internet in the mid-1990s, supported by technical advances in computing speed and power by 1995, as well as reduced costs, may have been a catalyst for change. To meet these challenges, university policy makers and administrators search for approaches to the appropriate integration of information and communication technologies into pedagogical and administrative systems. They need to know: how can information technologies be successfully applied to educational programs? To date, there is little policy that informs the adoption of educational technologies in Canadian teaching and learning contexts (Cuneo, Evers, Kahmin, Malinski, & Warwick, 1999). The use of learning technologies in Canadian universities needs to be assessed and the criteria for success need to be defined (Lewis, Smith, Massey, McGreal, & Innes, 1998). Effectiveness of instructional technologies depends on careful consideration of a variety of perspectives, such as cultural transmission, equity of access, learning gains, student and teacher satisfaction, administrative practice, and return on investment.

Despite the "relentless hype" (Mason, 1995, p. 197) surrounding technology use in higher education, research is beginning to document resistance to administrative policies that push adoption in courses and programs. Some of the variables that appear to affect integration are patterns of faculty use of and attitudes toward computers (Mitra, Steffensmeier, Lenzmeier, & Massoni, 1999). Other variables relate to levels of students' computer anxiety and literacy (Mitra & Steffensmeier, 2000), access, technical support and training (Jacobsen, 1998; Rogers, 2000b). Faculty members remain sceptical of claims for enhanced learning using technology. Many universities in Canada do not have adequate plans for proactively responding to these opportunities and challenges.

This study is one response to the compelling pressures for technology adoption affecting universities. Its uniqueness is that it responds to calls for research that explores "the interaction of technology and people" (Surry & Brennan, 1998) and is "grounded in practice and sensitive to the variety of ways our theories are used" (Wilson, Dobrovolny, & Lowry, 1998). Beginning with a discussion of university culture, the study situates the economic, political and social origins of these pressures for change, and aims to find appropriate initiatives in the research literature and experience of universities that have successfully harnessed teaching and learning technologies. This chapter describes the conceptual framework of the study and the organisation of the thesis. Specific research questions, a description of the design of the study, and its methodology follow. The next section provides an exploration of the environment including a presentation of the factors and factions pressing for change. The final section in this chapter presents an integrative critical review of recent literature in the field of higher education. Definitions of key terms are not only embedded in the text but also collected in a glossary at the end.

Conceptual Framework and Organisation of this Thesis

I understand "technology integration" to mean institution-wide adoption of educational technologies. This meta-level (Kaufman, Thiagarajan, & MacGillis, 1997, call it the mega-level) of adoption implies that the major barriers to technology acceptance have been overcome, and that technologies for teaching and learning have become part of the organisational culture. Ely calls this state "institutionalisation" (Surry & Ely, 1999), or the evidence that an innovation is "routinely used in settings for which it was designed." I make the distinction however between the notion of integration and that of implementation. By "technology implementation" I mean the use of particular technologies for specific purposes (e.g. computer mediated conferencing - CMC) by individual faculty members at the course level, or by departments at the program level.

My approach to technology integration hinges on a concept of educational systems design (ESD) embodied in learning environments represented by and operationalised in universities and the ways in which they meet the needs of society. My understanding of the need to plan at an institution-wide (meta) level for the effective micro- and macro-level implementations of technology into teaching and learning activities is framed by a combination of the three perspectives of Kaufman (1988), Banathy (1991) and Reigeluth (1995). Kaufman (1988) proposes outcomes-oriented, "responsible, results-based, people-oriented educational planning" (p. xi). Beginning with the learner, he advocates an educational systems environment that facilitates the acquisition of information and its conversion to knowledge. Learning theory and domain-specific content are combined with learner characteristics to inform decisions about appropriate instructional strategies and conditions for learning. Banathy (1991) contributes the notion of design as a process of inquiry for educational transformation. He points out that in contrast to conventional educational reform efforts that focus on existing internal environments, systems design looks to societal context as the first step to defining educational mission and formalising the vision based on core values. Reigeluth

(1995) explains that educational systems development draws from systems science, design and instructional theories to inform the fundamental and radical changes in the educational enterprise that are necessary to respond to the rapidly changing expectations of society.

While I accept the general limitations of hard systems approaches outlined by Banghart (1997), I propose this educational systems design approach not because of its tight structure and predictability, but because of its foundation in learning concerns and its sensitivity to the multiple and complex influences of reality on educational practice. In a post-modern critique of technology adoption practices and research, Wilson et al. (1998) suggest that multiple perspectives and cultural issues are too often ignored. I contend that cultural issues are at the heart of teaching and learning in universities; and so I have structured this research project to help in understanding them. The language I use comes from an instructional design perspective with a "theoretical sensitivity" (Strauss & Corbin, 1990) to learners and instructors and their needs. With its roots in systems and communication theories, educational systems design shares many processes and techniques with strategic planning, but it may be better adapted to planning in educational environments. This last point is critical and will be discussed later, in relation to the strategic planning approaches advocated by current technology integration models.

My conception of educational systems design is based on four distinct but mutually supportive processes: planning, design, implementation and evaluation, which are roughly analogous to the stages in most models of instructional design (analysis, design, development, implementation, evaluation). I visualise these processes as overlapping spheres of activity rather than as linear steps, however. My model is represented in two dimensions in Figure 1. Planning activities include visioning, establishing mission and broad goals, environmental scanning and identifying leadership. Design activities include identifying learning goals and instructional objectives, instructor expectations for content and performance outcomes and determining appropriate instructional strategies and technological resources. Implementation processes negotiate human and financial commitments and pull together these resources with training and support, time and access so that development and delivery activities can occur. Evaluation assesses how well objectives have been met and suggests improvements or remediation, both to the products and to the process.

This dissertation is organised following the ESD framework. Chapter I - Context deals with planning and orientation. In three sections it outlines the broad scope of the research, identifies the purpose of the study and establishes the societal context (i.e., what Kaufman calls mission analysis). This includes an integrative literature review that unveils issues of importance in technology integration. Thus Chapter I sets the stage for the inquiry and analysis that follow. Chapter II - Models deals with design, or function analysis in Kaufman's terms. It describes current models of technology integration and studies two of them in depth as a way to proceed with the inquiry. Chapter III - Integration applies analytical processes to synthesise the results of my two primary studies, the literature review and the analysis of models. Here I develop a new model that anticipates and responds to the emergent issues. Chapter IV - Conclusion provides the test of the model and evaluates the entire research project with respect to its limitations and its potential contribution to research and practice. It also includes recommendations for further research.

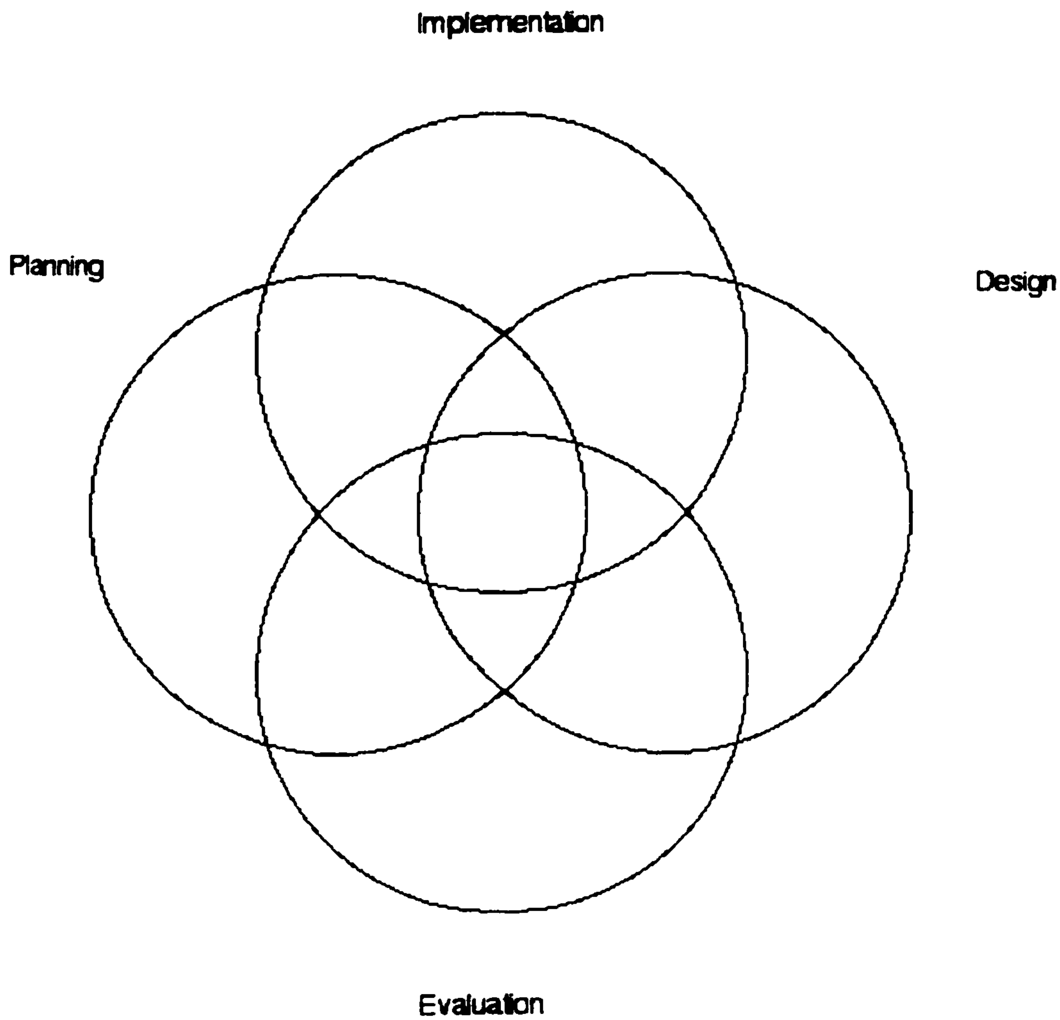

Figure 1. A model of educational systems design includes four overlapping spheres of activity: planning, design, implementation and evaluation.

Research Questions

My overall premise for this study is that a multiple perspective, collaborative approach is necessary to successful integration of technology across the university. Only by working together in consideration of the particular mission and culture of the university and its historical position in society will stakeholders succeed in building on its demonstrated strengths and overcoming its traditional weaknesses to respond to society's needs for higher education. My general question is: can these principles be embedded in a model for institutional-level technology integration? The specific research questions are:

1. What models of institutional-level technology integration are "out there"?
2. Do universities use models for technology adoption?
   If yes, which models?
   If no, what do they do instead?
3. What factors need to be considered in the development of integration policy and implementation procedures?
4. What would a model look like that considers all the factors appropriately?
5. How does the proposed model compare to existing university technology plans?

Assumptions

This study was inspired by my experiences in university development, strategic planning and technology integration initiatives. The underlying theme, the importance of collaboration and communication, was shaped by my conflicting roles as a member of more than one internal constituency struggling for control of decision making at the same time. The underlying assumptions of the study were informed by my personal belief that this issue is highly relevant to members of university communities everywhere. For these reasons the research design could not be experimental. The factors affecting meta-level technology integration are not easily separated into variables that can be operationalised and controlled. Rather the questions this study sought to answer required a broad conceptualisation of the issues and a multi-method approach. An emergent design allowed for an interpretive perspective and concurrent data collection and analysis to arrive finally at a synthesis of the evidence with a greater level of understanding. Conscious of the importance of trustworthiness in interpretive research, I dealt with issues of reliability and validity both in the design of the study and throughout the process as they appeared. As well I consider issues of transferability in the concluding chapter.

My assumptions about teaching, learning, technology and organisational behaviour are embedded in the definitions of key terms used throughout and collected in the Glossary. As a basis for understanding my references, for example, my working definitions of technology and educational technologies are stated below.

Technology is not a synonym for "tool" (Evans & Nation, 2000). "Technology is the art, craft and science of how to use a particular tool for a particular purpose" (p. 8). The Association for Communications and Technology (AECT) considers technology to refer to the "systematic process of solving problems by scientific means" (Ely, 2000).

Technologies for teaching and learning also referred to as *educational technologies*, include a variety of media such as textbooks, black boards, library resources, pre-packaged course materials, video and laboratory equipment and the pedagogical strategies for using them. In this thesis I am primarily concerned with computer-based information and communication technologies that are considered to have great potential for improving the educational transaction. These include productivity, presentation and simulation software, online databases, web pages, course management programs and computer-mediated communications systems (CMC). Educational technologies also include the processes involved in deciding how and why to use which medium for what purpose. The AECT defines *instructional technology* as "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (Ely, 2000).

Research Design and Methodology

This study combined several interpretive methodologies with an emergent design to explore the research questions. There were five distinct phases to the research process: (a) a critical integrative literature review, (b) analysis of existing "integration" models, (c) case studies of two technologically-integrated universities, (d) model building, and (e) an evaluation of the model against existing university plans. The first three phases were iterative, with the literature review informing both the framework for model analysis and the development of interview questions, and with the model review and case studies inspiring further questions to be explored in the literature. Model building began once the data collection and analysis were under way. The evaluation activities completed the study. Because this study does not fall neatly into established research designs, there will be questions about its validity. These questions are addressed in the subsections below and in the individual chapters that follow.

Integrative Literature Review

This phase of the data collection involved the analysis of peer-reviewed research reports published between 1995 and 2001. The procedures followed for integrating the literature were chosen from among those advocated by methodologists to enhance the validity of the approach, particularly with respect to its replicability (e.g., Abrami, Cohen,

& d'Appollonia, 1988; Cooper, 1998; Jackson, 1980; Yin, 1991). A systematic literature search resulted in more than 300 studies, including descriptive and interpretive reports, qualitative and quantitative designs, and representing a wide variety of disciplines and many different campus contexts. This comprehensive approach to reviewing the literature was an attempt to bring together the broadest possible sources of empirical evidence on university-level technology integration. Themes that emerged were compared across studies using the constant comparative method common in qualitative research, case study and grounded theory approaches (Glaser & Strauss, 1967). The synthesis of factors affecting successful technology integration that emerged shaped interview questions and further study. As well, these factors were used to analyse the existing integration models and to inform the design of a new model.

Model Analysis

This study explored three types of models that prescribe a process for designing functional technology integration approaches at the institutional level: planning models, design models and implementation models. Planning models (Bates, 2000a; Daniel, 1996) tend to prioritise business processes that lead to efficiencies for the purposes of maintaining competitive advantage and innovation in the university. Design models (Laurillard, 2002; Paquette, 1997) are focused on learning, and tend to use the principles of instructional design as the basis for developing educational systems in which technology is a component. Implementation models (Brown, 1999) include various examples of the "ubiquitous computing" approach to technology integration. Specific applications of the “laptop university” model (e.g., Acadia University, Wake Forest University) were explored using the case study method.

Case Studies

Case study research involves a detailed and in-depth study of a particular example of a phenomenon in its natural context (Gall, Borg, & Gall, 1996; Yin, 1994). The method explores the case from the perspective of the participants. In this study, Acadia and Wake Forest represent two mature examples of a model that attempts to prescribe the integration of learning technologies into teaching on campus. Data collection involved document review as well as interviews, in order to support triangulation of interpretation. I submitted ethical review protocols for the interviews and received approval from the Department of Education Committee. The "official" emic perspective is presented in the descriptive section while an etic perspective is offered in a cross-case analysis, in which my interpretations of the cases are supported by critical internal perspectives.

A Model for Successful Technology Integration

The new model that emerged from the synthesis of research and practice provides a framework from which to analyse current practice in technology implementation at the university level. It is comprehensive in its orientation and allows for the multiple layers of complexity involved in a university environment struggling with change. It incorporates elements of planning, design, implementation and evaluation. As well, the new model supports three very important meta-level values: shared mission and culture; broadly based participation; and shared language.

Model Evaluation

The new model was compared with the technology plans available on the websites of three Canadian universities, selected to provide a representative cross-section of higher education institutions (i.e. one large university, one medium sized university and one Francophone institution were chosen). By mapping the proposed model onto the elements of these plans, I show that it addresses the factors affecting technology adoption identified in the research and practice more comprehensively than any of them do. I suggest that the new model presents an alternative approach to institutions that are searching for answers to their questions about how information technologies can be successfully applied to educational programs.

The structure of this thesis is unusual. Rather than a standard linear report of introduction, method, results and discussion, the dissertation is structured following the conceptual framework. This means a certain amount of overlap between the chapters, which may be frustrating for the reader. Repetition between chapters is intentional and serves to emphasise key concepts and situate the new ideas in previous results. The structure reflects the iterative nature of the research project.

Having outlined the details of this research project and described its structure, I now turn to an explanation of the context that framed the study, presented in two sections. In the first, on the environment, I begin with a description of university culture, as a background to consideration of the change process involved in technology integration and to frame later discussions about resistance and facilitative conditions (Surry & Ely, 1999). This is followed by details of the economic, political and social forces for technology-supported and inspired change. The final section presents the results of the integrative literature review, which underlie the rest of the study. Here I describe the procedures followed and provide a general picture of research findings on technology integration in universities since 1995.

Environment

The Cultures of Universities

The world of higher education is complex and though some criticisms of the "ivory tower" suggest it is cut off from "real life," it is important to realise that if this ever were the case it is no longer so. Universities are embedded in their communities. They are directly affected by the economic, political and social influences of their particular environments.

Innis (1947) emphasises the central importance of communication and culture in the functioning of all social institutions. The culture of an organisation is difficult to describe in concrete terms but is represented by the familiar shared feelings and beliefs of its members. Schneider, Brief, & Guzzo (1996) talk about an organisation's "prevailing psychology" (p. 8), which is reflected by its climate and its culture. *Climate* refers to inferences made by employees about organisational priorities, values and goals based on policies, practices, routines and behavioural standards. *Culture* refers to their beliefs and values, their identity in fact. Culture can also refer to subgroups within the organisation.

In a university environment, historically rooted subcultures exist within academic disciplines, administrative departments and among different work groups (e.g., faculty, technicians, middle managers, front-line staff, etc.) The overall institutional culture is complicated by the pluralistic memberships of most individuals in different subcultures. Besides the functional, geographical and hierarchical subcultures described by Schein (1993) there are social subcultures of various sorts. These multiple memberships and interconnected relationships are not static and they can cross the boundaries of the canonical disciplinary and functional (Brown & Duguid, 1991) subcultures. How individuals prioritise their subculture memberships changes frequently and according to circumstances outside the control of the organisation. This reality can strengthen or undermine both the power of the overall organisational culture to affect individual behaviour and the commitment of individuals to the broader organisational goals. It is very difficult to map the multiple levels of cultures and relationships in an educational organisation, especially given that the boundaries between subcultures are permeable and mutable.

Each culture and subculture privileges different styles of communication and uses of language. Language can effectively include or exclude members of outside subcultures. This can have implications for bias based on gender, mother tongue, race or area of expertise. It is particularly true of the differences between leaders or administrators and faculty groups on most campuses. The effectiveness of change management strategies can be severely compromised by breakdowns in communication between faculty and executive levels in a university.

Universities are partly medieval craft-based institutions, and they are also modern globally-oriented businesses. This makes them unique and challenging organisations to manage. Paul's (1990) functionalist discussion of the four models of higher education organisations helps to clarify the dichotomy between medieval and modern, a separation that has both cultural and structural implications. Paul suggests that values conflict is inherent between faculty members and management. Groups of subject matter specialists who have the responsibility to develop new knowledge and to share their expertise with students often have little in common with the administrators responsible for managing their workloads, reward systems and professional behaviour. This is as true of Deans as it is of those involved in finance, human resources or other service departments. Paul proposes that universities are composites of four types of organisations: (a) bureaucratic, which explains the structure but not the decision-making processes; (b) collegial, which describes the culture but is not generally effective for problem solving; (c) political, which illustrates the predominance of internal power groups; and (d) anarchic, especially with respect to academic self-governance. The tensions within and between these aspects of university communities are exacerbated in times of change. Evans and Nation (2000) point out that as external pressures for accountability to government to meet global competition and to society for universal access policies have increased in recent years, internal pressures have escalated as well. These pressures are due to growing enrolments, increased faculty workloads, rising demands for numerous publications, and for incorporating advanced technologies. Given this context, technology integration plans need to address issues broader than "what information and communication technologies can we use?" and "how do we fit them into the existing teaching/learning environment?"

Economic Pressures for Technology

Financial arguments frequently inspire decisions to initiate educational technology projects. These arguments evolve from concurrent pressures to maintain levels of enrolment from traditional catchment areas and to extend university programming into new markets, both geographic and disciplinary with no additional funding. Technology-enhanced programs may answer both maintenance and extension needs by improving competitive advantage and by supporting or creating profitable market-driven educational opportunities. Corporate partnerships are widely available and can help to position a university for these initiatives by providing resources and special expertise (IBM, 2002).

Under the unchallenged assumption that computer technologies automatically contribute to the enhancement of learning environments, universities encourage technology use in the development and delivery of courses, both on campus and by distance. These assumptions are typically based on a quasi-religious faith in technology (Noble, 1999) and on notions of efficiency or effectiveness. Specifically it is assumed that electronic learning environments provide for economies of scale and thus reduce the cost of delivering education while allowing for increased enrolments. Computer advocates (e.g., Harasim, 1999; Hiltz, 1994; Mason & Kaye, 1989) have created expectations for online conferencing environments that suggest learning can be improved, and materials can be designed to meet a wide variety of learning needs. Programs for standardising equipment purchases and software applications supported on campuses address administrative concerns about both efficiency and effectiveness. Clear definitions of beneficiality and effectiveness that go beyond straightforward notions of time, cost and energy savings, however, are not widely accepted. This would involve stating what the financial and other standards are, including who benefits and who does not. In an age of increasing competition from organisations offering technical skills training and just-in-time competency development, the viability of the traditional university system may be in question (Burbules & Callister, 1999; Conlon, 2000). As well, evidence is emerging from research and practice that the costs of good quality technology-enhanced education are not lower than that of "traditional" classroom-based teaching and learning (Bates, 2000a, 2000b). When administrative technology advocates finally receive this message, they will raise critical questions about return on investment. Together with the economics of competitive advantage and enrolment, these arguments exert substantial pressure on educational policy makers.

Political Pressures for Technology

Politically, the pressures for technology adoption come from both internal and external sources. The traditional struggle for control of decision making and content in universities is exacerbated by technology integration. Universities have multiple constituencies, each with its own priorities for policy and procedures. An institutional approach to technology integration should take into account the multiple perspectives of various constituent groups. In a university, the key internal stakeholders are students, faculty members and staff. Other internal stakeholders include Boards, alumni and parents. External pressures come from governments, funding agencies, partners, and community organisations. University administrators are pressured to innovate by governments and corporate partners. This makes them vulnerable to the influences of sometimes unscrupulous technology entrepreneurs who advocate "efficient and effective" technology-based opportunities. These entrepreneurs may be corporate partners or they may be internal constituents.

As research and experience have begun to record the operational and learning problems associated with technology introduction (documented in the literature review), tensions between groups on campus have increased. Faculty associations have become extremely concerned about university policies on reward and recognition for work done to adapt courses to online delivery. Other important issues relate to academic freedom and privacy, ownership and control of course content, intellectual property and copyright protection, royalty payments and profit sharing opportunities. External pressures in the form of grants and other incentives from governments advocating broadly based adoption of Internet-based instruction have helped to crystallise the debate for faculty unions, and they are beginning to work together to steer and resist change. In November 2001, the Canadian Association of University Teachers (CAUT) held a national Conference on Online Education where the perspectives of faculty were explored. Future collective action was discussed while online education was "widely denounced" (CP, 2001) in favour of a "back to basics approach" (Hamalian, 2001).

In Canada, the federal government, through Industry Canada primarily, has commissioned a number of reports on the future of post-secondary education. These studies investigated such issues as strategies (Anderson & Downes, 2000; Bates, 2000b) and models (Harasim, 1999) for online learning; barriers to online learning (Keenan, 2000); the future of research (Expert Panel on the Commercialization of University Research, 1999); and the implications of technology-enhanced delivery for higher education (Lewis et al., 1998; Lowes, 2000). Most recently, the Advisory Committee for Online Learning released a report that challenges Canadian colleges and universities to take advantage of the opportunities offered by information and communication technologies, particularly the Internet (Advisory Committee for Online Learning, 2001). The United States government has sponsored similar studies. The Web-based Education Commission, for example, was established in 1998 and in December 2000 released its "urgent call to action" to harness the Internet's power for learning (Web-based Education Commission, 2000). The subject of technology-inspired transformation in educational practice has also been explored internationally, resulting in an action plan for change and development in higher education (Participants of the World Conference on Higher Education, 1998). The underlying assumptions in these actions are that there is an important role for technology-enhanced learning in the world, and that educational institutions should exploit the opportunities at their earliest convenience.

Social Pressures for Technology

Social pressures in support of technology relate to ubiquity and access. Tapscott (1999) and others (e.g., Patrick, 2001) argue that technology is everywhere and that young people are "instinctive" users. They can juggle multiple applications and have developed high comfort levels with a variety of Internet-connected appliances. Some wonder if universities that do not embrace technology fully in response to the expectations of the next generation of students are abdicating their responsibility, in effect violating their mission to society (McMillan & Hyde, 2000). As the population ages and high school leavers occupy smaller proportions of the student body, teaching and learning practices are changing. Lifelong learning has become widely recognised as desirable for all and also necessary for most workers who need to adapt to changing environments. Older adults have become the new target audience for university education in the humanities as well as in specialised studies. This raises issues of non-traditional access with respect to time, place and learning preferences. Teaching practice needs to offer new strategies for re-creation of knowledge. In order to make these kinds of improvements in their teaching, instructors need see to themselves as learners as well. According to the advocates, educational technologies may provide solutions to some of these problems. Traditionally, the mission of universities has involved teaching and learning for the "common good," research and community service. It has always been the job of universities to determine and explain what really is in the public interest (Frye, 1990). As society changes, definitions of what is in the public interest change as well. Creating knowledge today means different things to some people and organisations than it used to. What are the implications of these changes for the traditional role and practice of universities?

There is an urgent need for greater understanding of the interplay between these economic, political and social pressures, as well as their impact on academic culture and vice versa. How much will culture have to change to accommodate electronic teaching and learning? What aspects of university culture should be preserved at all costs? Are the multiple pressures for change cumulative or competitive? How can they be harnessed to support the university's missions? What is the appropriate balance between external and internal pressures? How can they be managed? Strategies for addressing the challenges raised by these pressures are necessary, but it is not clear that Canadian universities possess them (Cuneo et al., 1999). As an approach to understanding some of these issues, the next section reports the results of an integrative literature review of research that investigated technology integration projects in universities over a period of seven years, from 1995 to 2001. It was in 1995 that wide and easy graphical user interface (GUI) access to the World Wide Web became available on most campuses. Computers became more affordable. Productivity software made them more broadly attractive to academics. These developments increased the urgency of the pressures on campuses.

Integrative Literature Review

The purpose of conducting this in-depth analysis and synthesis of very recent literature was to extract the factors emerging from educational research that affect the success of efforts to integrate technologies in universities. Once identified these factors were used to inform the analysis of selected institutional-level models and particularly, to help frame the questions that guided two case study investigations.

Procedures

The process for collecting and analysing studies for the literature review consisted of the activities described below. A professional librarian, skilled in online database searches for educational research purposes, assisted with the formal aspects of the literature search. The inclusion criteria stated below were informed by a preliminary literature review undertaken in 1999 that confirmed many studies have investigated the variables of interest in university-level technology planning. Analysis and synthesis of the literature followed procedures for appropriate and rigorous methodology for integrative reviews recommended by Abrami et al. (1988), Cooper (1998), Jackson (1980), and Yin (1991). Particular attention is given here to describing the selection, collection and coding procedures I followed. Abrami et al. (1988) and Jackson (1980) stress the importance of explicit attention to methodological details, for the purposes of replicability and credibility of integrative reviews.

Gathering Materials

In May 2001, an initial ERIC search for "research reports" on "technology integration in higher education since 1995" returned 143 records. A PsycINFO search using the same criteria returned 28 records, only ten of which were not duplicates. In a second ERIC search conducted after a preliminary review of these results, the librarian and I used the key word "implementation" instead of "integration" due to the apparently synonymous use of these terms in the abstracts. We added several other descriptors suggested by the abstracts to this second ERIC search, including "utilization," "diffusion," "infusion," "adoption," "supportive" and "disruptive." The search returned 37 new records. Because "technology integration" and "higher education" were not available identifiers in the most recent Index to the Educational Technology Abstracts (1998), I selected the following subject headings: "design and technology," "educational innovation," "educational technology," and "information technology." There were 86 abstracts in these categories.

The total number of individual reports discovered in the first four technology integration searches was 294. I conducted three other ERIC searches as well. One used the key words "technology integration" and "barriers" and "higher education" and returned 11 records. Another duplicated the first two ERIC searches one year later, returning 35 new studies for the period 2000 to 2001. A copy of the actual ERIC search history is available in Appendix 1. The third search replicated the "barriers" search a year later in April 2002, capturing nine more records. This increased the total number of studies to be assessed to 349. Eliminating the duplicates resulted in a total of 292 studies from the database searches. Colleagues and classmates referred me to many more studies from other sources, seven of which I included because they fit the established criteria, for a combined final total of 299 articles.

Selection Process

In the context of another, more narrowly focused research project, two researchers evaluated a subset of these studies independently and then shared findings. This other project, referred to as Successful Practices (SP), was conducted under the auspices of the Centre for the Study of Learning and Performance (CSLP) at Concordia University, and was supported by a pedagogy-technology integration project funded by the McConnell Family Foundation. The results of the first exchange of researcher impressions of the abstracts yielded 85% agreement on the usefulness of the research to a study of successful practices in classroom-based technology integration. We resolved all differences through discussion, arriving at 100% agreement on what to read. In the context of the SP project, we eliminated studies that involved distance, open or virtual learning environments, but I retained them for analysis in my dissertation project. The process of clarifying understandings with an experienced educational researcher helped refine conceptual questions that also applied to my dissertation study and contributed to the credibility of my decisions about which articles to review. In other words the Successful Practices research project functioned as a pilot project for this dissertation literature review by testing the validity of my approach to the integrative literature review.

For the dissertation I decided to look exclusively at journal articles, relying on the peer review process involved in publication as an index of validity and study quality. A review of the conference papers from 1995-1998 indicated that several interesting and relevant presentations were converted into journal articles published between 1999 and 2001. This suggested that although publication delays might be a factor in reducing access to studies reported in conference papers from 1999 to 2001, I should not expect an unacceptable level of publication bias. This decision was also framed by the exploratory purpose of the literature review: to uncover the factors affecting technology integration efforts. I hypothesised that most of the factors would have been uncovered by researchers by 1999, given widespread access to WWW connected, computer-based educational products since 1995. The decision reduced the total number of studies to be analysed from 299 to 141.

Information Management

Eventually I was able to locate copies of all but five of the papers on the final list, either through local academic libraries, interlibrary loan, or online. Therefore, this integrative literature review considers 136 journal articles, a complete list of which can be found in Appendix 2. These I filed alphabetically by author for easy retrieval. I used an EndNote bibliographic database to help me organise the references. On a master spreadsheet in Excel, I recorded not only the decision process to a final selection of studies, but also my progress in reading, summarising and coding the articles. As data display tools (Miles & Huberman, 1993) for coding and analysis, I used a combination of SPSS and Excel spreadsheets and graphs.

Preliminary Reading and Classification of Articles

Following a preliminary reading of a random selection of the classroom-based articles in the context of SP, two researchers created a general analytic framework for coding the surface features of the studies. Initially, both of us read the same 20 articles in order to develop a common language. We each then prepared descriptive summaries on a form we adapted for our purposes from Stern & Kalof (1996, p.179). Discussion and comparison of our summaries allowed us to clarify our understandings and refine our summary form to more accurately record the information we needed. We took the opportunity to discuss our preliminary interpretations of the literature with research colleagues in two venues in October 2001. We wrote a summary report for EvNet, the Network for the Evaluation of Training and Technology (http://www.socsci.mcmaster.ca/srnet/evnet.htm), a research consortium assessing instructional technologies in work sites, schools, colleges, and universities with which the CSLP is affiliated. We also entered a poster in the CSLP research fair (Ives & De Simone, 2001). We brought new ideas from these activities together with our interim findings and proceeded with the analysis phase.

Development of the Template

When we felt confident that we were able to extract and record useful information from the studies using the instrument we had constructed, I read, summarised and coded all 69 articles in the SP subset for surface features. These included research model and design, discipline, orientation, theoretical underpinnings, perspective, instruments, teaching and learning strategies. Fifteen papers did not meet the original criterion of classroom-based research and were removed from the SP analysis. To check the reliability of my coding we randomly selected 20% (11) of the remaining 54 articles for the other researcher to read and code independently. When we met to discuss her coding we identified several categories that seemed unclear, as she found it difficult to assign codes consistently. As a result we defined the codes more clearly, merging some and eliminating others. We also eliminated one apparently redundant variable and cut two more studies. We randomly selected another 20% (10 articles) for her to code while I recoded the rest of the studies according to the revised framework. The next time we met we were able to confirm each other's understandings about the literature and, despite some remaining higher order ambiguity on two variables (orientation and theoretical framework), we can report 90% agreement on the coding. Over all, we reviewed 40 studies together, which represents 29% of the sample I selected for this dissertation review. This intensive and iterative process allowed me to develop a more credible analytic framework as a template for exploring the balance of the literature.

Inclusion Errors

The preliminary reading and classification of the articles for Successful Practices highlighted weaknesses in the literature search. Several articles categorised by ERIC as reports of research turned out not to be studies at all. Opinion pieces and editorials were apparently miscoded. Some studies were not set in the higher education sector. We found we had included one study, a conference presentation, by mistake. In all we cut nine articles from our original selection of 69, and classified six articles as "foundational" to that study, which means we removed them from the analysis of research reports but used them as theoretical or conceptual frameworks for the extraction of themes and patterns. Another seven articles did not exactly fit our criterion of classroom-based studies as they reported on larger scale projects or program implementations of technology. Two reported on research studies from primary and secondary education contexts. Other than the latter, I retained all of these for analysis in the integrative review, however. Once the

SP coding project was complete I was able to adapt the summary template and coding framework to this dissertation context and purpose. A copy of the final codebook can be found in Appendix 3. The purpose of the integrative review was to bring together the broadest possible sources of empirical evidence on university-level technology integration to identify the factors affecting success and to use those factors to inform the rest of the study.

Description of the Literature

The final selection of articles on technology integration in universities included 136 papers published between 1995 and 2001. They came from a variety of sources. The overall demographic characteristics of this body of literature are represented in the tables that follow.

Date of Publication

Table 1 reports the frequency and percentage of studies published in each year. The distribution of publications by year is represented in Figure 2. There were two roughly equal time periods: 1995-1997, accounting for 35% of the studies, and 1999-2001, accounting for 35% of the studies. These two periods enclose 1998, which alone accounted for 30% of the studies. The studies generally tended to report data collected from one to three years previous to their date of publication. Therefore I can speculate that one of the reasons for the higher number of studies in 1998 relates to increased attention to technology integration occasioned by the arrival in 1995 on most university campuses of graphical user interfaces for access to the world wide web.

Table 1

Date of Publication

Date	Frequency	Percent
1995	9	6.6
1996	10	7.4
1997	28	20.6
1998	41	30.1
1999	28	20.6
2000	18	13.2
2001	2	1.5
Total	136	100.0

This technical improvement made Internet use more attractive to administrators as well as to instructors and learners with lower levels of computer literacy. It is possible that web-based implementation studies were initiated in response to this development.

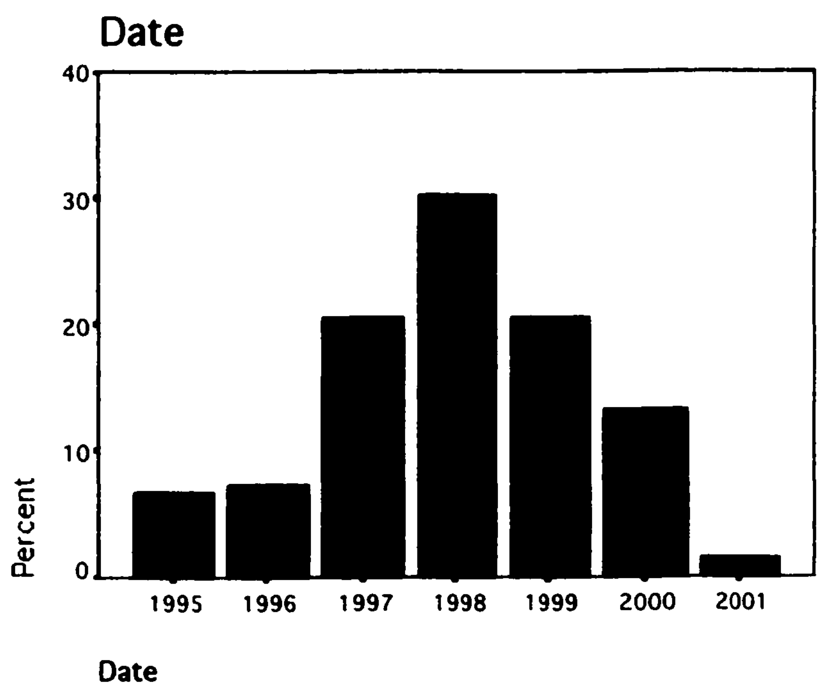

Figure 2. Percentage distribution by year of publication.

Another likely reason for the disproportionately low number of studies from 2000 to 2001 is the typical six to 18 month delay in posting materials to the ERIC database (Education Librarian, Personal Communication, November 2001). A further explanation might lie in the current availability of research in online formats or catalogued for access by Internet search engines in the last two years. I did not do a web search for literature, but it may be that online sources are beginning to compete with traditional publications.

Source of Articles

Table 2 indicates the heavy reliance on ERIC in this literature search. Over 71% of the studies were identified through this source. It should be noted, however, that when there were duplicates with other databases I preferentially recorded the ERIC search to preserve consistency with the librarian's procedures for eliminating duplicates.

Table 2

Source of Studies

Source	Frequency	Percent
ERIC #1	48	35.3
ERIC #2	32	23.5
ETA	23	16.9
ERIC #3	10	7.4
PsycINFO	9	6.6
Other	7	5.1
ERIC #4	6	4.4
ERIC #5	1	0.7
Total	136	100.0

Note. ERIC #1 - #5 refer to the five separate ERIC searches referred to above. ETA refers to Educational Technology Abstracts. PsycINFO is the database of psychology research.

This acceptance of ERIC as the prime source is partly the result of working with a librarian experienced in educational research. It may also be responsible in part for the predominance in the data of studies undertaken in education, as indicated in Table 3.

Disciplines Covered in the Research

Overall the studies came from 21 different disciplines. Those not indicated specifically in Table 3 include Computer Science/Engineering (9), French (1), English (1), Medicine (2), Pharmacy (1), Psychology (3), Educational Technology (5), Chemistry (1), Business (2), Museum Management (1), Geography (1), Italian (2), Journalism (2) Communication (2), Mathematics (2), Social Work (1), and Law (1). I collapsed categories for those disciplines with less than 10 studies for clarity in presentation. The natural/social sciences category includes Computer Science/Engineering, Psychology, Chemistry, Geography and Mathematics. Professional programs include Medicine, Pharmacy, Educational Technology, Business, Journalism, Communications, Social Work and Law. It is important to clarify that the code I applied for "All / Many / Unspecified Disciplines" indicates that these studies were pan-university activities, usually surveys of faculty or student attitudes, or both. Those coded "N/a" represent more general opinion-oriented or theoretical papers, or administrative or distance education research that did not focus on particular program areas.

It is interesting to note the relatively high number of library-related studies. These papers explored a number of academic issues related to research using technology that were not addressed in the other studies, such as the use of electronic bibliographic resources (Lending & Straub, 1997; Summey, 1997) and reference services (Rosenthal & Spiegelman, 1996).

Table 3

Faculty-based Disciplines

Discipline	Frequency	Percent
Education	42	30.9
All / Many Disciplines / Unspecified	31	22.8
Library / Museum / Information Science	17	12.5
Natural / Social Sciences	16	11.8
Professional Programs	16	11.8
N/a	10	7.4
Humanities	4	2.9
Total	136	100.0

They also investigated the administrative and technical complexities of computer-based activity leading to university restructuring and policy formulation in technology matters (Marshalsay, 1998). Individual studies analysed searching behaviours (Delgadillo & Lynch, 1999) and bibliographic display standards (Cherry, 1998) with a view to preparing for the time when "libraries will become self-directed learning centers for the training of information and/or technology literacy" (Toifel & Franklin, 1999). Lawson & Pelzer (1999) researched how technology-based projects were evaluated in promotion and tenure processes for librarians in American academic libraries.

Journals Accessed

The 136 articles reviewed came from 77 different journals. A complete list of titles can be found in Appendix 4. No more than 9 articles came from a single journal. Table 4 lists the journals that were the source for multiple papers.

Table 4

Breakdown of Journals Publishing Multiple Articles

	Frequency	Percent
Journal of Computer Assisted Learning	9	6.6
Journal of Research on Computing in Education	7	5.1
Journal of Educational Computing Research	6	4.4
Educational Technology Research and Development	5	3.7
Journal of Technology and Teacher Education	5	3.7
TechTrends	5	3.7
College and Research Libraries	4	2.9
Distance Education	4	2.9
Journal of Computing in Teacher Education	4	2.9
Journal of the American Society for Information Science	4	2.9
College and University Media Review	3	2.2
European Journal of Teacher Education	3	2.2
Innovation in Education and Training International	3	2.2
Action in Teacher Education	2	1.5
The Alberta Journal of Educational Research	2	1.5
Computers and Education	2	1.5
Educational Technology Review	2	1.5
International Journal of Instructional Media	2	1.5
Journal of Educational Technology Systems	2	1.5
RQ	2	1.5
Teacher Education and Special Education	2	1.5
Total	78	57.4

Country or Region Represented

Most of the studies were undertaken in the United States, but the literature review did identify research from other regions as well. Table 5 shows the geographic origins of the research reviewed.

Table 5

Country/Region

	Frequency	Percent
United States	91	66.9
United Kingdom	18	13.2
Canada	7	5.1
Australia	6	4.4
Europe	4	2.9
Unknown / Not Relevant	4	2.9
Asia	3	2.2
Africa	1	.7
Indonesia	1	.7
Many Countries	1	.7
Total	136	100.0

Research Model and Design

I approached the coding of "Research Model" and "Research Design" inductively as I did the rest of this literature review, originally intending to use the language of each study in the coding framework. Unfortunately, the literature is not consistent with respect to its use of terms. In the end, I was as faithful as possible to the literature by coding "Design" using the researcher's terminology while applying a code for "Model" based on my interpretation of the study's methodology if it was not explicitly stated. Table 6 indicates that the single largest group of studies was quantitative (40%) but that many (12%) used both quantitative and qualitative methodologies (e.g. Anderson, 1998; Blyth, 1999; Langone, Wissick, Langone, & Ross, 1998; Parker, 1997). I used the term "Meta-study" to represent those articles that reported on multiple studies. Usually this meant a document review (Bain, McNaught, Mills, & Lueckenhausen, 1998) or a study of five or less individual research projects (Burns, 2000; Falba et al., 1999), but it also applied to the articles by Hannafin & Land (1997) and Mason & Bacsich (1998). There were no meta-analyses among the articles I collected.

Table 6

Research Model

Model	Frequency	Percent
Quantitative	55	40.4
Qualitative	35	25.7
Not a study	25	18.4
Both	16	11.8
Meta-study	5	3.7
Total	136	100.0

Almost 20% of articles could not qualify as studies in the strict sense. These I coded "Not a study". The category includes theoretical and opinion pieces as well as articles that clearly involved research but did not report the results in a conventional way. Usually these articles were coded as "Narrative Review/Opinion" in the Research Design category. Table 7 shows the distribution of different research designs. Almost half (48%) were descriptive or exploratory studies (e.g., Amstutz & Whitson, 1997; Black, 1998; Jegede et al., 1995; McNulty, Halama, Dauzvardis, & Espiritu, 2000). In most cases the distinction between the two designs was not clear as many authors used the terms "describe" and "explore" interchangeably. This was one of the categories that were collapsed after discussions with my SP colleague. We also coded quasi-experimental (e.g., Belanger & Clement, 1995; Cole, Cantero, & Ungar, 2000) and comparative studies together but it should not be assumed from this code that all the studies included here were quantitative. Some used multiple methods of data collection and analysis. Others were longitudinal studies that looked at changes in behaviour or attitudes over time (e.g., Mitra & Steffensmeier, 2000; Peters et al., 1995).

Table 7

Research Design

	Frequency	Percent
Descriptive / Exploratory	65	47.8
Narrative Review / Opinion	25	18.4
Quasi-experimental / comparative	16	11.8
Case Study	15	11.0
Formative Evaluation	8	5.9
Ethnographic	4	2.9
Action Research	3	2.2
Total	136	100.0

Orientation

I was interested in identifying the orientation, or focus of each study, with a view to understanding what the main purpose of the research was. Table 8 indicates that more than half of the studies looked at teaching and learning issues, and a quarter explored administrative questions.

Table 8

Orientation of the Research

Orientation	Frequency	Percent
Learning	35	25.7
Administrative	26	19.1
Teaching	24	17.6
Learning and Teaching	20	14.7
Teaching and Administrative	8	5.9
Research	7	5.1
Teaching and Barriers	7	5.1
Barriers	6	4.4
Administration and Barriers	2	1.5
Teaching and Research	1	.7
Total	136	100.0

It was sometimes difficult to tell where the primary focus lay, which is the reason for the multiple coding possibilities with options for "Teaching and Research" or "Administration and Barriers". A few articles explicitly studied the barriers to technology integration (e.g., Ertmer, 1999; Ertmer & Hruskocy, 1999; Fabry & Higgs, 1997; Jacobsen, 1998; Lending & Straub, 1997; Rogers, 2000b). These will be discussed in more detail in Chapter III.

Perspective

Perspective refers to the primary voice of the article. In studies that surveyed students (e.g., Blyth, 1999; Crooks, Klein, Jones, & Dwyer, 1996; Halpin, 1999; Oliver & Omari, 2001) or faculty members alone (e.g., Amstutz & Whitson, 1997; Groves & Zemel, 2000; Mitra et al., 1999), the voice was almost always that of the participants, expressed through attitude measures. The researcher perspective (24.3%) was predominant in studies that studied both populations (e.g., Gallini & Barron, 2001; Sharpe & Bailey, 1999) as well as in the theoretical and opinion pieces (e.g., Mason & Bacsich, 1998; Reiser & Ely, 1997; Richey, 1997; Twigg, 2000). Two evaluations of pre-service teacher programs explored the reactions of graduates as a way of identifying areas for improvement in technology training components of the program (Langone et al., 1998; Topp, 1996). Table 9 reports the frequency and percentage of the various perspectives.

Table 9

Perspective of the Research

Perspective	Frequency	Percent
Learner	48	35.3
Instructor	37	27.2
Researcher	33	24.3
Policy Maker	15	11.0
Graduate	3	2.2
Total	136	100.0

Theoretical Framework

The most difficult of the demographic variables to code was the underlying theory (Table 10). This was also the category that challenged the inter-rater reliability the most. Over half the time the theory was not evident or clearly articulated, and I was forced to code "N/a". Constructivism was by far the dominant paradigm, underpinning nearly 30% of the articles including most of the classroom studies (e.g., Schwartz, Brophy, Lin, & Branford, 1999; Sharpe & Bailey, 1999; Slavit & Yeidel, 1999; Wetzel et al., 1996). Most of the literature in Education explicitly described classroom interventions using constructivist strategies with pre-service teachers needing to meet the standards of national accrediting bodies upon graduation. In general it seems K-12 educators in the United States, the United Kingdom and Canada are now compelled to teach according to constructivist principles and university education programs are adapting to this requirement. The theoretical papers seemed to be based on a view of technology that supports constructivist learning environments (e.g., Hannafin & Land, 1997; Khan &

McWilliams, 1998; Rogers, 2000a; Twigg, 2000). In this category I included studies that involved active, problem-based, collaborative and experiential learning.

Table 10

Theoretical Framework

Theory	Frequency	Percent
N/a	55	40.4
Constructivism	39	28.7
Other	13	9.6
Diffusion of Innovations	12	8.8
Instructional Design	9	6.6
Social Learning	2	1.5
Self-efficacy	2	1.5
Mental Models / Symbol Systems	2	1.5
Reflective Practice	1	.7
Adult Learning	1	.7
Total	136	100.0

At times there were two or three theoretical perspectives to choose from and I selected the one that was most directly related to the framing of the study in question and the analytical approach taken.

Two other notable features of this body of literature are (a) the reliance of research in technology integration on Rogers' (1995) diffusion theory (e.g., Anderson, Varnhagen, & Campbell, 1998; Danielson & Burton, 1999; Groves & Zemel, 2000; Moskal, Martin, & Foshee, 1997), and (b) the small subset of studies with an instructional design focus (e.g., Frost & Pierson, 1998; Richey, 1997; Telg, 1995; Wager et al., 1995). These are points to which I will return in a later chapter.

Unit of Analysis

To complete the description of the features of the literature reviewed it is necessary to know how the research was conducted, under what conditions and in what environments. Table 11 describes the breakdown between course-based research and other settings. If a study was undertaken in a specific learning environment, whether a classroom-based, distance education, virtual online class or face-to-face training workshop, I coded the unit of analysis as "course". Research conducted in courses was usually discipline-specific and content-based (e.g. educational psychology in Crooks et al, 1996; advanced computer programming in Jehng, Tung & Chang, 1999; Italian in Oliva & Pollastrini, 1995 and Sinyor, 1998; pre-calculus in Slavit, 1998). Articles reporting on program-level, college-level or state system studies were usually in Education (e.g., Bichelmeyer et al., 1998; Bourn, 2000; Carlson & Gooden, 1999; Drazdowski, Holodick, and Scappaticci, 1998). Institutional- and national-level studies involved research conducted through survey at one or many locations simultaneously (e.g., Hosie & Mazzarol, 1999; Hsieh-Yee, 1997; McKendrick & Bowden, 1999).

Table 11

Unit of Analysis

	Frequency	Percent
Course	45	33.1
National System	29	21.3
Program / Department	24	17.6
Institution	18	13.2
N/a	12	8.8
State System	3	2.2
College / Faculty	3	2.2
Consortium	2	1.5
Total	136	100.0

Instruments

Table 12 indicates the broad range of instruments employed in the various studies, and the rate of use. Studies using mixed methods tended to be mixed models using questionnaires, interviews and observations, sometimes combined with assessment instruments to measure achievement (e.g., Bélanger & Clément, 1995; Cole et al., 2000, Lee Liang & Chan, 1999, McKinney, 1998).

Table 12

Instruments

	Frequency	Percent
Survey / Questionnaire	54	39.7
Mixed	33	24.3
Interviews	14	10.3
Lit / Document Review	12	8.8
Reflection	10	7.4
Test / Exam / Assignment	5	3.7
N/a	5	3.7
Traces / Log files	2	1.5
Observations	1	.7
Total	136	100.0

Size of University

Few articles reported on the size of the university in which the technology integration activities being researched had taken place. For 60% of the sample I do not have these details. For those that reported this information, Table 13 reports the breakdown between small, medium and large institutions.

Table 13

Size of University

	Frequency	Percent
Unknown	82	60.3
Large	45	33.1
Small	6	4.4
Medium	3	2.2
Total	136	100.00

For those few Canadian universities mentioned (University of Toronto, Concordia University, University of Alberta, University of Calgary, and University of Lethbridge) I was able to identify the first four as large and the last as small. To classify other institutions I relied on what the author reported.

This completes the description of the demographic features of the literature reviewed. As the objective of the review was to identify factors affecting the integration of technology in universities, the next subsection highlights those influences. In some cases the factors were explicitly investigated, as in the studies of faculty or student perspectives (e.g., Anderson et al, 1998; Beggs, 2000; Jacobsen, 1998; Mitra & Steffensmeier, 2000; Mitra et al., 1999). In course-based studies (e.g. Bélanger & Clément, 1995; McKinney, 1998; Wetzel et al., 1996) the factors emerged as findings, often as expressed obstacles to effective and innovative uses of technology in specific courses, or as limitations to success. Needs analysis reports (e.g., Black, 1998; Groves & Zemel, 2000, Moskal et al., 1997) identified obstacles and incentives. Other articles reported the results of integration initiatives, including identified factors for success (e.g., Bichelmeyer et al., 1998; Danielson & Burton, 1999; Drazdowski et al., 1998; Falba et al., 1999). All these researchers recommended that universities attend to the identified barriers and incentives in advance of future action. Many suggested that policy be developed at the department or institutional level as well.

Factors Affecting Technology Integration

The literature generally reported slow rates of adoption in the initial phases of technology implementation in universities (e.g., Danielson & Burton, 1999; Fabry & Higgs, 1997; Jacobsen, 1998). Low levels of technology acceptance among faculty members were evident in two ways. The proportion of early adopters (Rogers, 1995) was very small, and beginning use of computer technology was usually confined to personal productivity tools rather than innovative curriculum or pedagogical approaches (Gibson & Nocente, 1998; Rogers, 200b). Some studies documented faculty attitudes towards technology innovation (e.g., Black, 1998; Ellis, 2000; Gibson & Nocente, 1998; Jacobsen, 1998). They pointed to the importance of barriers to implementation faced by most instructors. The obstacles were frequently blamed for slow acceptance or non-adoption of technologies. The notion of barriers is a complex one, and the research documents many types of impediments to technology adoption.

There are other ways of thinking about how constituents respond to technology implementation efforts, however. Some studies approached the research process with a more positive outlook (e.g., Mitra et al., 1999). These researchers generally focused on incentives rather than barriers. The difference appeared to be in their attitude as expressed by the language used. For example, the concept of "knowledge" or "experience" or "competence" was also expressed as the barrier "lack of training". Similarly, the incentive of reduced workloads for design and development activities was expressed negatively as "lack of time" to plan innovative technology-enhanced instruction. Moskal et al. (1997) asked faculty to rate 25 factors promoting their use of new educational technologies and then asked them to choose the top three of those factors "whose absence would act as barriers to learning a new educational technology" (p.13). All 25 factors appeared "in at least one respondent's top three choices" which the authors suggest indicates consistency in their attitudes towards incentives and barriers. The descriptions on the next few pages demonstrate the differences in perspective. In setting up the variables as "Factors Affecting Technology Integration" I attempted to avoid both negative and positive interpretations by focusing on key influences. This will be shown to be important to the development of a model and to suggestions for policy in Chapters III and IV.

Table 14 illustrates the breakdown of the 22 factors mentioned in the collection of studies reviewed. I coded these features as individual variables using a dichotomous "Yes" or "No" code. The percentages are not cumulative as many studies reported multiple factors. It is important to note that 51 of the articles (38%) did not report any factors. This group included classroom-based computer assisted learning interventions (e.g. Cole et al., 2000; Crooks et al., 1996; MacLeod, 1999), distance education studies (Belawati, 1998; Shin & Kim, 1999; Wilson & Whitelock,, 1998) and theoretical papers (Reiser & Ely, 1997; Richey, 1997; Selwyn, 1997). A correlational analysis showed many small to moderate but significant correlations among several of the factors, most at $p = .01$ (Spearman's *rho* = .2 to .6). Table 15 gives the correlation matrix for these factors. Each of the factors is described in more detail below using examples from the literature.

Table 14

Factors Affecting Technology Integration

Feature	Frequency	Percent
Training	48	35.3
Time	37	27.2
Support	35	25.7
Pedagogical approaches	33	24.3
Evidence of advantages for learning	32	23.5
Equipment	32	23.5
Funding	29	21.3
Climate	28	20.6
Access	28	20.6
Culture	23	16.9
Rewards	15	11.0
Strategic planning	13	9.6
Champion / leadership	11	8.1
Stakeholder participation	8	5.9
Student pressure	7	5.1
Economic arguments	7	5.1
Standardisation / standards / prestige	5	3.7
Useability	4	2.9
Government or other external policy	4	2.9
Use feedback for improvement	3	2.2
Habit / tradition	3	2.2
Ethics	1	.7

Table 15

Correlation Matrix for Certain Factors

	Time	Support	Funding	Access	Equipment	Training	Culture
Time	-	.585**	.408**	.547**	.557**	.551**	.253**
Support		-	.556**	.407**	.466**	.551**	36.3**
Funding			-	.268**	.473**	.367**	.292**
Access				-	.275**	.423**	.207*
Equipment					-	.425**	.166
Training						-	.200*
Culture							-

** p = .01
 * p = .05

Training

The need for training was a factor in 35% of the articles, expressed most frequently as the barrier of inadequate or inconvenient training. For many faculty members, the steep learning curves associated with specialised software made them reluctant to test out their new learning on current students (e.g., Smith, 2000) but eager to use it in future courses. Several studies suggested particular types of preferred training approaches, especially one-on-one mentoring opportunities in their offices and just-in-time approaches (e.g., Parker, 1997; Smith & O'Bannon, 1999; Sprague, Kopfman & Dorsey, 1998; Strudler et al., 1995; Wetzel et al., 1996).

Time

Time was the second most frequently mentioned factor, highlighted in 27% of the studies. Lack of time was reported to be an important obstacle. Many studies emphasised the considerable investment of time necessary to learn the new technical skills involved in unfamiliar hard and software applications. Time to apply the skills to the development of teaching materials was an issue (Ellis, 2000; Rogers, 2000b) as was the need for release time from teaching. Gibson and Nocente (1998) reported faculty concerns about the implications of time away from research activities. Smith and O'Bannon (1999) mentioned difficulties with scheduling mentorship sessions.

Support

Support was a key factor that emerged, reported in 26% of the studies. It is not possible to articulate a precise definition of the notion of support, as researchers tended to lump different ideas together under the general label "support". Barriers were reported related to inadequate resources, including unsupportive administrations and unreliable technical assistance, maintenance, troubleshooting and training. Scheduling difficulties for computer labs (Jacobsen, 1998) and inadequate classroom infrastructure (Gibson & Nocente, 1998; Jacobsen, 1998) were also a problem in several studies. Ellis (2000) suggested that lack of opportunity for research initiatives on technology implementation was an impediment. In general, support is a multiple construct, including elements that appear in other categories. Technical support overlaps with the categories of access, equipment and training. Administrative support includes concrete policy such as recognition and reward for promotion and tenure, and adequate funding (Panici, 1998), as well as less well-defined culture and climate factors, political influences and individual attention (Martinez & Sweger 1996).

Pedagogical Approaches

Twenty-four percent of the studies referred to pedagogical factors. To distinguish this category from the one that follows (evidence) I coded those articles that discussed the teaching beliefs and practices of faculty members as positive for this factor. These 33 studies clearly concluded that instructors needed to change their pedagogical approaches to properly support the use of educational technologies. (e.g., Gallini & Barron, 2001; Johnston & McCormack, 1996; McElhinney & Nasseh, 1998).

Evidence of Advantages for Learning

To further clarify the distinction between this and the above category, evidence of advantages is the factor that incorporates the notion of proof that technology enhancement leads to better student learning. Twenty-four percent of the articles mentioned this need for proof as an important factor in motivating faculty members to change established teaching behaviours. In the Moskal et al. (1997) study, this was the most important of the 25 factors, rated first by 87% of their sample. Beggs (2000) replicated Groves and Zemel's (1999) study and their results, finding that the instructional issues "improved student learning" and "clear advantages over traditional methods" were the top two influences for adoption at 97% and 96% respectively.

Equipment

Many studies referred to equipment problems, the cost of upgrading, maintaining and refreshing both hard and software (e.g., Hiniker & Reneau, 2000; Overbaugh, 1998; Parker, 1997; Smith & O'Bannon, 1999; Wetzel et al., 1996). Of particular concern was the dependence on specialised technical support staff to make technology-enhanced teaching viable (e.g., Duffield, 1997; McKendrick & Bowden, 1999).

Funding

Obstacles were identified that seemed to be related to funding. Researchers (e.g., Ellis, 2000; Ertmer, 1999; Fabry & Higgs, 1997; Gibson & Nocente, 1998; Rogers, 2000b) suggested that adequate funding could potentially address other barriers, including time, training, technical support and instructional development. Black (1998) specifically pointed to the need for financial resources for hardware and software purchase, maintenance and upgrading.

Access Issues

Several studies reported difficulties with hard and software including availability, flexibility and reliability of computer connections. The earlier research in particular (1995-1997) focused on frustrations caused by unreliable Internet connections and incompatible systems (e.g., Martinez & Sweger, 1996; Rosenthal & Spiegelman, 1996; Strudler et al., 1995).

Rewards

Faculty members perceived lack of institutional recognition or reward for innovation in teaching practice as an impediment to adoption of technology. University-level policies on promotion and tenure were cited as inadequate or unsupportive (Lawson & Pelzer, 1999; Seminoff & Wepner, 1997).

Climate and Culture

Despite my attempt to keep the clear definitions of climate and culture found in Chapter I in mind, I can not be sure that these categories as I have coded them represent distinct constructs. Sixteen studies were coded positive for both resulting in a moderate and significant correlation (Spearman's *rho* = .498, $p = .01$). Researchers seemed to be using the terms interchangeably, perhaps because the differences between a university's practices (climate) and its values (culture) are difficult to distinguish when they fail to support each other. The studies that discussed climate and culture factors tended to be oriented to administrative issues and were concentrated in the period 1998-2000 (e.g., Bichelmeyer, 1998; Danielson & Burton, 1999; Ellis, 2000; Levy & Foster, 1999; Marshalsay, 1998).

Other Factors

The less commonly reported factors emerged from a small subset (less than 10%) of the data. These articles were either opinion pieces based on reviews of research and practice (e.g., Leggett & Persichette, 1998; Rogers, 2000b; Twigg, 2000) or reports of institution-wide studies with a broad meta-level perspective (e.g., Beggs, 2000; Burns, 2000; Holt & Thompson, 1995; Marshalsay, 1998). With only a couple of exceptions these articles were all published in 1998 or later. Factors related to *Strategic Planning* included *Leadership* and *Stakeholder Participation*. Strudler et al. (1995) pointed to the value of a change agent on site assisting faculty with just-in-time training and support. In this case the leadership came from a technical coordinator. Others (e.g., Beggs, 2000; Holt & Thompson, 1995; Khan & McWilliams, 1999) recommended that leadership should come from the executive levels of the university as part of the evidence of commitment to a strategic mission in support of technology-supported teaching and learning. *Student Pressure* refers to the involvement of students in planning activities and thus is related to participation factors. It also refers to the importance of providing for student choice based on individual differences or learning preferences. *Economic Arguments* include notions of competitive advantage (e.g., Holt & Thompson, 1995; Hosie & Mazzarol, 1999; Mason & Bacsich, 1998; Weller, 2000) as well as *Standardisation, Standard-setting and Prestige* (e.g., Levy & Foster, 1998; Moore & Burton, 1998; Seminoff & Wepner, 1997). *Usability* emerged from technical studies that explored user interface issues (e.g., Cherry, 1998; Delgadiillo & Lynch, 1999). *Government Policy* was frequently referenced by education studies, especially with respect to emerging national standards for teacher competence with technology in the United States and the United Kingdom. The *Use of Feedback for Improvement* emerged in those formative evaluation studies that made recommendations for other practitioners. *Habit* was mentioned by studies exploring faculty reluctance to initiate technology-based experiments in their teaching and research (e.g., Delgadillo & Lynch, 1999; Goodhue, Littlefield & Straub, 1997). *Ethics* may be an emerging issue in distance education. Only Burns (2000) mentioned it, but I think concerns about the potential of educational technology to further marginalise vulnerable populations deserve further attention.

Psychological Factors

Black (1998) indicated that both faculty and students can be intimidated by technology. Fabry and Higgs (1997) concluded that motivational issues and faculty resistance to change were barriers that needed addressing. Table 16 indicates the breakdown between studies that mentioned instructor or student fear and anxiety as concerns as compared to those that referred to issues of interest and relevance. It is important to note however that the scope of discussion of psychological factors was limited. Most of the research made no reference to specific internal states of mind.

Table 16

Psychological Factors.

	Frequency	Percent
None	100	73.5
Interest/Relevance	23	16.9
Fear	13	9.6
Total	136	100.0

Summary of the Literature Review

In summary, the 136 studies represented a broad cross-section of disciplines, publications and research methods, although there was a predominance of work done in Education. The spread of publication dates over seven years approximated a normal distribution, slightly skewed to the right, with the mid-point at 1998. Research from the United States dominated the data, but several countries were represented. Seventy percent of the studies focused on teaching or learning issues, 25% on administrative questions and 11% on barriers to technology implementation. While 29% were framed according to a constructivist perspective on teaching and learning, 40% did not indicate a theoretical framework and 10% relied on some other theory. There appears to be a consistent picture of universities struggling with the challenges of technological change emerging from the findings of the different studies, despite the various research methodologies employed and the use of different terms to describe the processes. Changes are occurring at different rates at different levels of these organisations.

The systematic exploration of recent literature on technology integration in universities uncovered a number of important factors affecting the process. These factors will be discussed in more detail in Chapter III, in relation to how universities might deal will the challenges they present. Before that, Chapter II describes current models for planning, designing and managing technology on campuses.

Chapter II - MODELS

Models can be understood as abstract or symbolic representations of theories, processes or systems that help us to understand, explain and/or predict the phenomenon of interest (Valentine, 1992, pp.130-134). In soft systems modelling (Checkland, 1999) the parts of a complex system are often diagrammed as part of an iterative process of inquiry into human activity. As in a mock-up of an airplane or a house, models thus help to identify the parts of complex entities, and how they relate to one another by providing a visual or conceptual display of the interactions or interfaces among components. This understanding can then lead to action for ongoing improvement of the system in question. Models can be useful in the development of policy as the modelling process involves identifying the components of a phenomenon and the relationships among them. Policy-makers can use this understanding of what happens in the situations being modelled to ensure that procedures are developed to account for the possible actions and interactions in the system. With a view to informing policy development in the area of technology integration in universities, I have extracted the essential features from the published ideas of five contemporary educational administrators who have consolidated their experience into strategies for technology integration. For the purposes of this paper I refer to these collections of strategies as "models," whether or not the authors present them as models. I then compare and contrast these essential features in consideration of optimal policy and action towards the integration of educational technologies.

There are models commonly cited in the literature of technology adoption that I do not consider here. They include the diffusion of innovations model (Rogers, 1995), the technology acceptance model (Davis, 1989) and the concerns-based adoption model (Hall & Hord, 1987). Although the first of these can be and often is applied in institutional contexts, it involves classifying individuals with respect to their adoption behaviours. The other two models deal with the characteristics of individuals that support or inhibit adoption behaviours and patterns. But in this chapter my interest in models is organisational, at the level of processes for institutional decision and policy making.

Traditional models of administrative practice have been categorised as top-down or bottom-up. Top-down administration describes management that is planned and organised from the executive and senior levels of a traditional hierarchical organisation. Bottom-up planning and management involves front-line levels of the organisation and encourages all stakeholders to participate in the process. A third type of "horizontal" (Lick & Kaufman, 2000) management model, sometimes referred to as "middle out" (Ely, 1997), is more broadly integrated across an organisation. It combines elements of top-down decision making with bottom-up participative processes in a dynamic and interactive community of practice.

Although most of the research on teaching and learning with technology to date has been done at the course (micro) or program (macro) level, there are models that prescribe a process for designing functional technology integration approaches at the institutional (meta) level. In keeping with the conceptual framework provided by educational systems design, this chapter explores three types of models, which I define as planning models, design models and implementation models. Planning models (Bates, 2000b; Daniel, 1999) tend to prioritise business processes that lead to efficiencies for the purposes of maintaining competitive advantage and innovation in the university. Design models (Laurillard, 2002; Paquette, 1997) are focused on learning, and tend to use the principles of instructional design as the basis for developing educational systems in which technology is a component. Implementation models (Brown, 1999) include various examples of the "laptop university" approach to technology integration. Ubiquitous computing is characterised as the third wave of computing, after the ages of main frames and personal computing, and the subsequent transition to distributed computing through the Internet (Weiser & Brown, 1996). This is the age of "calm technology" where computing and telecommunications become embedded in our daily lives.

The investigation of each of these models (a) identifies its features, (b) compares and contrasts it with the others, (c) determines its ability to explain or suggest solutions for the factors constraining technology integration, and (d) evaluates its applicability to Canadian higher education contexts. The models have been synthesised with respect to how they address the various factors perceived by stakeholders and reported in the research and the case studies. This synthesis has informed the development of a new model, which is discussed in Chapter III - Integration.

Before discussing the models, however, it is important to clarify a common misconception about the connection between technology-enhanced teaching and learning and distance education in universities.

Distance Education

There are overlaps in the language used to describe technology-enhanced teaching and learning that can confuse the central issues of concern. For example, there is a tendency for those who pressure universities to embrace educational technologies to make broad references to online learning or e-learning as the future salvation of postsecondary education. The difficulty arises from the assumption that these technologies immediately imply distance education. This assumption operates sometimes in the minds of the enthusiastic message senders, sometimes in the minds of the receivers. Although this is a classic example of simple communication breakdown, in this case caused by inadequate attention to defining terms, it represents a serious confounding issue in the current state of technology integration in universities.

It is generally accepted that theoretically, one of the advantages of computer-based teaching and learning environments is their ability to support "anytime, anywhere" access to course materials, discussion groups and university services. In practice, not all communities are "wired" for Internet access (despite government claims) and those that are do not necessarily deliver high speed, broad band access. Nor are all potential students equipped with the current hardware and software necessary for access to multimedia resources and convenient downloading. Although wireless experiments are underway, reliable connections are not yet available. Universities interested in expanding their services to new markets through distance education need to be clear about to whom and where they are targeting their programs. There is a real danger that competent potential students who cannot afford it or who do not live in populated areas will not have access to expanded opportunities for higher education at all but may find their entry even more limited than in the past. Other populations that may become even more disadvantaged than they already are include learners with special needs and learners in less developed countries. This is an interesting irony given the history of distance education in providing access to education to marginalised groups, and given the attention to globalisation in the strategic plans and practices of the Open University of the United Kingdom (Daniel, 1999; Mason & Bacsich, 1998) and the University of British Columbia (Bates, 2000b).

It has been well documented (e.g., Bates, 2000a, 2000b; Berge& Muilenburg, 2000; Gibson, 1998) that distance learning environments require substantial up front investments of human and knowledge resources, including instructional design, materials development and production, project management, student services, communications channels and faculty and student training programs. Simple upload of course materials to a web page or course management system is not going to provide for the extra interaction and guidance needed by learners at a distance. The economies of scale predicted by technology advocates are not automatic, and probably can only be achieved by the "mega-universities" in content areas where the basic information does not need to be updated regularly. The Open University designs courses for a shelf life of 12 years (Laurillard, 2002; Mason & Bacsich, 1998). In many subject areas this would not be appropriate.

But technology-enhanced learning is not necessarily restricted to distance education. The literature review revealed many examples of computer-based innovations that supported on-campus teaching and learning (e.g., Blyth, 1999; Crooks, Klein, Jones, & Dwyer, 1996; Jehng, Tung, & Chang, 1999; Oliva & Pollastrini, 1995). Acadia and Wake Forest Universities have integrated laptops into classroom-based education while they take advantage of on campus opportunities for asynchronous learning. The particular mix of methods to be used is a key issue for universities planning to integrate technology into their academic activities.

There is another aspect to distance education that is relevant to this discussion. Typically, distance education units at dual mode universities have been marginalised. Despite academic and administrative systems in dual mode universities that ensure equality between distance and campus versions of courses (Ives, Roy & Boissonneault, 1997), the perception persists that distance education is lower in quality. In traditional university hierarchies, many distance education administrators suffer from low status and faculty members are often not rewarded, sometimes even penalised, for engaging in alternative delivery methods. Bates (2000b) suggests that project management, instructional design, team-based course development and other administrative and academic techniques perfected in distance education environments are critically important to the integration of technology in campus-based universities. But the failure to date of distance educators to make a major impact on academic policies and procedures in many universities has distance professionals worried not only about their personal futures (Landstrom & Watts, 2000), but about the potential failure of these institutions to make appropriate decisions about integrating technologies (Landstrom, 2002). The closing plenary session at the Annual Conference of the Canadian Association of Distance Education in June 2002 captured much of this concern. Denise Paquette-Frenette asserted that distance education in Canada is in a transition period and suffering from an identity crisis. Terry Anderson agreed about the transition but suggested that distance educators on traditional campuses "are no longer an annoyance...[they] are a threat" which presents them with an important opportunity for the exercise of leadership based on extensive research and practice conducted in technology-supported teaching and learning situations. Michael Moore referred to the notion of "transactional distance" which is psychological rather than location based, and commented reassuringly on the maturity of the field, especially with respect to pedagogy and instructional design. But he advised the conference audience to contribute their efforts to organisational and policy development: "We need a lot more organisational change" he stated.

The opportunity to influence institutional practice presented in the convergence of university-level distance and traditional education is a real one. But it is instructive to remember that there has also been a failure in the practice of technology integration in distance education, especially in the area of course evaluation. Despite careful application of instructional design principles in course development, formative evaluation is rare in distance education. Exigencies of time and budget often force course developers to skip the field testing stage. The first test of the material on students is often in the first delivery of the course, a practice that can compromise the students' learning. Summative evaluation is infrequent, at least in dual mode universities, where course evaluation instruments are generally designed for on-campus use. Conflict with faculty associations about the right of distance administrators to see teaching evaluations means that few courses are actually assessed systematically. For those that are, return rates of evaluation questionnaires are often very low, or the questions focus on technology (did it work?) rather than instructional issues.

These issues have implications for the integration of teaching and learning technologies in universities, which will be discussed further in later chapters. Distance education is not a model of technology integration - it is an application. As such, it can be situated within any of the models described in the next section.

Model Description

I focus on five contemporary models that prescribe the design of functional technology integration approaches at the institutional level. To distinguish among them, I refer to them by descriptive labels, which I have assigned as follows: (a) the Knowledge Media model (Daniel, 1996); (b) the Postindustrial model (Bates, 2000b); (c) the Virtual Campus model (Paquette, 1997); (d) the Conversational model (Laurillard, 2002); and (e) the Ubiquitous Computing model (Brown, 1999). The first two I categorise as planning models, the second two as design models and the last is an implementation model.

Introduction to Five Models of Technology Integration

The five models are designs for improving teaching and learning in postsecondary education using technology in pedagogically appropriate ways. Although the processes they describe are similar, each combines strategies in different ways to reach the goal of better education as the author defines it. There are subtle differences in the language used to describe the strategies. These differences highlight the various perspectives. One of the models appears to be top-down, three are bottom-up, and the fifth seems to integrate aspects of the others. Table 17 illustrates the main characteristics of each of the integration models, including the central themes.

The two planning modeis (Knowledge Media and Postindustrial) target educational leaders at the institutional level. They offer technology integration strategies

Table 17

Features of Five Technology Integration Models

Feature	**Models**				
	Planning		**Design**		**Implementation**
	Knowledge Media	**Postindustrial**	**Virtual Campus**	**Conversational**	**Ubiquitous Computing**
Model type	Top-down	Integrated	Bottom-up	Bottom-up	Bottom-up
Audience	Educational decision makers	College & university leaders	Educators and designers	University faculty and academic support staff	University faculty & administrators
Perspective	Business planning	Strategic planning	Instructional design Software engineering	Teaching and learning	Best practices
Vision	Educational transformation	Knowledge-based organisation	Socio-economic improvement	Learning society	Interactive learning communities
Theoretical framework	Management Instructional design	Management Learning	Instructional design Systems design	Instructional design Conversation theory	Educational theories of teaching & learning
Themes	Competitive advantage	Academic planning	Lifelong learning	Change from within	Efficiency
	Leadership	Shared leadership	Individualistic	Shared dialogue	Communication
		Project management	Research-based		
Options for change	Use existing system for gradual change	Reinvent the system	Learning focus remains paramount	Preserve the old; allow for the new	Preserve the old by encouraging the new

Knowledge Media Model

The term "knowledge media" refers to the convergence of telecommunications, computers and cognitive science. The Knowledge Media model (Daniel, 1996) is based on the notion of competitive advantage for universities in a technological age. Daniel identifies four concerns for the future of universities: (a) teaching effectiveness / learning productivity, (b) strengthening the learning community, (c) production and delivery of courses and other intellectual assets, and (d) the logistics associated with scalable distributed growth. He suggests that the knowledge media have the potential to assist institutions in their planned self-renewal and highlights the importance of a technology strategy.

The Knowledge Media model is top-down, directed at decision-makers developing and implementing institutional policy for integrating technology into conventional and distance education. It is grounded in management and learning theories and instructional design practice (e.g., Holmberg, 1977; Keegan, 1980; Pask, 1976; Peters, 1983; Porter, 1985; Romiszowski, 1988).

Postindustrial Model

This model (Bates, 2000b) proposes a set of systematic approaches for planning and managing technologies for teaching and learning. Bates insists that institutions will adopt technology appropriately only if they remain faithful to their publicly legitimated strategic mission and goals, keeping in mind the strengths and weaknesses of educational technologies. The potential for increased access to learning, enhanced flexibility for learners and improved teaching needs to be weighed against the high initial and ongoing costs associated with the acquisition and maintenance of the hardware, training and technical support infrastructures, and the lack of clear evidence of learning effectiveness. Bates suggests that technology strategies should be only one component of a clearly articulated and widely accepted academic plan. Although he argues for an institution-wide approach to these issues, he acknowledges that, in practice, teaching and learning plans are best developed and monitored by faculty members at the departmental level.

Bates' administrative perspective on the management of learning technologies illuminates the broad organisational issues. It is clear, however, that Bates is aware of and sympathetic to the practical realities of university life. He offers advice for dealing with legitimate resistance to change. Recognising the decentralised nature of the university, Bates advances the notion of a postindustrial (post-Fordist) model for managing for the future. He points out that traditional structures of the university, founded upon the needs of earlier agrarian and industrial societies, are no longer adequate to the modern conception of the university as a knowledge-based organisation. It will be necessary, he asserts, to completely restructure higher education systems in the twenty-first century. A critical feature of the postindustrial organisation is strong, visionary leadership supported by shared objectives and empowered and creative workers organised in teams.

Virtual Campus Model

At first glance, the Virtual Campus model (Paquette, 1997; Paquette, Ricciardi-Rigault, de la Teja, & Paquin, 1997) does not appear to address technology integration at the organisational level. It is a bottom-up learner-centred model of distance learning, built through research and experimentation from instructional design and software engineering perspectives. Since 1991, systemic model development and testing projects have been conducted at Télé-université, under the auspices of the LICEF (Cognitive Computing and Training Environments) Research Centre. In 1995, the Virtual Campus concept became LICEF's "unifying project," with the goal of combining the various research and development initiatives into a single, integrated learning system. To ensure that the LICEF model meets the learning challenges of the future it is based on constructivist pedagogical principles including active, learner-centred and just-in-time learning available at a distance. It offers support for autonomy, skills development and knowledge transfer, focuses on social skills and positive attitudes, and provides multiple methods of accessing and processing information. Paquette asserts that one of the important advantages of the generic Virtual Campus model is its adaptability and versatility. Therefore, the implication is that system-wide application of the model would provide for enhanced learner support and access to information on an organisational scale.

According to Paquette, the Virtual Campus model is the basis for the current re-engineering of Télé-université's technological infrastructure and course development process. Other institutions in Quebec, including the Université du Québec à Montréal (UQAM) and the turnkey computer-enriched schools project are also benefiting from the model's features as they move towards technology integration on a system-wide scale.

Conversational Model

This model (Laurillard, 2002) is based on a conception of teaching and learning as the central purpose of the university at the undergraduate level. In this context, Laurillard suggests that traditional, primarily didactic, approaches to instruction are appropriate, and she asserts that teachers have the major responsibility for what and how students learn. Unfortunately teachers are embedded in a system outside their control which not only does not necessarily support learning but which "actively undermines a professional approach to teaching" (p.3). She insists that academics are responsible for changing the system from within. To help design an "enabling" organisational infrastructure, Laurillard (2002) offers a bottom-up blueprint for an effective learning organisation that preserves academic values while allowing for new, more generative teaching methodologies. Technologies are thus not the inspiration for institutional change but rather the method by which changes in teaching and learning are accomplished. Laurillard's conversational framework, based on Pask (1976) and Marton (1988), provides a way of analysing and classifying various media, not by their attributes, but by their affordances (cf. Clark, 1994), or in other words by the learning activities that they support (e.g., narration, interaction, adaptation, communication, production).

Ubiquitous Computing Model

The Ubiquitous (or universal) Computing model of technology implementation targets university faculty and administrators (Brown, 1999). Although David Brown has been responsible for the Wake Forest University implementation of the Ubiquitous Computing model, he has emerged as the North American spokesperson for and champion of the general model as well. In various publications and many presentations, Brown details the lessons learned by a number of "laptop universities" in the United States, describing concepts and strategies that contributed to the establishment and maintenance of efficient computing and communications environments in these innovative universities. Two collections of vignettes (Brown, 2000a, 2000b) offer support for bottom-up planning approaches by illustrating successful classroom implementations and reporting the results of teaching/learning evaluations. An updated collection of the lessons learned by 13 North American laptop campuses over seven years was published in August 2002.

Strategies for effective technology integration described in the Ubiquitous Computing model are based on principles that keep teaching and learning concepts at the centre of decision-making. Brown (1999) insists on involving university faculty members in the planning activities from the beginning and throughout the process. Faculty commitment to institutional goals helps to ensure wide acceptance of decisions about standardisation, plans for pilot projects, strategies for training, and the provision of other support services. The Ubiquitous Computing model is teacher-centred, flexible and consensual. It is also contextual, with at least five different strategies for distribution of computers: (a) required but not provided; (b) provided by the program or university through lease; (c) provided by the program or university through sale or inclusion in tuition; and single vendor distribution to first-year students (d) in phases or (e) all at once (ThinkTank, 2002; Resmer, Mingle and Oblinger, 1995). The textbook model (a) carries the lowest institutional risk, while the departmental model (b) or (c) is a way for large universities to participate with a selected program only (Brown, 1998). The examples that follow all come from single vendor ubiquitous computing programs, which are the most comprehensive.

Comparing and Contrasting the Five Models

Though oriented primarily to planning activities, teaching and learning design issues or implementation practices, the five models advocate several similar integration processes. Some examples of technology strategies that are theoretically common to all models are (a) active participation of all stakeholders, (b) goal-based decision making, (c) teamwork, (d) leadership, (e) awareness of time, and (f) the importance of on-going research. Each of these process-oriented strategies is outlined below, along with how it is considered by each of the models.

Ensure Stakeholder Participation

Stakeholders are all participants in the learning environment who will be affected by decisions about technology. In universities this includes students, faculty members, staff at all levels, senior managers, and representatives of certain external communities. In discussing the Knowledge Media model, Daniel (1999) points out that "The collegial tradition of academic governance makes it unlikely that a technology strategy developed without extensive faculty input would have any impact. Involvement of the university community in developing the strategy is essential" (Daniel, 1996, p.137). A postindustrial strategic planning approach includes provision for broad-based participation in developing a vision for teaching and learning at the department level. The strategy for inclusion and acceptance is based on the recognition that technology is a potential solution to work load and other problems affecting teaching, administrative, technical and front-line staff and students. Thus "it is in everybody's interest to participate" (Bates, 2000b, p.48). The Virtual Campus model is based on a systems engineering model, which implies that every actor in the learning system has a function, and that each part of the system must be actively engaged for the system to function effectively. The Conversational model implies ongoing interaction and dialogue among faculty members that brings their learning up from the micro to the macro and meta levels of the organisation. "Higher education should be reformed through pressure from within" (p.3).

"It is the task of professional educators to change education" (p.7). For the laptop campus, Brown (1999) underscores the importance of respecting traditional channels for gaining faculty approval for academic change through "achieving a reasonable consensus" (Brown, 1999, pp. 31-35). He lists the following ten techniques for building consensus in the academic community (Brown, 1999, pp. 31-35): (a) follow established routes of approval; (b) keep everyone informed; (c) allow ample time and request feedback, to the point of redundancy; (d) use the peer culture; (e) recognise diversity; (f) empower many agencies throughout the organisation; (g) honour heritage; (h) consider a "package" of changes; (i) visit other campuses; and (j) be lucky. For Brown, technology adoption is fundamentally an academic, rather than an administrative decision.

Concentrate on Goals

Daniel (1999) affirms that goals for the integration of knowledge media should be consistent with the corporate image and with shared academic goals: "New uses of technology should be linked to shared academic goals and previous experiences of institutional success" (Daniel 1996, p.138). Bates (2000) identifies visioning as the most important of all the strategies he advocates for the postindustrial university. "It helps people working in an organisation to identify and share certain goals. Even more important, a shared vision provides a benchmark against which to assess different strategies and actions regarding the development of teaching with technology-based teaching" (Bates, 2000b, p.45). The Virtual Campus (Paquette, 1997) is based on widely accepted instructional design principles, the most basic of which is that learning environments are created to facilitate the attainment of learning goals. Generally, goals are developed as a result of needs analysis procedures that identify gaps between expected and actual performance. This process is not substantially different from the visioning process in strategic planning, which identifies organisational goals after an environmental scanning exercise. The Conversational model champions traditional academic missions and goals in the face of the challenges brought by learning technologies. Ideally, "Every professional academic has a responsibility to their students and their discipline. The technologies, the new organisational structures, and the re-cast business models are subservient to that end" (p.7). For the Ubiquitous Computing model, Brown lists the following questions to guide the development of campus wide understanding about goals and needs to be addressed by technology: "What is it that you are trying to achieve? What strengths of your organisation do you want to maximise?" (Brown, 1999, p.18). He refers to the success of several universities at matching "the big issues" (critical factors) to their respective missions, constituencies and circumstances as a way of focusing decision-making (Brown, 1999, p.29).

Work Together in Teams

The themes of collaboration, communication and networking recur in discussions of effective technology integration. The Knowledge Media model depends on co-operation, teamwork and support for successful implementation. Daniel states that "Mechanisms for implementation need to emphasise cooperation, teamwork and support. A technology strategy debate is an excellent opportunity to remind all staff of their stake in the future of the university and to obtain renewed commitment" (Daniel, 1996, p.138). Daniel (1999) suggests that universities capitalise on their strengths and adapt the competitive and peer-review processes used in awarding resources for research to the organisation of technology-based teaching. His argument is that technology offers the possibility of maintaining traditional peer governance structures for the management of innovation. For the Postindustrial model, the focus on team work is covered in Bates' (2000) discussion of project management as the best technique for efficiently organising and monitoring the various specialists who need to be involved in developing technology-enhanced courses. "The project management approach to developing and delivering technology-based teaching and learning ensures that resources are used efficiently and that individual team members contribute appropriate skills and knowledge to the project" (Bates, 2000b, p.68). Based on an object-oriented approach to learning systems design, the learner is designated the primary "actor" in the Virtual Campus model, supported in learning by "the informer, the designer, the trainer and the manager" (Paquette, 1997, p.7). Individuals within the learning system may hold more than one actor role at any one time. Each actor has the opportunity to evolve in five virtual spaces in the telelearning system: self-management and navigation, information, production, collaboration and assistance. In the Conversational model, Laurillard (2002) echoes Bates on project management and teamwork. These are the special advantages offered by distance education environments. Beyond this, the notion of teaching and learning as conversation implies ongoing interaction and dialogue among faculty members at various levels of the learning hierarchy. Brown (1999) emphasises that the value of technology in the Ubiquitous Computing environment is based on its ability to connect people together through communication.

Identify and Support Leaders

Daniel (1999) points out that a high quality technology strategy depends on its appropriateness and on the commitment of the stakeholders. Suitable leadership, which may be transferred among the members of the constituency, can help keep the process on track. "Those leading the process must inspire a vision of the future that is attractive to all concerned" (Daniel, 1999, p.138). Bates (2000) defines high quality leadership in terms of a team. For him "effective leadership usually comes in the form of a collective approach by the whole senior management of an institution. They will share the same basic overall vision but each member of the leadership team will have a different role to play in bringing about that shared vision" (Bates, 2000b p.43). He points out that the ultimate responsibility for effective leadership lies with those charged with selecting or electing the senior managers. In the Virtual Campus environment, the actors share responsibility for all functions, including decision making. In her blueprint for a new organisational infrastructure, Laurillard (2002) separates out the roles of academic management from academic teaching. The "learning organisation" she advocates in the Conversational model is based on individual learning scaled up to the level of the institution. This implies that each member of the community shares leadership with all others through "a dialogic process between individuals and groups at different levels of description of the organisation" (p.219). Brown also tends to refer to decision makers at the faculty level rather than leaders at the executive level. "Leaders of each sub-community need to feel a sense of ownership in the decision to adopt universal computing. In a university, the decision is best processed through the faculty governance system, for it is individual professors who lead each classroom 'community'" (Brown, 1999, p.26).

Expect Time to be a Factor

Consensual decision making typical in university environments takes time. In an age where technologies are renewed regularly, the political and financial pressure to move quickly with technology implementation plans is great. To respect the academic culture and the steep learning curves associated with learning to use computers in teaching activities, it is necessary to compromise. The 'S' in the ACTIONS model for selecting and evaluating technology (Bates, 1995), advocated by both the Knowledge Media and Postindustrial models, refers to the speed at which courses can be developed using the technology in question. One of the appeals of course websites is the fact that content can be updated as soon as it loses currency. Government and business pressure to adopt technology on university campuses comes with a sense of urgency that many academics find difficult to accept, especially when clear cut evidence of learning improvement is not yet available. The Conversational model recognises that improvement and innovation are continuous processes. In acceptance of these factors, the Ubiquitous Computing model involves a phased and piloted implementation process.

Build in Research and Evaluation

Daniel (1999) considers research on the scholarship of teaching (Boyer, 1990; Laurillard, 1993) to be promising for the university renewal he advocates in the Knowledge Media model. The Postindustrial model depends on research and evaluation for renewal and relevance. Bates (2000) emphasises the importance of asking the right questions in ongoing evaluation of teaching and learning using new technologies. For example, he endorses research that explores the incremental effects of technology on teaching and learning, "that investigates the unique contributions that technology can make to teaching and learning...[that] focus on the relationship between the use of a technology and different levels or types of learning" (Bates, 2000b, p.200). And he reminds us that good technology cannot save bad teaching. Some of the types of research themes he recommends include impact on student learning, advantages and disadvantages of a particular application, ease and reliability of use, cost-benefit analysis, and the identification of best practices. The Virtual Campus model is the product of extensive research and testing of an instructional/systems design approach that supports learning within an online environment. In the Conversational model, the new institutional infrastructure supports research on teaching as the core activity of the university. "By treating teaching as an extension of their research interests, academics will increase their own and their students' motivation....The close synergy between research and teaching ensures that a university remains a true centre of learning" (p.219). Brown's (1999) perspective combines the seven principles for effective undergraduate teaching (Chickering & Gamson, 1987) with the notion of best practices. Assessment of teaching and learning are necessary to continuous improvement.

Summary of the Five Models

These five models share a commitment to institution-wide strategies on the process of technology integration. Essentially, they agree on the important process-oriented strategies (i.e. participation, goals, teamwork, leadership, time and evaluation). To test the usefulness of the models for policy making, it is necessary to analyse their more specific content-oriented strategies. This is where they differ. Before exploring how these models address the perceived factors affecting technology adoption, however, I want to consider two examples of the implementation model in further detail. One reason for this investigation is the question of scale. The Knowledge Media, Postindustrial, Virtual Campus and Conversational models were developed with large, research universities in mind. All had distance education antecedents. In contrast the Ubiquitous Computing model is smaller and campus-based. Specific applications of the "laptop university" model (e.g., Acadia University, Wake Forest University) are differentiated by the way their support infrastructures range from centralised to distributed, and by their primary focus on the product or on the process of technology-enhanced education. Consequently, the next section offers a description of two cases of the Ubiquitous Computing model and a cross-case analysis.

Case Studies

One of the weaknesses of the planning and design models is that they do not directly address how to turn strategies and objectives for technology integration into infrastructures that support teaching and learning activities on campuses. Although the Knowledge Media, Postindustrial and Conversational models are well cited in the literature, I could find no evidence that they have been implemented in real-world academic contexts. The Virtual Campus model appears to be less well known. The potential of an implementation model to guide decision making for technology infrastructure and support intuitively seems much greater than that of a planning or design model, which seem to assume that implementation will happen just because it has been planned and designed. But implementation is a time- and resource-consuming process, not an event. The implementation model is the only model for which detailed examples are available and it is instructive to take a closer look. There are many institutional-level examples of the Ubiquitous Computing model, primarily small undergraduate universities and colleges and some schools in North America that have adopted the approach since the early 1990s (Brown, 1999). There are other program-based implementations of ubiquitous computing, especially in professional and graduate programs. For example, the business schools at Concordia and Laval Universities and the Faculty of Medicine at the University of Ottawa have adopted laptop programs. The Faculty of Science and Engineering at Laval is considering it, as are a number of specialised university programs in France, Japan and other countries (ThinkTank, 2002).

Method

To illustrate the range of possibilities and weaknesses inherent in institution-wide universal computing, I chose to study aspects of two apparently mature cases of the Ubiquitous Computing model. According to Yin (1994), "a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p.13). In a university attempting to adopt a Ubiquitous Computing model, it would seem difficult to distinguish between the technology implementation process and the inevitably changed environment. Thus a case study approach is appropriate to understanding the processes and support mechanisms that are central to technology integration. The research design was a holistic, comparative case study following theoretical replication logic as Yin defines it (1994, p. 51). In other words, the two cases were expected to produce some contradictory results as evidence of the adaptability of the model to different contexts. The unit of analysis was the institutional-level implementation.

Based on the first set of interviews at Acadia, I hypothesised that Acadia University and Wake Forest University, despite some similarities, represent the extremes of structure and attitude about ubiquitous computing. They have similar demographic characteristics, their corporate sponsor (IBM) often promotes them as classic examples, and they are willing to share their experiences with others. They describe themselves as coherent examples of the model. But it seems they think of themselves as substantially different (Participant #4, #5, #6). Specific data collection methods are outlined in each case description, but in general I gathered descriptive data from a variety of sources, following Yin's (1994) standards for triangulation through multiple sources of evidence.

Case studies generally follow specific procedures articulated in advance and outlined in a research protocol. The ethical review documents found in Appendix 5 summarise the interview protocol I followed. Other data collection activities were outlined in advance, but the emergent nature of this investigation allowed for ad hoc information gathering as well, based on referrals from interviewees and from hyperlinked and serendipitous web searches. My sources of information included three of the six sources described by Yin (1994): documents, interviews and observation. Specifically, these were educational research journals and the popular press, electronic publications and university websites, other publications such as books and internal reports, interviews with purposefully selected informants, informal discussions with a convenience sample of representatives, site visits and classroom observations, and conference presentations. These multiple sources of data allowed me to consider various perspectives within the two implementations, using documents, for example, to corroborate or contradict interview data. The convergence and divergence of the perspectives enhances the credibility of the picture I present.

Yin also recommends the creation of a database of evidence and preliminary reports or notes on the evidence. This repository of all information relevant to the case should be the basis for enhanced reliability through the principle of a "chain of evidence" (Yin, 1994, pp. 94-99). I organised all the materials gathered in two places: a separate filing box for hard copies of documents, interview tapes and transcripts, notes and reflections; and electronic files on my computer including an annotated bibliography, bookmarked websites and digital documents. They are easily accessed for inspection and the electronic files are also preserved on CD-Rom.

This case study report is divided into three subsections, one for each brief case description and one for the cross-case analysis. The analytic framework is descriptive, highlighting the infrastructure, policies and attitudes that were the focus of the investigation.

Acadia University

Acadia University in Wolfville, Nova Scotia, is a small, rural university offering a primarily residential liberal arts education for approximately 3,700 undergraduate students a year. The inspiration for ubiquitous computing came from the need to access the world's knowledge and information resources in order to "provide a high quality undergraduate learning environment" and to maintain and extend the university's position in the Canadian educational marketplace (Participant #6, Bates & McEwan, 1990). A partnership with IBM involved phasing in the requirement for universal student reliance on notebook computers over the period 1996-2000. The ThinkPads are leased annually and refreshed (replaced with a newer model) each September. Currently all offices, most classrooms and laboratories, and all residences are equipped with fibre optic cable connections to the Internet through the university's Intranet. The Student Centre, lounges and libraries have dozens of wired carrels. In all there are 7,000 drops on campus. The costs were covered by a major fundraising campaign that raised $26 million for infrastructure and scholarships (Participant #6), and by increasing tuition by $1,200 per year (Participant #5). Private sector partners (e.g. MT&T, Marriott and American Express) supported complementary technology applications including swipe cards for identification, payment and data collection purposes (Acadia University, 1996). To date, three cohorts have graduated that spent their entire university life using portable computers inside and outside of class.

My sources of information on the Acadia University case included seven formal, semi-structured interviews with selected staff and faculty members who were directly involved in the implementation process, and several informal discussions with students and instructors both on and off campus. The anonymity and confidentiality of these informants is preserved through references by number (e.g. Participant #x). I visited the campus twice, in November 2001 and January 2002, taking the opportunity to observe campus life in several venues including classrooms and the library. During these visits I initiated casual conversations with students and staff. Participants provided me with the original planning documents as well as texts of speeches and slides of presentations by executive officers and senior managers of the university. As Acadia has often been in the news, I also considered news releases and promotional information available on the university website, as well as newspaper and magazine articles describing the program and its results. I attended presentations by Acadia staff and faculty members at three conferences in 2000-2002 (Concordia University Educational Technology Conference, November 2000; CAUT Conference on Online Education, November 2001; and IBM Thinkpad ThinkTank, June 2002), and consulted academic papers published by instructors on their in-class activities with computers for learning. A complete list of sources can be found in Appendix 6.

Based on the initial "Global Library" goal of providing Acadia University faculty, students and staff with immediate access to the world's information through Internet connections at their "preferred location on campus" (Participant #6, Bates & McEwan, 1990). the ubiquitous computing experience is considered by many constituents to be an unqualified success (Participants #5 and #6; Green & Protheroe, 2002). Internal statistics show that in the 2000-2001 academic year, 85% of courses involved the use of technology, including the course management system. Students use computers extensively, both in and out of classes (Participants # 5, #6, #7). Acadia is the only university in Canada that offers universal mobile computing on campus. The Acadia Advantage program has received international recognition for its innovations, including a Canadian Information Productivity Award in 1997, the Computerworld Smithsonian Award in1991, and a Pioneer Award in 2001. In 2001, Maclean's magazine ranked Acadia University "Best Overall" in its category for the eighth year in a row (Acadia University, 2002c).

The planning process for the Acadia Advantage program began as a vision of the senior executive of the university, including the Vice President Academic (later the President) and the Directors of Computing Services and the Library. Broad campus consultations (Participant #6) led to Senate and Board of Governors approval of the global library concept in 1991, far in advance of the technological capability to implement it. By 1995, however, Internet-based laptop technology was available to support the universal access principle, the plan was formally approved and implementation was swift. In six months the Acadia Advantage program was running. Policy and practice were developed in response to needs (Participant #2). Staff scrambled to prepare the technical infrastructure including the campus backbone (Participant #1) and the support units (Participant #2).

The transformation of teaching and learning that has been documented (MacKinnon, 1999; Provencal, 1999; Retson, Williams, & Symons, n.d.; Watters, Conley, & Alexander, 1998; Williams, MacLatchy, Backman, & Retson, 1997) is seen as a welcome by-product of the original, far-sighted global library plan (1990) but instructional improvement was not among the original stated objectives (Participant #6). Two support units were designed to service the expected needs of new computer users, both technical in nature: the User Support Centre and the Acadia Institute for Teaching and Technology.

Hardware and software support are available to all students, faculty and staff through a state-of-the-art User Support Centre (Participant #7). Staffed by 16 full-time employees including three certified technicians as well as 10 part-time students (up from a total of three people in 1996), the Centre provides a one-stop front-line help desk service over the counter or by telephone. In-house laptop repairs are guaranteed within two hours or a replacement is issued. Other free services offered by the User Support Centre include classroom equipment maintenance and equipment lending through an Educational Technology Centre, Microsoft Certified training courses, and just-in-time classroom training on specialised software. The Centre also houses specialised resources such as backup drives, colour printers, CD burning facilities and a video editing suite. As needs have changed, the Centre has responded by adding or adapting services. Its motto is "service with a smile."

Acadia now appears to be in a state of transition from providing purely technical skills-based support for teaching and learning activities to offering more pedagogically-oriented support (Participant #3 and #5). Support services for faculty members exclusively are provided centrally through the Acadia Institute for Teaching and Technology (AITT). A substantial grant from the McConnell Family Foundation supported the creation and operation of this centre. Its purpose is to support faculty to adopt technologies in support of classroom teaching and learning through training, workshops, consulting services, and development expertise (Participant #5). Participant #5 continues: "And so we will build things for faculty…[for example] our course management system…[and] a grade distribution utility that will automatically send marks directly to students' email…very pedagogically focused or…very pragmatic and administrative, you know, making the life of the professors easier." Some of the unique features of the AITT include intensive summer technology training and curriculum development activities that pair technologically astute students with interested faculty members, a student-new faculty technology orientation program, and summer institutes for Nova Scotia teachers. This last initiative represents an extension of the AITTs mandate to serve as a resource for technology integration in education outside the university and is the result of external funding by the General Electric Fund (Participant #5). In 2001, the summer development program for on-campus innovation, affectionately referred to as the "Sandbox," completed 38 projects with 67 faculty members and 38 student employees. The focus in this and the new faculty orientation program is on "practical pedagogy," which involves identifying "the learning challenge" and working out solutions collaboratively (Participants #3 and #5).

A second grant ($1.8 million) from the McConnell Family Foundation was awarded to Acadia in April 2002, which will extend the work of the AITT in curriculum innovation and support the infrastructure to sustainability at the end of three years

(Acadia University, 2002a). Very little evaluation research has been published to date (Participants #3 and #6), although there is some evidence that the university is collecting meta-level data for analysis and future publication (Participant #6; Cutright & Griffith, 2000). Recent statistics on student use of and attitudes toward computers, including comparisons with other Maritime universities, are published on the university website (www.acadiau.ca/research).

The challenges of this implementation were substantial. Acadia faced serious collective action on the part of faculty members and criticism by students for not enough use of the computers in the classroom (Lewington, 1998). Public relations concerns developed over these and other problems in the early years of the program. Although students can still be found who refer to their computers as "useless crap" (unidentified student), the issues are apparently being resolved as the program unfolds and stabilises (Participant #5). Current administrative concerns include security (Participant #1) and the robustness of the laptops themselves (Participant #7). There is no evidence that the program will be changed in the near future, although with the anticipated resignation of the President in 2003 (Acadia University, 2002b) the key leadership may be weakened.

Wake Forest University

Located in Winston-Salem, North Carolina, Wake Forest University is a small, private (Doctoral II) institution. The Ubiquitous Computing model was implemented in the Undergraduate College only, which is committed to a liberal arts education and which has approximately 3,800 students, representing 63% of the university's total population. In 1993 a strategic planning process outlined a plan to completely renew the teaching and learning environment on campus. The move to ubiquitous computing on the IBM ThinkPad model was phased in beginning in September 1996. Students receive laptops at the beginning of their first year, which are refreshed at the beginning of their third year, and which they keep upon graduation. The campus is completely wired, including classrooms, common areas and residences. Explorations with wireless networking are currently underway.

As there is a considerable information published on the Wake Forest University case, and because of the prohibitive cost of a site visit, my sources included primarily documents and web-based virtual tours of the campus. I accessed planning and evaluation documents, news releases, texts and slides of presentations at North American conferences and in international venues from various Wake Forest web pages (www.wfu.edu). The university's laptop leader, David Brown, Vice President and Dean of the International Center for Computer Enhanced Learning, has written or edited six books on using technology in teaching and learning since 1999, inspired by the Wake Forest experience. I found several academic papers in published journals, including course-specific and institution-wide evaluation studies, and a number of general interest articles both in print and online. I conducted one email interview for clarification of details, and I attended presentations and had informal discussions with administrators at the IBM ThinkTank conference in June 2002. A complete list of sources can be found in Appendix 7.

Ubiquitous computing was only one component of the institution-wide "Plan for the Class of 2000," which also involved enhancing the first year curriculum, hiring 40 new faculty members and increasing scholarships and fellowships for students. To "preserve the distinguishing features of our heritage" (Wake Forest, 1993), the strategic plan articulated several goals. They included (a) a commitment to holistic education, (b) strengthened student-faculty relations, (c) greater student engagement with ideas, (d) improved effectiveness and efficiency of learning and teaching both in and outside the classroom, (e) better prepared, "information fluent" students, (f) recognition of diversity, and (g) increased quality and quantity of scholarship (Griffith, 1999). Longitudinal research using a full range of assessment instruments is beginning to show evidence of success through increases on many of the key quality indicators established at the beginning of the implementation. Some of these measures are freshman retention rates, student/faculty ratio, per cent of graduates receiving degree credits abroad, graduation rates, alumni giving rates and academic reputation (Griffith, Gu, & Brown, 1999). Comparative data with other universities is also analysed and published annually. Measures specifically relate to the technology initiative's focus on faculty and student use of and attitudes towards computers, and the relationships between them (Mitra & Steffensmeier, 2000; Mitra, Steffensmeier, Lenzmeier, & Massoni, 1999).

The planning process for the strategic plan involved elected representatives of all Wake Forest constituents, an environmental scanning exercise that included a comparative pricing study on tuition and other institutional benchmarking research, and a comprehensive needs analysis of students, faculty and staff with respect to resources including technology. Eighty-two open hearings and several open forums were held on campus. Initial faculty resistance diminished with the promised commitment to maintaining traditional mission and values, and increasing academic appointments. The student/faculty ratio is currently 10.5:1 (Wake Forest University, 2002). Early student resistance, expressed in protest activities in 1996, seems to have been reduced over time as well. The technology plans were bundled with other academic initiatives as part of the comprehensive plan to preserve academic excellence and were therefore difficult to resist (McMillan & Hyde, 2000).

Support services are decentralised throughout the campus. There are at least seven different units with responsibility for programs designed to enhance the effective use of computer technology at Wake Forest. A brief description of departments, programs and initiatives follows as an introduction to the support infrastructure. *Information Systems* is the department responsible for the technical systems, including laptop specifications, computer networks, servers and telecommunications. Under its auspices, the *Information Systems Support Center* provides an extended hours help desk and a series of student technology programs. These include student resident technology advisors (RTAs) in the dormitories, student technology advisors (STARs) who are assigned to work one-on-one with faculty members, and the Arthur Vining Davis Community STARs who assist teachers in local schools. The *Information Technology Center* in the library houses an extensive multimedia collection, film screening room, and computer labs, and provides software training for students, staff and faculty. A *Teaching and Learning Center*, also located in the library, supports excellence in instructional, curriculum and faculty development at all levels by assisting novices, sharing experiences, and leading innovation (not necessarily technological) in classroom activities. Governed by a faculty advisory committee elected annually, the centre provides a resource room and online catalogue of completed technology projects and teaching/learning resources, including links to similar centres at other universities. It also provides tutorials and a confidential teaching evaluation service. Through FORTE (Faculty Online Resources for Technology in Education), the Centre provides background information on the ThinkPad environment, job aids, suggestions for how to manage the classroom, and online technical help. The *Instructional Technology Group* is composed of academic technologists with discipline-based qualifications, who serve as full-time resource professionals to faculty members in the design, implementation and use of information technology in their individual courses. These academic computing specialists are assigned to individual departments. The *Advanced Technology Group* is an interactive multimedia authoring group and emerging technology centre that hosts seminars and workshops ("Tick-Tech-Talks") on technical issues and advanced software applications. Created by the academic computing specialists in Chemistry and Physics in 1998 who wished to share their growing digital expertise with the wider Wake Forest community, this group also provides design and production assistance to the *Interactive Multimedia Electronic Journal* (IMEJ). The *Computer Enhanced Learning Initiative* (CELI) is a faculty-based program for developing and disseminating effective uses of computers that preserve tradition and integrity in instruction, advance scholarship, and facilitate intellectual exchange. From 1997-2000 CELI coordinated a granting program that provided course load reductions for professors interested in designing new course materials that incorporated technology appropriately. Supported by IBM, the *International Center for Computer-Enhanced Learning* (ICCEL) offers for-profit customised conferences and workshops to K-12 and higher education groups interested in exploring the potential of technology facilitated interactive teaching and collaborative learning. The faculty-based

Committee on Information Technology (CIT) is responsible for developing, monitoring and recommending policy on current and future information technology issues.

Three laptop cohorts have graduated to date. David Brown has agreed to continue to lead Wake Forest's ubiquitous computing initiative for one more year, while he consults through the ICCEL with educational organisations around the world interested in laptop computing programs. The current partnership with IBM extends until 2006 (McMillan & Hyde, 2000).

Cross-case Analysis

Acadia and Wake Forest Universities represent two extreme cases of the Ubiquitous Computing model of technology integration. Table 18 lists the main features of comparison. Despite similarities in social environments and religious heritage and in the laptop program details, there are some critical differences between the two cases. These contrasts are apparent in the planning, design, implementation and evaluation phases of institutionalising their respective laptop programs. They point to fundamental differences in assumptions about teaching and learning.

Planning

The key difference in the planning phase was the original espoused goal. Acadia's purpose in moving to a ubiquitous computing environment was to make the global library plan a reality. Access to the world's resources did not imply broad cultural change or teaching innovation. Survival of this small university was based on providing "access to information and knowledge at the same level as a huge institution…like a Harvard or a

University of Chicago....Everything else was gravy" (Participant #6). At Wake Forest the goal was to preserve traditional faculty-student relationships by introducing technology-enhanced teaching and learning in support of more effective individualised education and to sustain established learning communities. This was a much broader objective in the sense that it was about using the technology to do ordinary rather than extra-ordinary things. This means that from the beginning the laptops were designed to be a part of the university's everyday life and culture. Both universities used strategic planning tactics to gain support from stakeholders for the initiative, beginning with very small groups of opinion leaders in Acadia's case and Deans in Wake Forest's. Both presented the plan to larger and larger groups of constituents, following a process of "change creation" (Lick & Kaufman, 2000), culminating in Senate and Board approvals. But Acadia's process lasted from August 1995 until February 1996 while Wake Forest's began in February 1996 and ended in April 1996. The Acadia Advantage program focused exclusively on bringing the laptop to students and faculty (Participant #6), but Wake Forest's comprehensive Plan for the Class of 2000 added the laptop component at the last minute (McMillan & Hyde, 2000).

Table 18

A Comparison of Two Cases of Ubiquitous Computing

	Acadia University	Wake Forest University
Demographics	Rural, Baptist heritage, East coast Public, residential, liberal arts (36 programs) Founded in 1838 - 3,700 students 343 faculty (15:1 ratio*)	Rural, Baptist heritage, Eastern U.S. Private, residential, liberal arts (34 majors) Founded in 1834 - 3,800 students 348 faculty (10.5:1*)
Laptop program details	IBM leases mandatory for undergraduates Standardised model, software applications Phased in 1996 - 2000	IBM purchases mandatory for undergraduates Standardised model, software applications Phased in 1996 - 2000
Goals for ubiquitous computing	"Access to the world's information resources" Competitive advantage for students Prepare graduates for real world	"More effective individualised education" Competitive advantage for students and faculty Prepare graduates for real world
Funding	Increased tuition $1,200 Canadian (currently $6,584) Fund-raising campaign Corporate partnerships and research grants	Increased tuition $3,000 U.S. (currently $24,750) Fund-raising campaign Corporate partnerships and research grants
Leadership for innovation	President (charismatic)	President through Vice Presidents (pragmatic)
Planning and consultation process	Strategic Time constrained Specific to technology Selective	Strategic Time constrained Bundled with educational renewal Participative
Support infrastructure	Centralised - location and services	Decentralised - locations and services
Faculty development approach	No existing teaching/learning support service Group workshops, tutorials Students for summer curriculum development Responsive Generic Teacher control of classroom	Existing teaching/learning support service One-on-one mentoring, training Students during academic year Proactive and invitational Discipline-based Teacher-scholar ideal Community of learning
Benefits / successes	Public recognition Anecdotal evidence	Benchmarking results Systemic, regular assessment on established criteria
Problems	Resistance - faculty collective action ongoing	Resistance - student protests initially
Overall analysis	Applied	Integrated

Notes: *reported on the website - ratios do not compute exactly

Design

The contrast between Acadia and Wake Forest is most evident in the faculty support infrastructures that evolved. Acadia centralised academic and technical services while Wake Forest elected to build on existing faculty development services by assigning academic technologists to specific departments. This allowed for extensive, distributed, one-on-one pedagogical and technical consultations and training. Student assistants were available on call to meet with faculty members in their offices. Although Acadia's AITT accepted responsibility for individual training when resources permitted it (Participant #4), the multi-disciplinary group workshop on software skills approach was considered more efficient than distributed support. The summer "Sandbox" activities became the focus for selected innovators and student support. Participant #6 suggested that Wake Forest "didn't invest in their faculty they way we did." Participant #3's interpretation, however, was that the emphasis on the technical was the result of not recognising the pedagogical implications of universal computing. In fact, both universities are extremely proud of their faculty development efforts and consider their models to be a key factor in the success of their programs. It is interesting how differently faculty development is defined and operationalised in the two locations.

Implementation

Most of the Acadia informants suggested that there was no explicit implementation plan (#1, #2, #3, #5). Though the vision was clear the details were not (Participant #1). Within six months of approval the first Acadia Advantage cohort arrived on campus. In that time the campus was wired, a publicity campaign was launched and fundraising began. Expectations soared. Staff worked "really long hours" (Participant #7) making up the implementation strategy "as we went along" (Participant #2). Although the original commitment was to not force faculty to use the laptops in the classroom, student and outside pressure was enormous. In 1998 the faculty boycotted the program, refusing to use the laptops in class, and backed their actions up with the threat of a strike. It took many months before a collective agreement that guaranteed faculty control in the classroom was ratified. Included in the terms were: (a) commitment to more pedagogical support for computer use, (b) recognition of educational research in promotion and tenure decisions, and (c) agreement not to force use of computers during class time (Participant #3). Bitterness is still evident and all Acadia informants were careful to point out that faculty members retain control of classroom behaviour. I did not uncover evidence that Wake Forest suffered from similar implementation problems. I speculate that as a private university they did not have publicly aired labour relations problems. Perhaps their faculty development plan was more in line with professors' needs and cultures. MacMillan and Hyde (2000) suggest that faculty scepticism was most evident at the beginning of the process.

Evaluation

Acadia University has not published institutional-level evaluation data yet, although informants were willing to share the success stories of individual students or faculty members. In contrast Wake Forest University publishes the results of its ongoing assessments annually both in print and on the website. Longitudinal studies are beginning to appear that document changes in student and faculty attitudes to and use of computers for learning and teaching (Mitra & Steffensmeier, 2000; Mitra et al., 1999). These processes suggest an openness at Wake Forest that is not found at Acadia, perhaps due to the different types of cultures found at private and public universities and the expectations for accountability, perhaps due to personality or a combination of other factors. Acadia interviews confirmed that there was no one at the university with an interest in educational research when the Acadia Advantage program began (Participant #3 and #4). There are copies of a few classroom evaluations posted on the AITT website, however, linked to pages describing faculty best practices.

Maturity

Surry and Ely (1999) identify six "commonly accepted indicators of institutionalisation" (p.6). Since the IBM ThinkTank conference presented the Acadia and Wake Forest cases as "mature" I have used these criteria to verify the level of technology integration each has achieved.

Acceptance by relevant participants. This is the perception that the innovation legitimately belongs in the organisation. It took several years for Acadia faculty members to ratify a collective agreement that guaranteed their rights to choose when to use the laptops in teaching, and under what circumstances. Given that a former union president (Sacouman, 2001) represented himself at the CAUT Conference in November 2001 as speaking "from the belly of the beast" it may be that this criterion has not been completely satisfied at all levels of the university. He expressed bitter disapproval of the number of new administrative support staff who had been hired since 1996. On the other hand, another faculty member at the same conference indicated that the Acadia Advantage program was entrenched in the organisational culture. External opinion as represented by Maclean's ratings and the recent McConnell Family Foundation grant seem to indicate public acceptance of the program, however. As well, applications from prospective students increased 40% from 1998 to 2000 (Participant #5). Wake Forest seems to meet the criterion of maturity, based on the fact that the website no longer focuses on the laptop program. The class of 2000 graduated two years ago and the university's relative position has improved with respect to benchmarks such as student-faculty ratio and tuition and the university remains competitive.

The innovation is stable and routinised. Staffing levels have stabilised at both universities. Acadia's User Support Centre has had the same personnel complement for three years (Participant #7). The new McConnell funding will sustain the AITT for another three years and external consulting contracts are beginning to contribute to operations costs. Wake Forest has recently clarified and confirmed the role of the academic technologists, changed the name of the program from Academic Computing Specialist to Instructional Technology Group, and established a system of recognition and promotion based on expertise at the specialist, consultant and analyst level.

Widespread use of the innovation throughout. The official report (Participant #5, Cutright & Griffith, 2000) is that 85% of Acadia University courses have web presence through the course management system, an indicator that equates presence with utilisation. At the ThinkTank conference it was suggested that Wake Forest's student technology assistant program (STAR) would soon be disbanded. The lack of continued funding for this support program may indicate that faculty no longer need individualised training.

Firm expectation that use will continue. Both Acadia and Wake Forest continue to promote their programs to potential students and both collaborate with their corporate partner IBM by allowing their in-house experts to serve as consultants for other organisations considering ubiquitous computing. This suggests a commitment to continuation at the executive level. Anecdotal evidence of success by individual Acadia graduates emphasises their new skills and high levels of preparation for the world of work, suggesting firm belief in the value of continuing the Acadia Advantage program.

Continuation depends on the organsiational culture, structure or procedures. Given the anticipated departures within the year of both champions, (Acadia's president and Wake Forest's vice-president), it appears that both universities may be satisfied that their presence and involvement is no longer necessary to the success of universal computing on their campuses. It is difficult to say in advance whether or not this is actually the case. Participant #6 suggested that at Acadia it is now the students, for whom computer use is "instinctive" who drive the process, implying that bottom-up development will prevail.

Routine allocations of time and money. Acadia may not be meeting this criterion, given that the AITT is dependent on outside funding. Other support services are budgeted annually, however. Wake Forest was aiming to fund its computer services at 6% of the annual base budget, an amount equivalent to that targeted to the library.

Summary of the Models Chapter

The planning and design models seem to provide answers to some of the questions university decision makers have about meta-level technology integration. They offer strategies and advice for large-scale implementations with a distance education focus. I assume they are informed by practice, given the extensive professional backgrounds of their authors. The implementation model is more narrowly described here as a potential solution for smaller, campus-based universities. There are successful examples of ubiquitous computing in operation, although there is more than one way to manage the implementation. It seems that variables such as leadership style, institutional culture and pedagogical philosophy will affect how the Ubiquitous Computing model is applied. It is unclear whether or not it is scalable to a large university. Currently the largest institutional implementation is at Northern Michigan University, which has approximately 7,000 full-time students (ThinkTank, 2002). Questions about the sustainability of the model will likely be answered in the next two to three years, as Acadia and Wake Forest move to new leadership.

Chapter III - INTEGRATION

This chapter integrates and synthesises my findings to this point. It begins with a brief overview of the findings of Chapters I and II. I survey the factors influencing institutional-level technology integration as they emerged from investigations of the environment, the research literature, and the theory and practice of post-secondary education. Following the review of factors I look at different ways of understanding them. I describe several conceptual frameworks that offer different perspectives on the process of technology adoption. I use one of these to analyse how each of the three types of technology integration models (planning, design and implementation) addresses the influencing factors. In the next section I explore the strengths and weaknesses of these and other applicable conceptual frameworks. Then I turn to strategies for organisational change and consider how effectively they might manage the factors. The value of an educational systems design (ESD) framework will become clear as the critique develops. It points to the need for a new model for technology integration in universities. The final section describes and explains this new model.

Factors Influencing Technology Integration

The Environment

In the first chapter I outlined a number of cultural, technical, economic, political and social forces currently influencing university change. Traditional consensual academic decision making processes struggle to keep pace with the impacts of rapid technological advancement and the concomitant expectations of society for "more, bigger, better, faster" education. The convergence of communication and information technologies, as well as their ubiquity, has consequences for how instruction is delivered and received. A shift in emphasis has changed the focus from teaching to learning, and the craft of teaching, originally highly interactive and learner-focused, having already adapted once to industrial large-scale educational processes, now has to adapt again to changing social needs for greater individualisation and relevance. Pressures for economic, political and social accountability cause leaders to think in terms of standardisation, competitive advantage and return on investment. They are highly influenced by arguments for effectiveness, efficiency and entrepreneurial programs that deliver just-in-time training to new and growing markets. These trends appear to be at odds with internal demands for continued control and ownership of the process as well as the products of learning.

The Literature Review

In the literature review I identified the factors that influence the application of new educational technologies as they have emerged from research activities undertaken in universities. These factors can be described either in terms of first-order and second-order barriers to technology integration or as facilitative conditions for the implementation of technologies in teaching and learning. Both approaches seem to be focused on the problems encountered during the process of institutionalisation. Less than half of the studies (40%) reported course-based research into specific applications. These considered some of the technical and social factors that underlie the broad educational mission of universities. For example, the research in Teacher Education considered new needs for collaborative and active learning as articulated by national standards organisations. Some studies reported on experiments with the capabilities of the Internet for research or with the potential of specialised software to support learning through hypertext. These micro-level studies were complemented by a smaller number of macro-level studies of program-based curriculum redesigns, especially in Education, in response to social and political pressure for technology-based teaching. There were a few meta-level studies of faculty and student attitudes about technology that offered some insight into cultural factors, but not at a very high degree of detail. The concepts of culture and climate need to be unravelled for a better understanding of how they impact on technology-based innovation in education. In short the research offered almost no exploration of the economic and political pressures for technology adoption.

The Models

The technology integration models described in Chapter II, on the other hand, seem to be grounded in the environmental impetus for change. Planning models are primarily focused on the economic arguments for technology, with some attention given to cultural and social factors. Design models tend to address the technical and social issues of using particular applications to meet the expressed learning needs of identified groups. Implementation models seem to be motivated by a deep understanding of the economic and social factors, and are predicated on technical advances. All three types of models consider certain of the factors identified in the research literature but none is adequate to address all of them on its own. And though all the models talk about the importance of evaluation, none prescribes a process for doing it.

Ways of Understanding the Factors Affecting Technology Integration

Barriers Models

Three models of barriers emerged from the literature review. Their authors proposed them as ways of framing the interactions that contributed to non-adoption of technology by faculty members. Leggett and Persichitte (1998) reviewed the historical evidence of obstacles to technology use and asserted that little had changed in the 50 years since film was introduced to classroom teaching. They grouped critical factors into five sets of obstacles, and called their model "TEARS" (Time, Expertise, Access, Resources and Support). Patricia Rogers' (2000) framework separated the set of correlated variables she identified into internal and external categories, with an overarching set of factors (including time, funding and institutional culture) that crossed the boundaries between the two others. Internal barriers included faculty attitudes, perceptions and skills, and could be used to determine where individual faculty members fall on the continuum of adoption (Rogers, 1995). Barriers from external sources involved access to hardware and software, support, and stakeholder development. Rogers' (2000) model acknowledged the complex interdependence of the various barriers.

Ertmer (1999) suggested that barriers could be classified as first-order (external) or second-order (internal) (Ertmer & Hruskocy, 1999). First-order barriers were those perceived by faculty members to originate outside themselves. They were extrinsic in that they were beyond the control of the individual. Access, time and support were classified as first-order barriers. Second-order barriers were those that originated within individual faculty members. Because they were intrinsic, they were assumed to be within the control of the individual. Instructor beliefs, attitudes and practices were classified as second-order barriers. Ertmer proposed that first-order barriers be attended to in the initial phase of a technology-based implementation. Without reliable access, adequate support and appropriate training on a system-wide level, the more personal and cultural second-order barriers cannot even be addressed.

Ertmer's analytic framework surpassed Leggett and Persichitte's and Rogers' descriptions of the barriers by arranging them hierarchically. Her model recognised the source of each barrier from the perspective of faculty members. That is, from the instructor's perspective, the barrier is either external or internal to the individual. This has implications for the individual's perceived ability to control the obstacle or to change its impact. It also anticipates where the responsibility for eliminating it lies - either with the institution or with the instructor.

Taken together the barriers models seem rather narrowly focused on faculty perspectives. They seem limited by the underlying assumptions that technology in teaching and learning is necessarily good while non-acceptance is necessarily bad. This notion of barriers is a reactive, even negative one. It does not address the perspectives of students or administrators.

Facilitative Conditions

Ely (1990) has contributed another approach to understanding the process of organisational integration of technology. A focus on facilitative conditions is inherently more positive than a focus on barriers. Ely's research has identified eight conditions that contribute to "institutionalisation" of innovations. These conditions include: (a) dissatisfaction with the status quo, (b) knowledge and skills exist, (c) resources are available, (d) time is available, (e) rewards and/or incentives exist, (f) participation is ongoing, (g) commitment is evident, and (h) leadership exists throughout the organisation (Surry & Ely, 1999). In order to compare the facilitative approach with the barriers approach, Table 19 lists Ely's facilitative conditions along with the various barrier models and with the factors identified in the literature review. One advantage to Ely's contribution is that it begins to unpack the very complex notions of climate and culture. Both P. Rogers and Ertmer lamented that our understanding of internal factors is extremely limited. As well, Ely's perspective is more broadly focused on institutional potential rather than on individual needs. But it appears to be an external, research-based perspective, rather than one that reflects the involvement of participants in the institutionalisation process.

Table 19

A Comparison of Perspectives on Factors Affecting Technology Integration

Factors	Ertmer	P. Rogers	Leggett	Ely
		External / Extrinsic / First-order Barriers		
Time	√	√	√	√
Support	Resources	√	√	Resources
Funding	√	√	Resources	
Rewards	√	√		√
Access	√	√	√	Resources
Equipment	Access	√		
Training	√	Stakeholder development	Expertise	Knowledge & skills
		Internal / Intrinsic / Second-order Barriers		
Culture	√			
Climate	Support			Dissatisfaction with status quo
Pedagogical approaches				
Evidence of learning advantage				
Psychological factors	Attitudes	Attitudes		Commitment
		Perceptions		
		Skills		
		Other Factors		
Strategic Planning				
Leadership				√
Participation				√
Students				
Economics				
Standards				
Usability				
Feedback				
Habit				
Ethics				

Note. I use check marks to indicate that the researchers explicitly identified the factors listed. When their discussions addressed the factors less specifically, I use their terms to show which factors I infer they were describing.

How the Technology Integration Models Address the Barriers

Despite the narrow cast of the barriers approach, I use the Ertmer model to analyse how the design, planning and implementation models attend to the factors identified as affecting technology integration. This is appropriate given that faculty resistance to change and to technology is one of the key challenges in contemporary university culture. A model's usefulness for planning and policy making about contentious issues is limited if it does not address generally accepted impediments up front. In the following sections, I review how different types of models deal with first-order and second-order barriers.

First-order Barriers

First-order barriers are those that are perceived by faculty members to originate outside themselves. They are extrinsic, in that they are out of the control of the individual. Strategies that target first-order barriers aim to remove external factors that block or retard implementation.

Planning Models

The Knowledge Media model focuses primarily on using technology to establish and maintain institutional competitive advantage through cost leadership or differentiation (Daniel,1999, p. 139). Its main concern is with institutional resources, especially academic strengths and financial policies. Daniel advises the adoption of activity-based cost accounting procedures, including treating technology as an operating rather than a capital expense. This approach considers first-order barriers as a function of strategic decision making about funding. The implication is that appropriate financial strategies can manage issues of time, resources and reward by allocating funds in support of those activities. Questions of access, novelty and speed of particular technology configurations need to be answered with clear reference to the basic academic goals of the implementation strategy. For Daniel, the "purpose of using technology in teaching is to give better value to students (and other buyers like employers and the state)" (Daniel, 1999, p.146). He does not address training directly.

The Postindustrial model suggests that technology planning should take advantage of opportunities (such as external funding partnerships and internal willingness) to adopt technology-enhanced teaching and learning. Bates addresses the issues of time, resources, reward, access and training with the awareness of someone who has personally experienced each of the first-order barriers. For example, he admits that faculty workloads can be substantially increased if laissez-faire or "Lone Ranger" models (Bates, 2000b, pp. 59-64) are allowed to flourish. Use of project management techniques results in shared workloads, adequate learning and course development time, available technical and pedagogical expertise, and cost-efficiency. Accessible and reliable technology infrastructures, both physical and human, need to be integrated with the rest of the university's communications and human resources in order to properly service both academic and administrative needs. Bates supports activity-based accounting and the suggestion that costs for technology should be considered operating expenses. He argues for a wider range of criteria for faculty rewards and recognition: "Quality of teaching, no matter the format, needs to be a major criterion for appointment, tenure and promotion"

(Bates, 2000b, p.119). Although an introductory orientation to technical skills may be necessary, Bates de-emphasises training.

Design Models

Although the Virtual Campus environment is described as the learning system at the heart of Télé-université's technological re-engineering, the model does not yet include the administrative elements of an institutional application. Paquette does not address first-order barriers directly.

The Conversational model is based on the process of iterative knowledge creation of an ideal learning organisation. Laurillard proposes meta- and macro-level policy that standardises equipment and optimises staffing and resources at levels necessary to support technological innovation. This includes setting realistic expectations of time and funding, and organising staff development that is time efficient and subject specific. With respect to appraisal and promotion procedures, an institutional learning and teaching strategy that includes policy on promotion and reward in support of teaching excellence is critical. Otherwise "innovation in teaching will be confined to the selfless enthusiast, and will not be an integral part of the university's development" (Laurillard, 2002, p. 235).

Implementation Models

Universal computing in a university is based on the notion of anytime, anywhere access to learning resources by all stakeholders. The computer's role is in the facilitation of communication between learners, their teachers and those who support them. According to Brown, and substantiated by both cases studied, universities organised on this model attend to the environmental imperatives by assuring reliable and universal access to computers, and providing adequate and convenient technical training and support. They have generally adopted a standard technological platform and courseware architecture that help to substantially reduce barriers associated with training, technical support and infrastructure. "In colleges and communities where dollars are scarce, depending upon learning by immersion is a valuable strategy" (Brown, 1999, p.16). Nevertheless, basic training and help desk assistance are essential (Brown, 1999, p.64) and substantial support infrastructures exist at both Acadia and Wake Forest. Because the entire institutional culture is focused on making technology-enhanced teaching work, obstacles related to time and reward are usually worked out collaboratively as a part of the implementation process or in advance. At Wake Forest, technology expenditures, proposed to eventually reach 6% of the total institutional budget, are considered operating rather than capital costs. Other financial decisions are made on the basis of teaching/learning priorities and on multi-year budgets based on academic plans (Brown, 1999, pp.27-28). These critical implementation strategies "contribute to a coherent, effective and efficient system" (Brown, 1999, p. x).

One of the ironies of the competitive advantage argument is that once all universities have moved to universal computing by addressing first-order factors, the value added of access to educational technologies disappears. This points to the critical importance of addressing individual and cultural factors, for the ability of universities to effectively use the technologies in the teaching/learning transaction will make them competitive in the future.

Second-order Barriers

Second-order barriers are those that originate within individual faculty members. Because they are intrinsic, they are assumed to be within the control of the individual. Strategies that target second-order barriers aim to change attitudes, teaching practices and even university culture to facilitate adoption.

Planning Models

The Knowledge Media model assumes that organisational culture change is required for the successful implementation of technology. This will involve greater emphasis on teaching issues such as specialisation and co-ordination, and on learning issues such as access and interactivity. It will offer an opportunity to "strengthen the relationship between research and teaching" (Daniel, 1999, p.140). Daniel reminds us that "Innovation in technology-based teaching requires the same care and understanding as the development of knowledge in any other field" (Daniel, 1999, p. 141). He does not offer suggestions for managing change, however. Nor does he address personal fear, resistance or pedagogical training.

The Postindustrial model responds to the real difficulties experienced by institutions struggling with technology implementation. In this view, university-wide culture change is essential to meeting the challenges presented by the barriers. Teaching and learning practices need to be totally revamped to take advantage of the opportunities technologies provide for communication and interaction among learners, their teachers and resource materials. Bates' strategies centre on faculty development activities that go beyond training to support experimentation, sharing of successful practices and evaluation research.

Design Models

The Virtual Campus environment offers synchronous and asynchronous access to learning resources. It differs from traditional learning environments delivered by educational institutions in its learner-centredness and its assumptions of instructional design. Resources for learning are made available to all actors by the open, modular and highly adaptable system. The structure of the Virtual Campus supports interaction among participants in the teaching and learning environment at a higher level than in traditional models. Individuals' fears of technology or resistance to change are not addressed.

Expanding knowledge and sharing information and resources in the Conversational model should lead to a supportive, learning focused culture for all. Laurillard recognises that "New technology disturbs the whole environment into which it is introduced. Both management and teaching play a part in ensuring stability in the face of change" (Laurillard, 2002, p.233). This model is based on the learning conversation between instructor and student, involves feedback and evaluation at all levels, and leadership by example.

Implementation Models

In the Ubiquitous Computing model, institution-wide decisions about first-order barriers free up stakeholders to work on building a new, collaborative, student-focused culture. The main focus for addressing second-order barriers at both Acadia and Wake Forest is on imaginative and inspirational faculty development programs that encourage and support "the actual use of computers in teaching" (Brown, 1999, p. 38). These strategies are based on an understanding and respect for the traditional character of faculty culture. Brown summarises the proven strategies this way: "To succeed, an initiative for faculty usage must be faculty led, student facilitated, multifaceted and well supported" (Brown, 1999, p.50).

Summary of How the Models Address the Factors Affecting Integration

Table 20 indicates which of the factors identified in the literature review each technology integration model considers. Top-down approaches such as the Knowledge Media model may effectively address first-order factors by deploying institutional resources to take advantage of economies of scale in technology support, infrastructure and incentives. Bottom-up approaches that focus primarily on teaching and learning, such as the Ubiquitous Computing model, may deal appropriately with some of the second-order factors that depend on leadership example and team support to overcome the culturally-determined attitudes of faculty and other stakeholders in the university. Resistance to change and reluctance to adopt technology have their roots in inadequate service and support as well. Perhaps the more important question about the models is not what factors they address but how they are used to inform action and policy.

Interestingly, four of the five models investigated in this study (Knowledge Media, Postindustrial, Virtual Campus and Conversational models) were conceptualised by distance educators, three of them with extensive experience at the Open University of the United Kingdom (Daniel, Bates and Laurillard). There may be important differences between the priorities and attitudes of distance education administrators and those whose experience is based in the face-to-face model.

Table 20

How the Models Address the Factors

	Planning		Design		Implementation
Factors	Knowledge Media	Postindustrial	Virtual Campus	Conversational	Ubiquitous Computing
	External / Extrinsic / First-order Barriers				
Time	√	√		√	√
Support	√	√		√	√
Funding	√	√		√	√
Rewards	√	√		√	√
Access	√	√			√
Equipment	√	√		√	√
Training		√	√	√	√
	Internal / Intrinsic / Second-order Barriers				
Culture	√	√		√	√
Climate		√		√	√
Pedagogy		√	√	√	√
Evidence	√	√	√	√	√
Psychology					√
	Other Factors				
Strategic planning	√	√			√
Leadership	√	√			√
Participation	√	√		√	√
Students					√
Economic arguments	√	√			√
Standards	√	√	√	√	√
Usability			√		√
Feedback		√	√	√	√
Habit		√		√	√
Ethics					

Note. Check marks indicate that the models explicitly address the factors affecting technology integration.

Large, successful distance universities such as the Open University and Télé-université are based on an industrial model (Peters, 1983) of teaching and learning. Despite the provision of tutors for distance students, the characteristics of industrialised education delivery are distinctly different from the features of smaller universities such as Acadia and Wake Forest that pride themselves on high student-faculty contact, individual attention and facilitated co-construction of knowledge. None of the models I explored focuses on the unique features of medium-sized educational institutions. How adaptable the models are to different sizes of universities is an important question.

Neither the top-down nor the bottom-up models addresses all first- and second-order barriers, and neither by itself represents a sufficient model for real change. The Postindustrial model, which considers the university to be a knowledge-based organisation, may allow for a "middle out" approach (Ely, 1997). This model proposes implementation strategies that combine the strengths of both top-down and bottom-up models, and involve faculty members in the process. It also suggests that real change is best planned, designed, implemented and evaluated at the program or department level. The Conversational model may offer another "middle out" approach. It assumes that the teaching/learning conversation normally conducted at the individual level is scaleable to conversations between faculty members at the departmental level and ultimately to dialogue among constituents at all levels of the university. One of the advantages of the Ubiquitous Computing model is that it also has the potential of being adopted at the program or departmental level. I will return to this possibility in a later section.

Other Factors

Table 19 lists a number of "other factors" identified in the literature which are neither extrinsic nor intrinsic. Most of these other factors can be categorised as "contextual" (e.g., strategic planning, leadership, participation, economic arguments, ethics). The "student" factor relates to both student participation in the integration process and to the pedagogy of individual differences. "Standards" refers to technical infrastructure, which is access, and institutional image, which is contextual. "Usability" refers to equipment and access. "Feedback" is part of pedagogy. "Habit" is a psychological factor. This suggests a possible new three-level classification of factors, that includes first- and second-order barriers which are consistent across technology integration efforts, and contextual factors which are specific to each environment. This will be explored further in another section.

Strengths and Weaknesses of Current Conceptualisations of Technology Adoption

In the seven-year period covered by this study, evidence of the need for new approaches to integrating technology into academia has been recorded in the theoretical literature of the field (e.g., Burbules & Callister, 1999; Conlon, 2000; Khan & McWilliams, 1998; Twigg, 2000) as well as in the research. Dissatisfaction among faculty members has exploded into collective bargaining and strike action or threats (e.g., York University, Acadia University, etc.). Several book-length explorations of the subject have been published (e.g., Brown, 2000a; Brown, 2000b; Burge & Haughey, 2001; Ellsworth, 2000; Evans & Nation, 2000; Hanna & Associates, 2000; Oblinger & Rush, 1998). List serves, web sites and online journals are now collaborating in the debate. One good example is the transformation of *Educational Technology Review* from a print to an online journal, dynamically enhanced with the other resources of the Association for the Advancement of Computing in Education (www.aace.org/pubs/etr). This section opens discussion of the possible reasons why current models are not satisfactory and leads to a suggestion in the next section of a new model.

Two types of approaches to organisational development concern me here: top-down and bottom-up. These perspectives involve strategies and policies at either the institutional or the individual level. I begin with a brief look at the individual interpretations before turning to the institutional-level integration approaches. The key distinction is in perspective. Individual conceptualisations consider faculty implementation of technologies for teaching and learning. Institutional-level approaches are focused on meta-level integration issues, which is a much broader perspective involving policy for academic support and administrative coordination across the university.

Individual-level Conceptualisations

Barriers Models

I indicated earlier that the barriers models seem to reflect only the perspective of faculty members. Nevertheless, Ertmer's model may have implications for changing the current reality in university education. Analysis of an educational implementation using a first-order, second-order conception of contributing factors might suggest strategic approaches to addressing the difficulties of technology integration. She points out for example that traditionally, training efforts and administrative practice have tended to focus on first-order barriers. Ertmer also remarks that first-order barriers are easily measured and quantified. She suggests that university policy and procedures can clearly address issues of time, resources, funding, access, reward and technical training. Implementation strategies for first-order barriers focus on broad institutional goals in these technical and logistical areas, with an emphasis on improving the effectiveness and efficiency of technology use. They do not attempt to change teaching practice or university culture and as a result technology is applied on top of the existing industrial process. Technology gets used as a tool but it does not fulfil its potential for fundamental reorganisation of the academic enterprise. For these reasons Ertmer insists that future professional development initiatives should be designed to teach instructors how to leverage technology for learning by addressing intrinsic types of barriers as well.

Most of the literature reviewed that identified barriers (and 38% did not) recommended that the factors affecting technology adoption in teaching and learning warrant special and specific attention in the development of integration plans for university campuses. These studies proposed that attempts to support the use of technology-enhanced teaching and learning activities take barriers into account in the design of intervention strategies (Danielson & Burton, 1999). The implication is that faculty members, who are most affected by the barriers, should be involved in technology planning activities.

The assumption is that community consultation, collaborative decision making and administrative practice can be brought together in a focus on real technological and cultural change. This will depend on the development and adoption of strategies to alleviate the intrinsic, second-order barriers and to integrate technology into teaching and learning practices as well as other aspects of university life.

The value of the barriers models is that they identify and label internal and external influences on adopters. This is an important practical reality that deserves attention. The weakness of Ertmer's model is that it does not adequately situate technology adoption within the environment. Rogers' (2000b) model gets closer to the reality of contemporary university culture, with its inclusion of overarching conditions. But it does not describe or explain the internal barriers very well. The TEARS model is inadequate as it focuses strictly on the first-order factors, which is understandable if technology is seen as a tool rather than as a new environment for learning. In the literature, few of the documented obstacles fell into the category of second-order barriers. The notion of institutional support (other than technical or administrative) is a fuzzy one.

Culture and attitude variables that are hard to identify and describe are also difficult to address. Lack of training becomes an intrinsic barrier when there is no help for faculty members to build student-centred and technologically appropriate instructional strategies into their teaching materials. The literature review indicated that very little research has been done in the area of pedagogical or psychological factors.

To study the context of learning requires a "holistic" research methodology, one that is "reflective, grounded and open," and that focuses on the social and cultural environment (Holloway, 1996). Given that very little is known about second-order barriers, further research is recommended to understand them and the impact they have on the implementation process more completely. Qualitative research methods offer the potential for deep exploration of attitudes and other cultural factors affecting technology adoption among faculty members. Action research (Carson & Sumara, 1997) adds the opportunity to design research that will explicitly inform practice and policy. If the goal of technology-enhanced education is better learning, then serious consideration of the results of ongoing research in learning effectiveness is also integral to the planning process.

Technology Acceptance Model

Since the technology acceptance model (Davis, 1989) describes adoption of technology on the basis of perceptions of usefulness and ease of use, it begins to get at some of the attitudes and beliefs that encourage or deter individual adoption decisions. Research by Venkatesh (1998) in a non-educational environment indicated that the model explained about 40% of the variance in intention and usage of a general application software. Venkatesh concluded that although the model explained rational factors it did not account for irrational or social factors and influences. Subjective norms, political issues and cultural influences, which are critically important in universities, were not embedded in the technology acceptance model. Wolski and Jackson (1999) studied the technology acceptance model in a university environment and concluded that despite its ability to measure potentially pertinent beliefs in faculty acceptance of technology, the model failed to capture all of the relevant components. They concluded that individual technology adoption decisions are not strictly cognitively-based. Therefore this model, which interprets individual-level adoption patterns from the perspective of the theory of reasoned action, is not useful in the complex, multi-layered environment of higher education.

Technology to Performance Chain Model

Other research explored a model that was hypothesised to explain individual acceptance of technology in an academic context. The Technology to Performance Chain model (Goodhue, Littlefield, & Straub, 1997) posits that faculty members look for a fit between themselves, the task and the technology before deciding to use it. The model also recognises the influences of social norms, habit and facilitating conditions. In a qualitative validity test (Lending & Straub, 1997), fit proved to be the most important factor impacting on use, followed by facilitating conditions. Social norms were less important. The quantitative validity test (Goodhue et al., 1997) showed some high and significant correlations as hypothesised but did not support the entire model. This model is not relevant to meta-level study, but may prove interesting in a future study of second-order barriers or psychological factors influencing technology adoption by university instructors.

Diffusion Models

Many educational researchers have used diffusion theory (Rogers, 1995) as a basis for understanding how, why and when individuals decide to adopt technological innovations. At the individual level, this model labels people as innovators, early adopters, early majority, late majority and laggards. Aside from the judgmental tone of these labels, particularly the last one, this research tends to apply the underlying assumption of the theory, that innovation is inevitable and good for its own sake, to educational technology. This contributes to the evangelical enthusiasm that is regarded with suspicion by many thoughtful people. Diffusion and infusion models do not seem to encourage the study of individual decision making about appropriate uses of technology in teaching and learning. The innovation bias that results is a kind of theoretical blindness (Wilson, Dobrovolny, & Lowry, 1998), which weakens the potential of this model to explain individual adoption decisions. Diffusion models do have some value at the institutional level, however.

Institutional-level Models

Diffusion Models

Research (e.g., Anderson, Varnhagen, & Campbell, 1998; Geohegan, 1998) that explores adoption rates of learning and teaching technologies using diffusion theory (Rogers, 1995) offers a framework for understanding institutional-level integration. Jacobsen (1998), for example, has compared the profiles of faculty at different stages of adoption with a view to informing faculty development strategies. This helps to clarify that meta-level integration is a gradual process, not an event, and that different kinds of support services are necessary for faculty members at different places on the adoption curve. Rogers' (1995) distinction between centralised and decentralised diffusion adds to our understanding of the differences between Acadia University and Wake Forest University, and highlights issues that need to be addressed in university planning. For example, answers to the following questions (Rogers, 1995, p. 366) can guide planning efforts: (a) who will control decision making and power?, (b) will the diffusion be top-down, bottom-up or horizontal?, (c) what are the sources of innovation?, (d) who will decide which innovations to diffuse?, (e) is the approach innovation centred (technology-push) or problem centred (technology-pull)?, and (f) how much local adaptation will there be?

Facilitative Conditions

Without repeating the previous discussion, it is useful to explore further the potential of Ely's (1999) conditions that contribute to implementation. Ely also suggests other critical meta-level variables, including organisational climate, political complexity and demographic characteristics of the setting. As well he reiterates the importance of Rogers' (1995) contribution with respect to the attributes of the innovation: (a) relative advantage, (b) compatibility with organisational values, (c) complexity, (d) trialability, and (e) observability. Surry and Ely (1999) conclude that "there is no formula for this process .... There is no substitute for a 'front-end analysis' or needs assessment that yields the goals and objectives to be attained. Communication among all participants throughout the processes is essential" (pp.6-7).

Strategic Planning

Generally speaking, the planning and implementation models for institutional-level integration of technology target first-order barriers directly. In both models the activities proposed begin with a strategic planning exercise. Some planners have identified weaknesses (Kaufman, Thiagarajan, & MacGillis, 1997) in trying to apply strategic planning in universities. This difficulty may be partly due to cultural factors, notably use of language and hierarchical notions of power and I discuss this further in a later section. Other models (Hulser, 1998; Moran, 1998) collected by Oblinger and Rush (1998) also profess commitment to strategic planning concepts. Each plan is "unique to each institution and its culture" (p. xv). For example, Hulser (1998) insists that technology upgrades in the library be planned systematically and linked with the overall university mission. Moran's (1998) model for technology planning is based on a strategic alignment between institutional and information technology plans for integration and consistency. "A core philosophy of strategic alignment is that any component of a strategic plan must support the fundamental mission of the organisation, both in terms of the results that it will achieve and the values that it reflects" (p. 44). Acadia's global library plan was articulated as a strategic plan (Participant #6) as was Wake Forest's Plan for the Class of 2000. Paul (1990) lists the advantages of top-down strategic technology planning as (a) production and service efficiencies, (b) information access and (c) management and coordination improvements. Teaching and learning issues are not specified in his description of how education will be improved with technology.

Among educational administrators and organisational change consultants there is general agreement that planning for the integration of technologies should be part of an institution's strategic planning process. This means that change management activities should be informed by the organisation's mission, its vision of its place in society and the goals that have been accepted as appropriate and strategic by the stakeholders. Bates (2000b) identifies the main elements of most traditional strategic plans as mission, environmental scan, vision, objectives-goals, strategies, and monitoring. Daniel (1996) details different types of content and process strategies in his discussion of how to go about developing broad support for technology strategies. He strongly suggests that these strategies link appropriately with other corporate, business and operations strategies, and with the academic culture. Bates (2000b) and Brown (1999) consider the strategic technology plan as a component of the overall academic plan. Paul (1990) cautions that "Ultimately, unless the planning, priorities and management of information technologies mirror the organisation's central values and directions, they will hinder rather than facilitate the attainment of the institution's mission and goals" (p. 141). Whether technology planning is best done as a component of an institution's overall strategic planning process, of its academic planning activities or as a stand-alone parallel process aligned with the broad organisational mission may not matter in general terms. The critical success factors may be that technology-planning approaches should be situation-specific, strategic, culturally appropriate, and connected to or supportive of the organisation's mission.

The mission of an organisation is an inspiring if somewhat vague statement that describes its overall purpose. It is based on an understanding of historical practice, social context, current and anticipated needs and is articulated by a representative group of constituents. In educational organisations, the mission typically includes a general statement of theories of teaching and learning, a description of the populations targeted and an overview of the programs offered. Visioning is the process of establishing a common understanding among stakeholders so that it is possible to describe the mission, usually in as few words as possible. The visioning process is explained by theories of social constructionism (Gergen, 1994) which hold that social interdependence and relationships are the foundation of meaning, and that identities are constructed through narratives told through language. Visioning offers opportunities for participants to share mental models and to develop a common language about the organisation. If properly facilitated, the visioning process offers active engagement of the participants in multiple points of view about the organisation and allows the group to construct an institutional vision that draws on the multiple perspectives. Constructing the vision and mission of an organisation are extremely challenging activities and meetings often break down into unproductive debate where individuals who are members of different subcultures (described in Chapter I) talk past one another or disagree fundamentally. Written statements of the mission and vision do not always capture the meanings of group decisions in inclusive language that is neither too general nor too simplistic. There are techniques for assisting groups to understand each other's languages and learn to "dialogue" (Schein, 1993) effectively.

Because the mission specifies the strategic direction for the organisation, it should be reflected in all budgets, activities, procedures and policies. Educational technologies have the potential to affect all teaching and learning budgets, activities, procedures and policies. Whether these technologies are integrated across the institution should be decided with reference to the mission. How the integration occurs is determined by the implementation strategies.

Generic implementation strategies, with the tactics and tasks that support them are one phase of the strategic planning process. Generally the implementation steps detail the resources and skills necessary to conduct the activities, identify the persons or units responsible, and establish deadlines. Strategic planning often fails at this stage, especially if the general commitment to the mission and goals is not strong (Kaufman et al., 1997). Sometimes the implementation plans are left to individual units to design, and without common acceptance of the overall mission and key goals, unit plans do not integrate well with institutional-level plans or do not attract the resources they need to be put into place.

Conventional business-like strategic planning approaches may be inappropriate for organisations seeking to integrate educational technologies. Kaufman (1997) suggests that strategic planning is often misunderstood as tactical or operational planning and fails to connect to the organisational mission of adding value to society. Despite its theoretical commitment to inclusiveness and representativeness, strategic planning is often managed in bureaucratic ways that support the established hierarchy. Communication breakdowns can recur throughout the strategic planning process. They stem from the way the process is handled, which has more to do with organisational climate and culture.

A Discussion of the Impact of Culture

Cultural factors may lie behind the unwillingness of some faculty members to adopt innovative technologies.

Universities are knowledge-based communities that employ large numbers of intelligent, well-read and thoughtful people. As professionals they typify "smart people who find it difficult to learn" (Argyris, 1991). Organised in discipline-based groups, faculty members in particular have been enculturated into an individualistic community, where teaching and research have traditionally been solitary activities (Evans & Nation, 2000; Innis, 1947). According to Rothwell (2001), the core values of individualism include autonomy, self-actualisation, personal growth and competition. Technology-enhanced learning environments require new instructional strategies that support co-construction of knowledge. Teamwork in course development, project management and collaborative research demand new skills. The core values of collectivism are commitment and loyalty to the group, responsibility, conformity and cooperation. Transition from individualism to collectivism would involve a serious change in values and beliefs. Evans and Nation (2000) point out that academics are trained to think critically while they maintain their privacy and individual freedom. It is likely that faculty members are familiar with and influenced by such critical perspectives on media and technology as those of McLuhan (1962), Noble (1999), Postman (1996) and Menzies (1996). Graff (quoted in Schwoch, White & Reilly, 1992) suggests that the university culture is based on "programmed ideological dissent" (p.123). It is not surprising that faculty members reject anything that looks like technological determinism, quasi-religious fervour, exploitation or corporate control of content. One example of organisational behaviour that can feel like exploitation is when recognition and reward policies do not value work done towards improving teaching using technology, despite explicit institutional commitment in the form of goals and objectives for technology-enhanced teaching and learning. The conflict between climate and culture may become intolerable for some faculty members as it did in the early years of the Acadia Advantage program (Participant #3). This meta-level mismatch is analogous to the dissonance that emerges when individuals are faced with evidence that their espoused theories do not match their theories-in-use that Argyris (1985) has documented among business leaders faced with change.

Another way to look at resistance to technology adoption is from the broader context of organisational and social change. Senge (1994) suggests that from a systems perspective, resistance can be seen as the balancing feedback loop of a system attempting to maintain an implicit (possibly hidden) goal. This holistic view of the impact of organisational change on individuals suggests that personal mastery over tension and threat, and culturally determined perceptions underpin resistant behaviours. Too often change agents miss these important cues. Time and communication are needed to explore the resistance, with a view to building shared vision for change and shared mental models of the future. Senge's advice to leaders dealing with resistance is: (a) do not push; (b) check the source for evidence of perceived threat to the status quo, perceived irrelevance or fear of failure; and (c) model the preferred behaviour as a designer of learning and practice the desired skills of mentoring, coaching and facilitating. This suggests that resistant attitudes may also be based on the implicit undermining of faculty values such as student learning, whether through cultural exclusivity in the use of language, through the use of strategic planning approaches that are explicitly business-like, or through the introduction of any other change.

Not all faculty members are resistant to innovation. As in most general populations, there are early adopters (Rogers, 1995) and interactive (Banathy, 1991) individuals who react positively and creatively to change. But the historical social position of universities as creators (Frye, 1990), conservers and preservers of knowledge has contributed to an inherent conservatism in faculty cultures (Innis, 1947).

Importance of Language to Culture

One important way that organisational culture is represented, shared, transmitted and changed is through language. There are qualitative differences in the way that language is used within subcultures that can make communicating between them very difficult. Schein (1993) illustrates this fact with reference to executive- and management-level cultures for whom understanding is based on power. He concludes that: "We must take the impact of subcultures on language and mental models seriously, and we must take the subcultural differences between hierarchical strata seriously, especially the differences between the executive stratum and the rest of the organisation" (p.50). If Schein is correct, then the models for technology integration described above may need to be reconsidered from the perspectives of the technology adopters themselves. Technology implementers, whether faculty or those who support the teaching/learning mandate of the organisation such as technicians, instructional designers, student services staff or librarians, are much lower down on the traditional hierarchy than those who have proposed integration models. The perspectives of Daniel, Bates, Paquette, Laurillard and Brown may have little in common with those who actually manage the daily process of teaching and learning. This suggests that their understanding of how such key concepts as effectiveness, efficiency, accessibility, interactivity and evaluation apply in an educational technology context may be quite different.

In discussion with members of the Acadia University community at various levels of the hierarchy, I felt the different perspectives in subtle ways - in style and tone of conversation, degree of formality, use of language and range of topics covered - but there is nothing I can point to in the transcripts as evidence without identifying the participants. McMillan and Hyde (2000) reflected on the differences between the "eloquence" of the leadership and the various "voices of conscience" in their case study of Wake Forest University's cultural changes since 1996. They concluded that greater understanding of the "conscience formation process" may enhance understanding of "how change really happens."

Schein (1993) proposes a face-to-face technology called "dialogue" to help people learn to understand and appreciate the language used by members of other organisational subcultures. Dialogue is facilitated conversation designed to open up new and valid communication across subculture boundaries with the purpose of developing "an overarching common language and mental model" (p. 41). This is presumed to support more effective problem setting and solving and ultimately, through changes in individuals, to lead in the direction of organisational learning. Other organisational development consultants and researchers (e.g., Argyris, Putnam, & Smith, 1985; Schön, 1987), also focus on the importance of group communication through reflection-in-action and reflection-on-action and sharing mental models within communities of practice. These techniques presuppose a high level of motivation for collaboration, or an academic crisis situation that demands creative problem solving. They also require individuals to move beyond the "defensive routines" embedded in their subculture memberships and allow trust to develop.

Conventional strategic planning approaches have had the effect of alienating certain internal communities within higher education institutions. Strategic planning activities generally refer to "customers" and focus on profitability and productivity in measurable terms. The language of "customer" or "client" only partly describes the students in a university, and those who believe in students' responsibility for and active participation in their own learning find it especially difficult to accept. Strategic planning for performance improvement (Kaufman et al., 1997) emphasises other goals and measurable missions as well. Certain learning goals can be difficult to measure. Given the understandable cultural resistance of some faculty members to business language and of others to quantification of learning, it seems reasonable to propose a learning-focused educational systems design approach to planning for technology. The instructional design language focuses on learners and their needs. With its roots in systems theory and communication theory, educational systems design shares many processes and techniques with strategic planning, but it may be better adapted to planning in educational environments.

A New Model

So far in this dissertation I have explored current challenges of integrating educational technologies into universities. The complexity of the issues and the variation in individual implementation approaches evidenced by the case studies and the theoretical models suggest that careful preparation in advance is critical to success. It seems clear that barriers must be addressed strategically and in a manner appropriate to the particular context. Size of the university may be a critical factor in decision making. Stakeholder support of and active participation in the planning, design, implementation and evaluation processes are essential for effectiveness. I have focused almost exclusively on faculty members' and leaders' perspectives, with some minor references to students. This is the unfortunate reality of the research and the models, which generally overlook the perspectives of the non-academic middle- and lower-level managers and support staff, who do the work of running the institution. In this group are administrative professionals in a variety of occupations who do not necessarily contribute in a direct way to the process of teaching and learning. These accountants, maintenance and security personnel, information officers or purchasing managers may not always agree that the primary purpose of the university is the creation and re-creation of knowledge.

Having established the critical importance of understanding both the environmental forces for change and academic culture before planning for a pedagogy of technology, I now describe a process for designing it using a modified version of educational systems development (ESD) (Reigeluth, 1995). This may be a more successful approach to technology planning in organisations with teaching/learning mandates. Its participative perspective stresses the importance of shared understanding among the members of the various discipline- and function-based subcultures who are required to work together to accomplish institutional goals. In terms of the management of technological innovation in universities, Noblitt (1998) shows that there is a "deep mutual dependency" (p. 151) between top-down program advocates (administrators) and bottom-up project advocates (faculty members) for adoption. This dependency needs to be leveraged for comprehensive multi-perspective planning. Administrators and faculty members belong to different subcultures in the academy, and thus have different beliefs, values and priorities. I believe that the model I propose supports dialogue among all constituents because it focuses on learning as the core business of the university. Even administrators working in units as diverse as accounting or physical plant can relate to this vision of the post-secondary organisation.

ESD offers a simple but comprehensive and multi-dimensional structure for representing the different types of factors affecting integration and their origins. It helps visualise the interactions between and among factors. I assume that universities engaged in technology planning have moved beyond the simple introduction of computers into academic life. The literature review confirmed that the large majority of university faculty have acquired basic skills and are using computers for a variety of personal productivity purposes (e.g., Black, 1998; Gibson & Nocente, 1998; Jacobsen, 1998). Other research (e.g., Acadia University, 2002c; Patrick, 2001; Tapscott, 1999) indicates that students have developed a high degree of comfort with computers. A framework is necessary that facilitates going beyond first-level individual adoption patterns to an understanding of the competing and complementary influences involved in broad organisational-level thinking. An ESD approach suggests systemic strategies for addressing influences by indicating what types of approaches could facilitate adaptive changes in the environment.

While strategic planning is broadly focused on the position of an organisation in society, my conception of educational systems design is concerned with the learning environment represented by and operationalised in the organisation and how it meets the expectations of society. Table 21 attempts to illustrate the similarities between the phases of educational systems design and the steps of strategic and mega-level planning (Kaufman, 1988).

Table 21

Similarities Between Educational Systems Design snd Strategic Planning

Educational Systems Design	Strategic Planning	Mega-level Planning
	Planning	
Societal context Visioning and core values Educational mission	Environmental scan Visioning and core values Business mission	Mission analysis
	Design	
Learning goals-objectives Design - instructional strategies, resources, media	Goals-objectives Implementation -strategies	Function analysis
	Implementation	
Development - instructional materials, resources, media Delivery/offering	Implementation - tactics	Methods-means analysis
	Evaluation	
Formative Evaluation Summative evaluation Program evaluation Communication/dissemination	Monitoring Reporting	

Note. The steps at each stage of three types of planning processes are identified within the four phases of an ESD conceptual framework (planning, design, implementation and evaluation).

But a table is not able to represent the overlaps among phases. The model needs to be visualised as three-dimensional spheres of activity rather than as clear-cut linear steps.

Besides the use of language focused on learning, the strengths of a model based on instructional design are: (a) its prioritisation of the educational mission through its emphasis on learning, (b) the details of the design and development stages, (c) the evaluation and communication processes, and (d) its formative approach to ongoing improvement. It is at the points in the planning process where discussions turn to the use of educational technologies that the advantages of this approach become evident. Consideration of how best to combine media and other instructional resources to facilitate learning forces designers to rethink the stated learning goals and objectives in terms of learner characteristics such as prior knowledge, location, access to the Internet and computer literacy. Both faculty members' and students' requirements need to be considered along with content and administrative issues. The choice of technologies also depends on the organisation's mission with respect to providing access to educational opportunities for geographically dispersed populations, for example. The risk of failure in implementation is reduced in relation to the level of detail undertaken in the design and development phases. Instructional design is also specific about producing instruments for and conducting formative and summative evaluations. The above discussion should hold true whether the educational design is being applied at the course, program or institution level.

Educational systems design has the cultural advantage of not using explicit business language. Its weakness, however, is that educational design as I have described it so far does not deal explicitly with budget issues. This very important component of technology planning needs to be integrated into the planning process using strategic actions. The key strength of the ESD approach, however, is that it offers a methodology for a university to answer the two questions that underlie resistance: (a) why do we need technologies for teaching and learning?, and (b) what choices do we have for technologies that answer our needs?

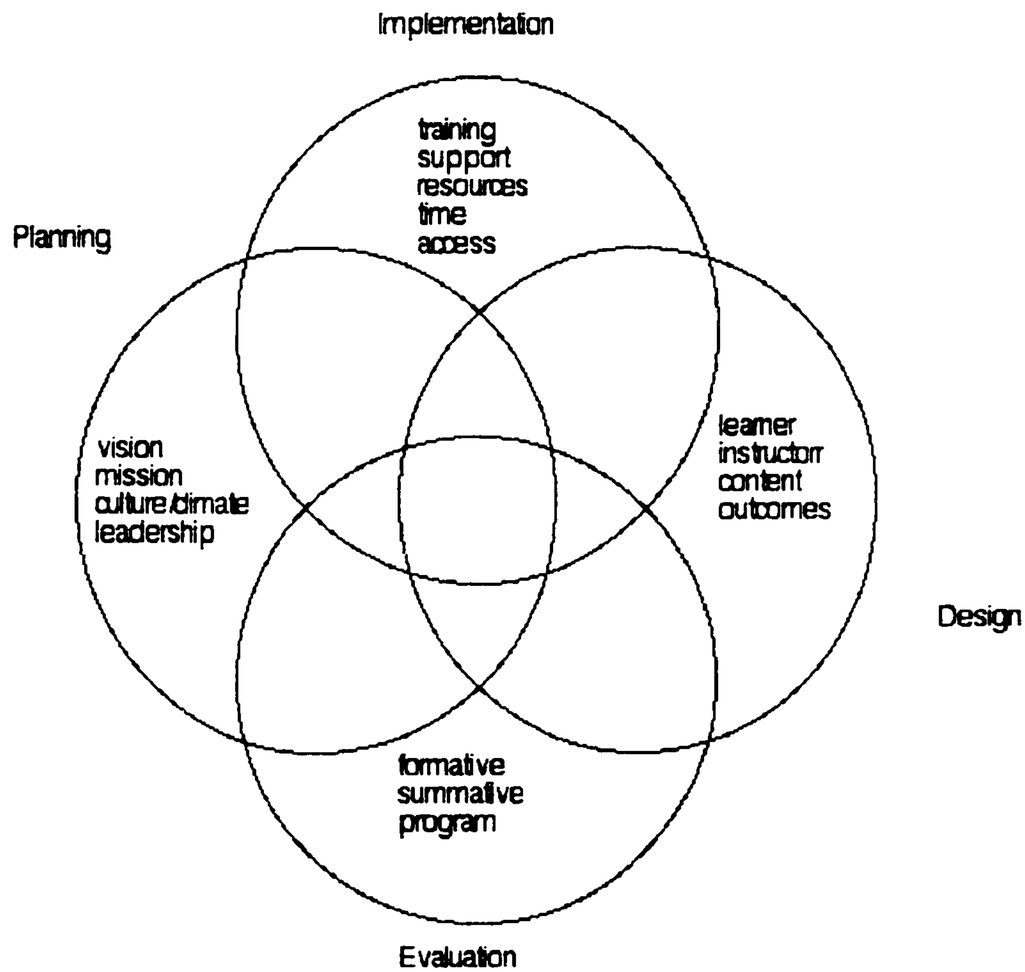

Figure 3. A two-dimensional perspective of a three-dimensional model of educational systems design for technology integration in universities. Key processes in each phase are indicated within the spheres.

The elements of this ESD-type model are those to which I have been referring throughout this thesis: planning, design, implementation and evaluation. As portrayed in Figure 3, I understand the elements to be overlapping spheres of activity to allow for mutual understanding, exchange of information and feedback among participants in the process. The four phases are mutually supportive and though I describe the process as beginning with planning, it should be possible to apply the model at any phase. Research is a key component of the entire process. As well, though I propose the model as a solution to meta-level challenges it is conceivable that it could be applied at the macro level, and I make some suggestions as to how that could be accomplished. Bates' advice that technology-based change is best coordinated at the departmental level and Laurillard's application of the Conversational model at multiple levels make sense in a university context. It is at the disciplinary macro-level where professional and personal affiliations and identity are often the strongest.

Planning

Planning for technology integration into teaching and learning refers to those activities typically associated with context setting and strategic planning described earlier. A university mission for technology enhancement is articulated following environmental scanning and a visioning process that involves representatives of all stakeholders. Participants would likely include faculty members from the early adopter, early majority and late majority groups, representing a broad cross-section of disciplines, subcultures and attitudes. As well, students and graduates, computer specialists, pedagogical experts, program administrators and union representatives should be involved. Individuals who belong to more than one subculture should be particularly welcomed into the process in an effort to economise on people's time without overlooking any critical perspectives. There will likely be a mix of volunteers and appointees participating actively. Choosing an effective leader for this group will be a challenge, depending partly on university culture and partly on the personal qualities of the candidates. The leader, or champion, needs the power of direct access to the highest levels of decision making and budget authority, as well as interest in and comfort with the use of technology in teaching. She or he also requires the respect of both faculty members and administrators. A key factor is commitment to the institution and continuous service throughout the integration process.

Once the mission is accepted, it should be communicated to the entire university community as a high priority, including to those not expected to be directly involved in the integration process. This exercise serves the purpose of sharing the broader social mission while keeping the process open. By inviting feedback, it sets the standard for transparent decision making as well. At this point it should be clear to all why the university intends to integrate technology. Decisions about which technologies are needed for what purposes come next.

Front-end analysis may include needs assessments of human and physical resources including the skills of students and faculty and the potential capabilities of facilities (e.g. robustness of the backbone, available bandwidth, and number and location of Internet connections). In the case of new program initiatives, market analysis should be undertaken. Benchmarking of current technology use within the institution and exploratory activities at other sites might be needed to determine what technologies are appropriate to the identified needs. The most pressing requirements would likely be in hardware, software, connectivity, finances and skills, depending on the nature of the specific objectives targeted. By this point the planning group, which should include some, but not necessarily all, of the visioning group, should know what technologies exist that meet the needs of the university. A key question is whether the implementation involves a meta approach, involving the entire community in a comprehensive strategy, such as the choice of a broadly integrated course management system, connected to student records systems, that would be available to all disciplines. An alternative macro approach might involve a specific technology that would be used only in selected departments or faculties.

At this stage, individuals or units would be delegated responsibility for the specific goals of the plan, or they might take responsibility on themselves, depending on the culture of the university. Budgets should be established now, based on the costs identified in the research. This will also bring new participants into the educational design activity. When it comes time for the evaluation, it helps to have had financial specialists involved in the planning.

Normally, timelines would be established by consensus in relation to externally imposed targets and available financial resources. A participative planning process that moves into the design phase might involve one or several internal change agents or project leaders, usually reporting to the institutional leader, depending on the culture of the university, the nature of the projects and the particular mix of leadership skills.

Design

The design phase of technology planning involves the identification of learners' and instructors' prior knowledge, the specification of the subject areas, the learning outcomes to be assessed and the evaluation instruments. This may happen at several levels concurrently or in succession as meta-level objectives are established, then macro- and eventually micro-level objectives. How this phase is applied is completely dependent upon the content to be learned, the broader university goals, the nature of technology initiatives, the delegation (or assumption) of responsibilities and the institutional culture. Instructional strategies and appropriate resources are identified as well at this stage. Research may be needed to identify successful practices in other environments with the potential to be adapted locally. Timelines might need to be adjusted. Expenditures will need to be approved for release time for participants in the process, research costs, and acquisition of specific applications. At this point, the answers to the two key questions (why technology? and which technology?) should be clear. Participants are organised in cross-functional teams that focus on the translation or adaptation of meta-level goals into macro-level objectives. This phase is an ideal opportunity to focus on learning and teaching processes and how they interact, and to design activities to improve the relationships as well as the outcomes. As the development work may be carried out within or across faculties and departments, it is also an occasion to share the details of specific technology initiatives with stakeholders who are not involved in current projects. This further communicates openness and invites feedback. The micro-level parallel to this process is instructional design, usually applied to one course at a time.

Implementation

Implementation is the process of acting on the plans and design to carry out the project. According to Kaufman (1997) this is the stage where strategic planning often breaks down in universities. Based on the resources and accountabilities identified in earlier phases the work is undertaken to meet the objectives. At the micro-level this means the teaching and learning strategies are enacted and the course is "delivered." At the macro- and meta-levels, however, this may mean installing new equipment or cabling, renovating space, training faculty, staff and students in new applications, or experimenting with additional instructional strategies using the new technology. If the activity is a course or curriculum redesign, this phase implies development time. In development situations it may become necessary to adjust timelines again, as well as other estimates for resources and funds. This is the time when project management and communication skills are in high demand. Experience in universities suggests that unless the priorities are clear and reinforced regularly, tasks in the implementation process can be set aside in favour of more pressing, less challenging or more highly rewarded responsibilities, such as in class teaching and research. The project leader or leaders will need to be aware of glitches in the process, since plans do not always work out as expected and follow through on plans cannot be guaranteed. Leaders will need to resolve conflicts and solve problems efficiently. High levels of frustration can be expected in new implementations, no matter how detailed the planning. There will be unanticipated consequences, both positive and negative, which deserve to be carefully documented for two reasons. Case studies of successful and unsuccessful practices in technology implementation are in demand at all levels of education, but also in training and other environments. There are currently numerous opportunities to share this kind of research at conferences and in publications. Evaluation activities need the data from the implementation phase to determine strengths and weaknesses of technology projects, and to prescribe areas for improvement. In order to maintain enthusiasm throughout the community for new approaches and to support future risk taking, it will be critical to identify the sources of failures and address weaknesses or inefficiencies in the system in a timely manner.

Evaluation

Ideally the feedback loops between and among phases (represented in the diagram by the multiple overlapping circles) allow for ongoing assessment of progress toward goals and adjustment of plans or actions as necessary. Project management skills will help support regular assessments. But a comprehensive evaluation phase will involve reporting schedules and expectations for formal formative and summative assessments, whether at the course, program, department, faculty or organisational level, based on goals and objectives accepted earlier. The data collection and reporting activities should have been formulated in the design phase, but they will not be limited to learning outcomes. Financial audits will also be expected, particularly when the technology implementation was financed by external sources such as grants or fundraising activities. Communication plans will also be necessary. Evaluation results should be shared with stakeholders regularly to inform ongoing activities and to improve the process as well as future planning initiatives. Sharing successful initiatives in technology-enhanced teaching and learning seems to contribute to faculty motivation (Participant #5; Brown, 1999).

How Does This Model Address the Factors Affecting Technology Integration?

The educational design model assumes that basic hardware and software access issues have been addressed. The literature and experience suggest that universities are now well supplied with computers for personal productivity and that computer-enhanced teaching and learning spaces are being continually upgraded on many campuses. Government policy (Advisory Committee for Online Learning, 2001) assures that all universities in Canada are connected to the Internet. The other first-order factors such as policy changes related to time and reward for teaching with technology, the provision of adequate human and financial resources, and training opportunities are dependent on the cultural and pedagogical factors described as second-order in this chapter. Once meta-level goals have been set and activities have been assessed, further technological developments at the macro and micro levels should be determined using this model, which focuses on making decisions about technology based on priorities for learning. The model is not technology-driven. It has the potential to build relationships across the university and ultimately to change attitudes that block appropriate innovation through open communication about teaching/learning priorities using dialogic processes for accommodating and understanding the needs of other stakeholders.

The values embedded in the model are those of designing instruction to meet specified learning needs. This means the model is responsive to environmental opportunities but faithful to a university's mission. It provides an alternative to universities of any size and orientation in any location. A long-term approach to change respects tradition, is sensitive to culture and context, and permits phasing in new technology-based activities as resources allow and needs demand. The result is a multi-perspective, participative approach to designing and implementing comprehensive or specific technology integration in universities. Informed by learning and instructional theory and educational practice, this model provides a framework for analysis and action based on a collaborative process that neither ignores nor exploits what Burge (2002) calls the "multi-chotomies of the university." The process described by the model is open and manageable by all constituents. It is not secretive or exclusionary. It provides for thoughtful, considered change in keeping with educational mandates.

These are values that underpin the historic position of the university as a centre of knowledge creation and re-creation. They support the understanding that seems to be lacking when government or business press on universities to adopt technology without first evaluating its applicability or usefulness. A higher education system built on learner-centred values is more likely to address the other factors affecting technology integration that were identified in the literature review: time, reward, training, pedagogical practices, assessment of learning effectiveness and climate. Ongoing evaluation of how well universities are meeting society's changing needs is likely to be well received among external constituents as well.

The value of the ESD model is that it offers an alternative to conventional strategic planning approaches or theoretical models for technology integration in universities. As it was designed to specifically address the factors affecting technology integration, it contributes by building on the knowledge about the process accumulated through experience and reported in the literature. Table 22 summarises how the ESD model accounts for each of the identified factors. This includes the political pressures discussed in the first chapter, which do not appear explicitly in the literature. The strategies listed come directly from the synthesis of the lessons learned as described in the research reviewed and in the case studies. Most have already been discussed in earlier sections of the dissertation, but there are a few that need elaboration.

The first is action on reward and recognition for technological innovation in teaching. Laurillard's (2002) notion of the teacher-scholar lays the groundwork for the important cultural changes that are necessary to effectively support improved instructional practice. Acadia's Participant #3 emphasised that it does not matter if technology-friendly policies for tenure and promotion are in place if departments and faculties continue to reward according to traditional standards. Along with training, this factor crosses the boundary between first- and second-order factors and cannot be completely entrenched until cultural change supports it. Wake Forest's Participant #8 reported that "There has been an immense change in how 'effective teaching' and 'quality research' are being interpreted! Instead of attempting to bring technologically enhanced teaching to parity with 'effective teaching,' we have taken the far better course of emphasizing that effective teaching typically includes technological enhancements."

Another issue that has caused difficulty in ubiquitous computing environments is not providing equipment to everyone concerned (Participant #2). It is important that non-academic staff who support computer-based teaching and learning enhancements be provided with equivalent hardware and software to the academics with whom they work. In some universities, it is administrative staff who are better equipped. Whatever the case in a particular context, it is important to give attention to achieving an appropriate balance with practical equivalence so that collaboration is facilitated.

At a time when external pressures including the "technological imperative" (Bates, 2000b, p. 18) are forcing major change on post-secondary educational practice, it is important to be aware of the implications of technology adoption on the entire community. The research on technology implementation reminds us that there are multiple factors affecting institution-wide integration that should be considered in the development of policy and in the management of the change process. No single plan fits all universities.

Table 22

How the ESD Model Addresses the Factors

Factors	Actions
	External / Extrinsic / First-order Factors
Time	Establish timelines and adjust as necessary, based on evidence from ongoing assessment - provide learning, reflection, development, research and dissemination time for faculty - make time for evaluation and communication - expect incremental not transformational change
Support	Build, staff and maintain human and technical resource infrastructures as appropriate to the second-order and contextual factors as well as for technical support
Funding	Use research to identify costs - set budgets - fundraise if necessary - audit during evaluation to determine cost-effectiveness - make sure priorities lead to realistic budgets
Rewards	Change policies to reflect teaching with technology priorities set in mission - support policies with cultural change - recognise success stories publicly - scholarship of teaching approach
Access	Provide budget, expertise and infrastructure to meet priorities set in mission - consider potential for and impact of excluding certain groups - monitor level of access needed
Equipment	Standardise on platforms and models selected by stakeholders to meet their needs - ensure universal distribution to all employees - establish policy on student requirements
Training	Provide technical, software and pedagogical training in a variety of formats in response to expressed needs and preferences, including modelling and using student assistants
	Internal / Intrinsic / Second-order Factors
Culture	Establish beliefs and values in planning phase - engage multiple perspectives
Climate	Ensure practices support the mission - assess attitudes regularly - identify inconsistencies - use formal and informal leadership to model desired behaviours - reward appropriate practice
Pedagogy	Use training strategies and faculty development to extend range of pedagogical approaches and knowledge about appropriateness - demonstrate effectiveness - try instructional skills training
Evidence	Audit during evaluation to determine learning effectiveness - share results of successes and other lessons learned
Psychology	Be realistic - do not expect immediate or complete change in practice or beliefs - encourage risk taking and experimentation, but not at the expense of learning or budgets

Factors	Actions
	Contextual Factors
Strategic planning	Use the techniques but not the language - stay focused on teaching and learning needs and aspirations
Leadership	Guarantee power and authority - individual leaders for individual projects, possibly reporting to a university-wide champion
Participation	Ensure representative involvement of stakeholders - ongoing communication
Economic arguments	Involve those who understand and can articulate their importance - use dialogue
Political arguments	Involve those who understand and can articulate their importance - use dialogue
Ethics	Attend to unanticipated consequences and overall mission through evaluation

Note. The table lists specific actions within the ESD model that will help to address the particular factors indicated. These strategies emerged as recommendations in the research and case studies.

Appropriate integration policy must take account of the particular conditions of each institution and must interface with the current system. Real technological and cultural change depends on the development and adoption of strategies to alleviate the intrinsic, second-order barriers. Regular formative and summative evaluations of courses, programs and infrastructure are required to ensure that initiatives are meeting expectations. Ongoing communication of successes is important, as is sharing information about identified areas for improvement.

A study of university culture shows that integrating technologies into teaching and learning activities can be threatening. The process threatens traditional power relationships, budget priorities, human resources policies, and traditional theories and practice of teaching and learning. More specifically, technology threatens people. Technology opens up the private practice of pedagogy, forcing faculty members to work in groups with other specialists. The members of various subcultures are likely to have difficulty communicating with one another. Technology confronts established beliefs and values and is paralysed by bureaucratic, protectionist and competitive attitudes. For many people, technology has come to symbolise all that is bad about change.

Summary

I have shown that conventional strategic planning approaches to building an organisational culture and climate for technology are inadequate. Strategic planning by itself cannot resolve the problems caused by such intense and multi-faceted pressure for change in teaching and learning practice. Every educational organisation is faced with identifying its role in society and clarifying its position on technology with respect to its mission and goals. Visioning, the process for arriving at shared perspectives among members of the organisation, depends on open and valid communication among the subcultures of an organisational culture.

Once the mission and goals are established, technology advocates typically face resistance at many levels of the organisation. First-order barriers have been well-documented in the literature and research seems to suggest that organisational planning efforts can address them effectively providing the mission is clearly articulated and is supported by the core values and beliefs of employees, and by the budget. Second-order barriers are not yet well understood, and further research is recommended in the teaching subculture. Contextual factors are less reported in the research, but a clear understanding of how they support or impede change is critical. They need to be identified and addressed directly through the technology integration process.

It is important for universities to recognise that resistance to change is a normal human reaction to perceived threat. They are responsible for addressing resistance in advance by providing mechanisms for dialogue and other techniques to improve communication between subcultures. By supporting the development of concrete skills of assumption-checking, self-expression and listening (Schein, 1993), the broader community opens itself to interchanges that have the potential to break down the "we-they" behaviours of members of subcultures in favour of shared mental models and collaboration. Working together on educational advancement helps stakeholders learn about the priorities of others in the university. In conclusion, I offer an educational design framework as a learning-centred alternative approach to planning for the integration of technology. I suggest that using the language of learning is a more appropriate, and possibly more effective, way to talk about educational technologies than the language of business.

I would argue that the integration of information and communication technologies into teaching and learning activities is one type of organisational challenge that could profit from communications strategies such as dialogue and reflection. If Bates (2000b) is correct and the postindustrial university needs to transform its culture and operations completely to meet the demands of the future, everything needs to change, beginning with the hierarchical communications channels in the traditional organisation. If organisational learning consultants (Senge, 1994) are right, organisational culture cannot change unless those who belong to it do so. Educational design, applied systemically from within the context, and with a focus on making the learning process effective at all levels, offers one way of involving the subcultures in a community of pedagogically-appropriate technological practice. Suitable choices of technologies for learning will ensure that efficiency is not measured solely in cost terms but also in cognitive terms

(Cobb, 1997). The choices would then be subject to formative and summative evaluation, with a view to enhancing the learning environment through information sharing.

If the integration of technology is a crisis to be resolved, educational design procedures offer alternative means for defining and analysing the nature of the problem, for identifying the possible solutions and for selecting from among them. The process, which is participative, assists in developing the details and the solutions, implementing them, evaluating them and rethinking the problems for ongoing improvements.

Chapter IV - EVALUATION

The purpose of this thesis was to identify and describe the factors affecting institution-wide technology integration efforts with a view to informing action and ultimately more effective policy. The investigation was conducted using a variety of sources, beginning with an analysis and synthesis of recent research on technology-enhanced teaching and learning undertaken in universities. Three types of university models were explored, using two case studies to learn about one model more in depth. The models were then analysed with respect to their ability to address the factors that emerged in the research. A new model for designing and integrating technologies for teaching and learning emerged from the analysis and synthesis of research literature and models.

Evaluation assesses how well objectives have been met and suggests improvements or remediation, both to products and process. If the evaluation process is to be useful and valid, it should be framed by criteria set in the planning and design phases of a project, which is when the goals, objectives and assessments are identified.

In an age where economic, political and social arguments for technology integration are accompanied by intense pressures for accountability, evaluation is a critically important process. Performance indicators for universities are imposed from the outside through market forces, government funding, research support, reputation and financial audits. These need to be balanced by internally framed assessments of learning effectiveness, student and faculty performance, management perspectives and equipment reliability. This chapter evaluates aspects of the dissertation as follows.

The first section reports on an evaluation of the proposed model for technology integration. The following section evaluates the entire research project by examining the components of the study, including the literature review, model analysis and integration activities. The evaluation explores the dissertation's limitations as well as its potential contribution to knowledge and practice. Implications for action toward policy development in postsecondary technology integration are highlighted at the end.

Model Evaluation

In order to examine the potential usefulness of the educational systems design model for technology integration I compared it with the technology plans available on the websites of three Canadian universities, selected to provide a geographic cross-section and a representation of sizes of higher education institutions. The University of British Columbia (University of British Columbia, 2002), located in Western Canada, enrols more than 40,000 students annually, including full and part-time students, undergraduates, graduates and post-graduates, who learn on campus or by distance. Brock University (Brock University, 2002), located in Southern Ontario, registers approximately 11,000 students each year, mostly on campus. In the last academic year (2000-2001) l'Université de Moncton (Université de Moncton, 2002) attracted more than 6,000 students to its three campuses in New Brunswick.

The web search was extensive and time consuming. Internet search engines such as www.google.ca returned American examples of university strategic or technology plans, or Canadian courses on strategic planning or technology. After several attempts using a general search strategy I decided to go directly to individual Canadian university websites. The selective strategy was more successful as I could choose potential sites based on my knowledge of their language, size and location. Not all university websites include reference to institutional-level planning. Some that do bury this information very deeply, on Presidential or Vice Presidential home pages, for example. Few are as detailed or open about their technology plans as Acadia and Wake Forest Universities. Most sites I found that did have information about meta-level priorities on any subject either restricted it to a promotional presentation or had allowed it to become dated. The three universities I chose to profile represent the best combination I could find. I do not suggest that other universities do not have technology plans, only that they were not publicly accessible. This is an age of electronic communication. University websites have the potential to attract the attention of potential students, to serve as a portal, and to keep other constituents informed about their contribution to society. It is tempting to infer that a university whose technology plans are made public through its website has at least reached a certain level of comfort with technological tools and a commitment to using them.

None of the technology plans were detailed enough to compare favourably with all phases of the educational systems design model. All of them included evidence of attention to some of the components, however. Table 23 illustrates the comparison.

Moncton's website had recently been updated while those of both UBC and Brock had not. I suspect therefore that the latter two websites may not accurately reflect current activities related to technology planning on those campuses.

Table 23

A Comparison of University Technology Plans with the ESD Model

ESD Phase	UBC	Brock	Moncton
Planning			
- context	√	√	
- vision, mission	√	√	√
- goals	√	√	√
Design			
- learning objectives			√
- outcomes	√	√	√
- resources, media		√	√
Implementation			
- resources, media		√	√
- training, support			√
- time	√	√	
- accountability	√	√	√
Evaluation			
- formative			
- summative			
- program	√		
- communication	√	√	

Note. Check marks indicate that the university websites show evidence of addressing the aspects of ESD phases listed.

University of British Columbia

In September 1996, UBC posted a vision statement for distributed learning, using the following 1995 definition from the Institute for Academic Technology at the University of North Carolina.

> A distributed learning environment is a learner-centred approach to education, which integrates a number of technologies to enable opportunities for activities and interaction in both asynchronous and real-time modes. The model is based on blending a choice of appropriate technologies with aspects of campus-based delivery,

> open learning systems and distance education. The approach gives instructors flexibility to customize learning environments to meet the needs of diverse student populations, while providing both high quality and cost-effective learning.

The vision statement describes a scenario that illustrates an anticipated "perceptible shift in UBC's educational philosophy" over a 10-year period to 2006. This document invited responses from the university community to be sent to the Director of Information Technology and Instructional Support in the Faculty of Arts, or the Director of Distance Education and Technology in Continuing Studies, both members of the steering committee of the Centre for Educational Technology (CET). Other details about the CET describe its purpose, governing structure, subcommittees and funding projects, and list the electronic educational technology objectives established in May 1996. The four main objectives included various strategies to (a) support the teaching effort of the university, (b) develop access policies concordant with a distributed learning environment, (c) place a greater emphasis on a learner-centred approach to teaching, and (d) assess the impact of educational technology and make recommendations for policy.

Another part of UBC's website describes the University's overall strategic plan, "Trek 2000." Within the plan there are principles, goals and strategies for learning that clearly endorse the objectives listed above. Specific strategies include: (a) students will be exposed to interactive learning, facilitated two-way dialogue and "hands on" experience enhanced by new teaching methodologies; (b) full integration of information technology with instruction in all areas appropriately supported by the Library and the CET, with a vision for a "global campus;" and (c) expansion of distance learning initiatives through continuing education opportunities that draw on all aspects of multimedia and alternative scheduling. The most recent strategic plan activity report indicates that targets were met as follows. By the summer of 2000, an academic IT plan and an overall distance education strategy were developed, the classroom management plan was revised, and very high speed connections were delivered to teaching hospitals. By the spring of 2001 new programs were developed for non-traditional students and a "weekend college" was piloted. As well 2,500 new or upgraded network ports were added on campus, complemented by a further 15% of classroom and lab upgrades completed in the fall. Enhanced web involvement in distance education and continued classroom and equipment upgrades are identified as ongoing.

The text of the President's address to the Board of Governors in 2001 is further evidence that UBC is actively and strategically addressing the challenges of the next century, including the influence of technological innovation. She identified the trends in education that were most critical, including the impact of information technology, changes in pedagogy and demographics, and competition. It is clear from the website that UBC has taken steps in recent years to develop a strategic technology plan linked with its institutional strategic plan. There is evidence of a dedicated effort to planning activities, including environmental scanning and delegation of responsibilities, and a commitment to evaluating the impact of technology integration. The level of participation by stakeholders is not clear. There is an indication that communicating the results of the institutional strategic plan is a priority. But there is not enough information about either the Academic IT plan or the Distance Education strategy to know whether or not design and implementation activities have been adequately articulated at the course or program level. Nor are there details about how evaluations would be carried out.

Brock University

In 1997 Brock University established a President's Task Force on Planning and Priorities that identified values related to innovative programming. This activity subsequently led to the creation of an ad-hoc committee in 1998 on emerging IT issues, and eventually to the Vice President's Task Force on Information Technology (TFIT) in 1999. The purpose of the TFIT was to contribute to strategic planning efforts by exploring the potentials, assessing needs, establishing standards, and recommending priorities, policy and strategies for research, professional development and instructional uses of information technology. The composition of the TFIT was representative of the faculties and involved people with an interest or expertise in information technology. Though it sought student participation there is no evidence that representatives were found.

The TFIT mandate was to help Brock "strategically and wisely" address the three environmental challenges of globalisation, demographics and competition through effective integration of information technology. This was understood to involve institutional reorganisation, budget reallocation and enhanced professional development. At the time Brock was "in the enviable position of planning for what tools" it would develop, and it is clear that the Task Force members took the time to research the context as well as the experiences of other universities that were further ahead in this planning process. They confirmed that few higher education "institutions have a clearly articulated policy or plan for how IT will evolve in the coming decade." To avoid the problems experienced in universities where unilateral top-down imposition of instructional technology led to faculty negative reaction (likely a reference to the collective action at Acadia and York Universities), the Task Force proposed informed and open dialogue of the issues among all interested parties on campus.

In 1999 the TFIT identified several issues of concern to be addressed before proceeding, including the pace of technological advancement, inadequate space on campus, technical problems, resistance to change, negative attitudes, pedagogical assumptions, faculty working conditions, political impact, copyright issues and budget implications. These institutional and cultural barriers were likely a factor in slowing down the process of change.

In March 1999, after extensive study, the university acquired a user licence for WebCT. The background arguments and recommendations for a web-based campus-wide computing infrastructure including a communication system, and hardware and software guidelines were posted to the website. The document described the key enabling features of the Internet and the WWW: low relative cost, vendor independence, assumed web literacy of students, and seamless adaptability. An Interim Status Report was delivered to the President in July 1999. This report includes information about a proposed training program for faculty and a residence technical support program, both involving students. It also includes a discussion of standards, funding, faculty development, intellectual property and on-campus activities coordinated by the TFIT. Specific recommendations were expected in the fall of 1999, however there has been no new information posted to the website since January 2000. A note on the TFIT home page indicates that the Task Force is a "work in progress. The committee is still actively preparing a document that will receive broad distribution in the University. Where approvals are required those will be sought through appropriate channels." I infer from this that there have been difficulties with the process of change advocated in other documents on the website. I can speculate that the Task Force is struggling with conflicting priorities, a lack of implementation support and possibly inadequate institutional commitment.

Université de Moncton

The Université de Moncton has a unique mandate in Canada as the only comprehensive French university outside Quebec. Its mission extends beyond supporting the culture and aspirations of Acadians to making higher education available in French to students from New Brunswick, the Atlantic region, all of Canada and the rest of the Francophone world. Answering the needs of these widely distributed communities requires strategic use of information and communication technologies. There is no information on the website about the planning processes that arrived at these institutional goals but the most recent Annual Report indicates that the university has taken steps to provide human resources and an infrastructure in support of high level technology on each of its three campuses. Strong user demand contributes to ever-increasing improvements, paid for in large measure by outside donations.

Moncton's commitment to distance education dates to 1984. The program has offered courses using a variety of technologies, including audiographics, audio and video conferencing. Established in 1999, a learning technologies team now provides support for needs analysis, development, delivery and ongoing improvement of Internet-based courses. Team members have expertise in instructional design, graphic design, digital photography and videography, animation, technical support and service, project management and training. As well, they administer an in-house integrated course management system, TheoriX, with multimedia, presentation, communication and assessment capabilities. More than 280 online courses were available in 2000. A portal allows the university to offer a virtual campus learning environment to the entire university community.

Moncton's technology services fulfil most of the design and implementation components of the ESD model. Planning and evaluation activities are not described on the website, but as a small university with a specialised target market, it is likely that some attention was focused on them.

Summary of the Model Evaluation

There is evidence that all three universities have spent enormous amounts of time working out the details of their technology plans. From the information published on their websites, it would not be accurate to conclude that any of them have completed all the phases of the educational systems design approach: planning, design, implementation and evaluation. Implementation and evaluation details are missing from all three websites, which is surprising given their potential to act as communication channels for participants in the integration process. This is analogous to the successful instructional practice of modelling that emerged from the literature review: use the technology to teach the technology (Ives & De Simone, 2002). In the case of a technology planning process it would make sense to use the technology to share implementation details and evaluation results. It would not be surprising if the lack of details is evidence of a breakdown in the process, given the findings of the literature review and an understanding of the magnitude of the challenges involved (Cleveland-Innes, Emes, & Ellard, 2001; Cookson, 2000).

Earlier I identified the two questions that are central to any technology planning effort as (a) why is technology important to us? and (b) what technology will answer our expressed needs? All three universities have clearly articulated answers to these questions.

Conclusions and Recommendations

Information and communication technologies are changing the way educational institutions are organised to carry out their missions. Coping with computer-based and networked alternatives to traditional teaching and learning processes is a major challenge. Like their colleagues in the private sector, university leaders are asking: "how can we leverage these new technologies to grow our business?" and "how can we optimise our adaptation of these technologies to improve what we do and how we do it?" A generation of change management consultants and organisational development specialists has offered frameworks for addressing these and other questions (e.g. management by objectives, organisational learning, strategic planning, total quality management, leadership development, performance improvement, team-based work processes, etc.). Universities have tried to apply some of these concepts to planning for integrating technology into their teaching/learning environments, with varying degrees of success.

A broad analysis of the literature suggests that critical success factors are organisation-dependent, related to variables such as organisational mission, goals, culture and practices, all of which depend on people. Research and practice imply that in order to ensure educational technologies make a positive contribution to learning and teaching in organisations, they should be integrated in principled ways with ongoing activities and future opportunities. This means that the organisation's mission should drive the integration process rather than letting technology drive decision making. It also means that planning should be system-wide rather than allowed to develop on an ad hoc or project by project basis. The responsibility for the success or failure of integration efforts rests with individual practitioners organised in groups. As individuals adopt educational technologies in their own practice, they will learn about what works in their context. As they learn they will change and share their new knowledge with colleagues. Over time, change in many members of an organisation may lead to transformation of the organisational culture. The organisational learning that results may provide a firm foundation for the management of future change (Argyris & Schön, 1996; Brown & Duguid, 1991; Senge, 1994).

The following subsections assess the research activities I undertook in this dissertation study. Each of the five main phases is analysed with a view to highlighting its contributions and identifying its limitations.

Evaluation of the Literature Review

The literature review phase of this study was designed to answer the third research question: "What factors need to be considered in the development of integration policy and implementation procedures?" The review followed established procedures in educational research for integrative reviews, thereby assuring its replicability and trustworthiness. The search accessed a wide variety of research reports from several countries, from universities of different sizes, and from a variety of disciplines. Its education bias might have been avoided by searching disciplinary journals specifically for studies of instructional environments using technology. A web-based search would likely have identified recent research published in online peer-reviewed journals. It is arguable however, whether following more comprehensive search procedures would have led me to identify more or different factors affecting the integration of technology. The barriers and incentives faced by faculty were consistently identified in studies undertaken in course situations and in surveys of attitudes and use patterns. I reached theoretical saturation on the factors (Glaser & Strauss, 1967) before I had finished reading half the articles. Studies of student perspectives did not typically focus on disabling factors other than individual computer anxiety or technical issues of access to and reliability or stability of course platforms and web-based systems. There were enough studies looking at administrative and policy issues to extract the larger political, economic and cultural factors, to the extent that they have been documented.

An examination of the literature from the perspective of the ESD model may indicate a gap in the research. There is an imbalance in the attention given to the different phases. Table 24 illustrates the breakdown by phase.

Table 24

Categorisation of the Literature Studied by ESD Phase

ESD Phase	Frequency	Percent
Planning	38	27.9
Design	32	23.5
Implementation	7	5.1
Evaluation	45	33.1
N/a	14	10.3
Total	136	100.0

Note. Frequency represents the number of articles coded in each of the ESD phase categories.

There were very few articles I could code as implementation studies, which may not be surprising given the objective of educational research to evaluate the learning outcomes in educational practice. This does not necessarily include process outcomes related to adoption. The articles I could code as implementation tended to be descriptions of institutional restructuring activities (e.g., Anderson, 1998; Danielson & Burton, 1999;

Peters, O'Brien, Briscoe, & Korth, 1995). It is possible that implementation research is not done, or that it is published in sources other than those accessed in the literature search. If the former, it may useful to think about whether or not educational practice can be improved with a research focus on implementation issues. If this research is done but published in administrative journals for example, then this would be evidence of a weakness in the literature search procedures. Another possibility is that I did not apply these codes consistently and consequently the reliability is low. Because the new model is mine and because I did not develop it until after the main work on the literature review was done, there was no colleague with whom to validate my coding process. As the subject of a future research project, this validation would be a useful contribution.

Evaluation of the Model Analysis

The model analysis activities of this study were designed to answer the first two research questions: "What models of institutional-level technology integration exist?" and "Do universities use models for technology adoption? If yes, which models? If no, what do they do instead?" I did not find evidence that universities used specific models in their planning and policy development, other than the Ubiquitous Computing model. I assume that the University of British Columbia's approach has been highly influenced by Bates' perspective on the Postindustrial model, given his position there as Director of Distance Education and Technology. Brock University's environmental scan acknowledges a paper prepared for the Department of Employment, Education, Training and Youth Affairs in Australia. This paper identifies three models for the introduction of IT in universities: "The models can be placed on a continuum from IT as a tool to enrich the learning community to IT as the vehicle for the delivery of most teaching and learning." The third model occupies the middle of the continuum and is a blend of the other two. Brock chose the "technology as a tool" model. The purpose of investigating examples of university-level technology integration was to determine if models existed that could guide other institutions facing the challenges of educational innovation. This study identified five abstract models, one of which had been operationalised in the university sector.

Daniel, Bates and Laurillard regularly refer to each other in their writing. Individually and collectively they are frequently cited in publications that explore the management of change in universities (e.g., Evans & Nation, 2000; Garrison & Anderson, 2000; Haughey, in press; Khan & McWilliams, 1998; Tait & Mills, 1999). I infer from this that each of them is influential within a certain group of university decision makers, and that the ideas they have shared in their publications and conference presentations have made an impact on institutional policy, either directly or indirectly. But it is not possible to verify this inference. Based on the limited perspective provided by the sources cited, my overall interpretation of these three strategists is that Laurillard's model is designed to preserve the old ways but allow for the new, Daniel's approach is to use the existing system for gradual change, while Bates' ideas advocate reinventing the entire university system. The subtle differences among these models might be difficult to operationalise in a real situation. They might also represent the differences between short term, medium term and long term time frames, and thus might parallel the three options described in the Australian policy document.

It is also not possible to directly answer the research question about what universities do when they do not use models for technology integration, other than by inference. The Brock case may illustrate that some universities struggle through the decision making process without actually coming to closure on a policy. It may be that small, culturally specific universities like Moncton, Acadia and Wake Forest, do not have as complex political or strategic issues to deal with as large, or even medium-sized ones do, and are freer to develop their own solutions, or to buy solutions from a vendor. Or, it may be that their constituents have a greater sense of affinity for the university, which supports a participative change process. Some larger institutions such as Concordia and York Universities tend to make decisions about technology on a program or faculty basis, and opt for macro-level vendor solutions such as FirstClass® or Learning Space®. WebCT is currently in use at dozens of universities in Canada (including UBC, Brock and Acadia), surely because it is affordable, was designed in Canada and is available in both English and French, characteristics that make it an attractive solution.

A deeper exploration of the five distinct technology integration models suggested similarities between two of them (Knowledge Media and Postindustrial) with respect to their strategic planning orientation, and comparable approaches between two others (Virtual Campus and Conversational) that evolved explicitly from instructional design principles. The fifth model (Ubiquitous Computing) clearly had a different focus from the others. This realisation led to the classification scheme of planning, design and implementation models, which ultimately led to the alternative model I propose. Inductively derived, this categorisation of models has not been validated objectively. It represents my interpretation of the materials I gathered and my reflections about them - an appropriate approach in a qualitative study (Denzin & Lincoln, 1998a, 1998b).

Other considerations with respect to the analysis of the models relate to the case studies. Yin's (1994) criteria for exemplary case studies require that the researcher attend to the (a) significance of the study, (b) completeness of the description, (c) alternative perspectives about the issues of concern, (d) evidence for the claims, or validity, and (e) style of presentation (pp.147-152). With these standards in mind, the limitations of the brief studies of Acadia and Wake Forest Universities have to do with the interconnected criteria of completeness and perspective. Though aware that students' perspectives are important to university procedures but seldom considered in the process of policy development, I did not examine them systematically at either university. This decision resulted in less complete presentations of the two environments. Nevertheless, I believe that the case studies offer a useful counterpoint to the more theoretical discussion of the other models and that together they provide an adequate description of the Ubiquitous Computing model. With respect to multiple perspectives, I chose to protect the identity of participants because I did not intend to correlate comments with position. The case study descriptions may be a little less precise in detail as a result.

The cross-case analysis illustrates substantial similarities between Acadia and Wake Forest and it may be tempting to dismiss their differences as unimportant. At the IBM Think Tank in June 2000 it became clear that many examples of universal computing share standard features (e.g., Seton Hall, Renselaer Polytechnical Institute, etc.) but their institutional cultures are unique. The institutional choices about centralised or decentralised support have led to fundamentally different teaching and learning environments. My overall impression of the case studies is that Acadia is using the tools of the future to protect the present, while Wake Forest is using the tools of the future to preserve the past. Neither has reconceptualised its role in society or its educational mission.

Evaluation of the Integration Activities

There might have been an alternative approach to integrating the findings of the literature review with the models. But given the power of the resistance effort at some universities (e.g., York) and Geohegan's (1998) explanation of the chasm between early adopters and mainstream faculty, I believe that a focus on barriers provided the most stringent test of the models. The implications of research and experience for policy are clear. University communities must know why they are integrating technology and what (and what not) to expect from it. Institutional-level commitment to the priorities established in a collaborative process must be evident in policy and infrastructure. The choices made about specific technologies must be grounded in the university mission and the answer to the "why technology?" question. First-order barriers must be addressed explicitly and realistically before individual faculty members will risk their time and reputations in what often amounts to technology-based experiments. The network must be stable and classroom equipment must work reliably and consistently before issues of pedagogy can be addressed. One lesson from Acadia is that restricting support to software and technical training leads to perpetuation of the instructionist paradigm and a reliance on technologies like PowerPoint and ICQ, which do nothing to change teaching practice (Participant #3).

Evaluation of the New Model

The fourth research question, "What would a model look like that considers all the factors appropriately?" led to the development of a new model for technology integration. Building on the classification of current models as planning, design and implementation, it became clear to me that none of these included specific procedures for evaluation of integration efforts. The literature review confirmed that meta-level evaluation activities were seldom specified in advance, and that micro-level evaluations seemed to focus on student and faculty satisfaction and the performance of the technology but not on learning outcomes. Yet one of the important factors leading to technology adoption was evidence of improved learning. It seemed obvious that evaluation should be an important component of any new model that purported to address the factors.

Another key indicator for a new model that emerged from the literature was the consistently reported dissatisfaction with organisational-level support. Faculty members were calling for real changes to policy and practice that demanded university-wide solutions for technology integration at more than just the curricular level. They seemed to be asking for technology to support the processes of learning, not just the products or the delivery. Thus an educational systems design-type model seemed appropriate. Further research into the appropriateness of the model as a tool for planning and action in a real-life context is recommended. This dissertation has only begun a process of inquiry into meta-level technology integration in universities. To complete the research cycle, future studies should consider using action research (Carson & Sumara, 1997) or soft systems methodology (Checkland, 1999).

One limitation of the ESD approach relates to language. The terminology of learning theory and instructional design is the language of a subculture. Faculty members do not necessarily understand it. This may weaken the claim that educational design uses more accessible language than strategic planning. But faculty members untrained in pedagogy still know what they want their students to learn and how they should be able to demonstrate their new knowledge. I have found that many experienced professors have an intuitive understanding of instructional design principles. In universities, recent suggestions for faculty development initiatives by technology advocates (Bates, 2000; Brown, 1999; Gibson & Nocente, 1998) are likely to increase the number of opportunities for them to learn about pedagogical theory and practice. The current trend in Australia and the United Kingdom (Evans & Nation, 2000; Laurillard, 1999) to certify university professors in instruction may influence North American practice in the future. In time, this limitation will be less of a problem.

Evaluating the Model Evaluation

The purpose of the model evaluation was to answer the fifth research question: "How does a proposed model compare to existing university technology plans?" The decision to make the comparison against the plans of three institutions of differing sizes and locations was an attempt to test the theoretical generalisability of the new model. Incomplete information on the websites weakened the test and it is not possible to conclude that my model is necessarily better than what universities are currently doing as it has not yet been applied in practice. It does offer an alternative approach, however, that includes a focus on learning and evaluation, and it deserves further testing.

Another way to evaluate the model might be to compare it with very recent literature. For example, Lick and Kaufman (2000) offer a detailed map to "change creation" that builds on Kaufman's (1997) "mega-level planning" approach. Based on the "universal change principle" that "learning must precede change" (Lick & Kaufman, 2000, p. 27), change creation advocates proactive leadership focused on multiple roles, and a detailed action plan for implementation, evaluation and reporting. Haughey (in press) "reviews the pressures facing postsecondary institutions and examines the need to undertake a planning exercise to address this challenge." The planning approach she advocates is holistic rather than strategic. Recognising that change plans often falter at implementation levels, partly due to the effects of academic culture, she proposes a "contextual model," which is broadly participative. After reviewing a selection of classical models for educational change (including diffusion of innovations, conditions of change, concerns-based adoption, systems approaches and others), Ellsworth (2000) offers a "comprehensive model of change communication" (p.238) as a solution. His strategy synthesises the other models into a coherent systemic whole that is based on communication theory and stakeholder development. Though Ellsworth's work focuses on change in school systems rather than higher education, his awareness of the complex, nested interdependencies of the various subsystems is instructive at the university level as well.

The similarities among these three proposals and my model suggest a convergence of opinion among people interested in planning and managing educational change. I did not learn about these alternative ideas until after I had designed my model.

Contribution to Knowledge

This study synthesised the extensive research published in the last seven years, drawing out themes common to studies of technology integration initiatives. Research and experience suggest that projects are not building on the contributions of prior research. Whether this is because practitioners are unaware of research results or because researchers are focused on issues of lesser concern to practitioners is unclear. The synthetic review of theory and practice described in the literature offers a broad understanding of factors affecting technology integration in a variety of institutional and social contexts, across many disciplines, in studies using different methodologies. Pulling together the literature in this way and combining its lessons with the experience of practitioners at two different universities provided multiple perspectives on efforts to integrate technology and led to the development of an institutional-level model. The model offers an alternative to universities developing technology plans or adapting the ones they have discovered to be inadequate.

Contribution to Practice

The new model is based on successful practices as documented in the literature and further explored through case-based data from two institutions using a similar model for their technology integration efforts. Because the thesis compares the same variables across different contexts, it should be testable by analogy in other situations and adaptable to other environments. Whether it is directly transferable to other situations will depend on testing and further research, but I believe the model resonates with the experiences of those studied. This study thus offers answers to questions about technology adoption that are troubling people from various constituencies within the university sector. It is timely and its findings will be useful to those looking for new ways to manage technology integration activities. Its scope of generalisability is consistent with what Yin (1994) describes is appropriate for case studies: readers determine for themselves how the results apply to their particular situation. I believe the model also provides an approach to dealing with the confrontational "we-they" syndrome developing between professors and administrators on Canadian campuses, which was so clearly exhibited at the CAUT conference in November 2001.

Implications for Action

The research reported here suggests that postsecondary education may be in a state of transition on a number of levels. Policy makers may be reassured to know that they are not alone in their struggles to decide what is the most appropriate role for information and communication technologies in their particular environment. The factors influencing technology integration do not seem to vary much from university to university. Strategies for addressing the factors have been tested at pioneering institutions around the world. Several models exist for organising the integration effort.

To practitioners the literature and experience documented here confirms the following reality. Educational technologies that challenge traditional patterns of teaching and learning behaviour cannot be ignored. Significant resources (human, technical and financial) are necessary to support teaching and learning with technology. Every university is likely to be facing some or all of the challenges of integrating technology. Effective integration depends both on coordinating the implementation activities of a number of interdependent subsystems within the organisation, and on addressing external forces.

Policy needs to start with an answer to the "why technology?" question that is contextual and supportive of the university's mission. Action needs to address how a university proposes to leverage technology in the services of its mission. Will it be a tool for delivery or a tool for learning? Will the educational model be connected or distance or distributed or virtual or classroom learning, or a combination of some or all of these? How will the integration proceed? Who will be responsible? Will the nature of change be incremental or transformational? Is a proactive or reactive approach more appropriate? In the current competitive market, what should the balance be between focusing on the products or the processes of learning? Different strategies probably need to address short-term, medium-term and long-term aspirations and resources. The answers to key questions will come from a multi-perspective, collaborative approach to planning, design, implementation and evaluation that has as its objective to integrate technology across the university system in the service of teaching and learning. Participative educational systems design may provide a new understanding of the factors that will support these activities and a methodology for addressing them.

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Appendix 1

Sample ERIC Search

ERIC Update - April 2002

Search History

* #10 #8 and #9 (35 records)
#9 integrat* and (PY=2000-2002) and (DT=JOURNAL-ARTICLES) (1174 records)
#8 #5 and #7 (35 records)
#7 #3 and #6 (491 records)
#6 #1 or #2 or #4 (1089 records)
#5 integration and (PY=2000-2002) and (DT=JOURNAL-ARTICLES) (457 records)
#4 (elearning or e-learning or (e adj learning)) and (PY=2000-2002) and (DT=JOURNAL-ARTICLES) (29 records)
#3 ((postsecondary or higher education or universit* or colleg*) in DE,ID) and (PY=2000-2002) and (DT=JOURNAL-ARTICLES) (7443 records)
#2 ((distance education or open universities) in DE,ID) and (PY=2000-2002) and (DT=JOURNAL-ARTICLES) (552 records)
#1 ((educational technology) in DEM,DER) and (PY=2000-2002) and (DT=JOURNAL-ARTICLES) (628 records)

Appendix 2

Articles Included in the Literature Review

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Appendix 3

Codebook

AUTHOR

DATE

SOURCE

1 ERIC #1
2 ERIC #2
3 ERIC #3
4 ERIC #4
5 ERIC #5
6 PsycInfo
7 ETA
8 Other

REVDATE Date Reviewed

REVIEWER Reviewer(s)

1 Cindy
2 Christina
3 Cindy & Christina

DISCIPLI Discipline

1 Education
2 Computer Science/Engineering
3 All/many Disciplines/Unspecified
4 French
5 English
6 Medicine/Pharmacy
7 Psychology
8 Educational Technology
9 Library/Information Science
10 Chemistry
11 Business
12 Museum Management
13 Geography
14 N/a
15 Italian

16 Journalism/Communication
17 Mathematics
18 Social Work/Law

FACDISC Faculty-based discipline

1 Education
2 Natural/Social Sciences
3 All/many Disciplines/Unspecified
4 Humanities
6 Professional Programs
7 Library/Museum/Information Science
8 N/a

RESEARCH Research Model

1 Quantitative
2 Qualitative
3 Both
4 Not a study
5 Meta-study

DESIGN Research Design

1 Descriptive/Exploratory
2 Quasi-experimental/comparative
3 Ethnographic
4 Narrative Review/Opinion
5 Formative Evaluation
6 Case Study
7 Action Research

PHASE ESD Phase

1 Planning
2 Design
3 Implementation
4 Evaluation
5 N/a

UNIT Unit of Analysis

1 Course
2 Program/Department
3 Institution
4 National or larger system

5 State system
6 College/Faculty
7 N/a

JOURNAL Journal

1 European Journal of Teacher Education
2 Conference Proceedings
3 Canadian Journal of Educational Communication
4 Distance Education
5 Innovation in Education and Training International
6 College and University Media Review
7 Reports
8 Educational Technology Review
9 Journal of Vocational Education and Training
10 RQ
11 The Quarterly Review of Distance Education
12 Research Strategies
13 Canadian Journal of Higher Education
14 Learning Environments Research
15 Journal of Educational Computing Research
16 Information Technology and Libraries
17 The Alberta Journal of Educational Research
18 Medical Teacher
19 The Profession
20 College and Research Libraries
21 Open Learning
22 TechTrends
23 ETR&D
24 Journal of Computer Assisted Learning
25 ERA Spectrum
26 Information Processing and Management
27 Journal of Research on Comoputing in Education
28 T.H.E. Journa;
29 Journal of Technology and Teacher Education
30 Action in Teacher Education
31 Journal of Technology Studies
32 Journal of Resaerch on Technology in Education
33 Journal of the American Society for Information Science
34 Instructional Science
35 Journal of Interactive Instruction Development
36 Science and Technology Libraries
37 International Information and Library Review
38 Computereducation
39 International Journal of Instructional Media
40 Educational Research

41 International Journal of Education Management
42 Indian Journal of Open Learning
43 Journal of Documentation
44 Business Communication Quarterly
45 Canadian Journal of Information and Library Science
46 Vocational Education Journal
47 Journal of Technical Writing and Communication
48 Computers and Education
49 Journal of Educational Technology Systems
50 Technology and Learning
51 Academic Medicine
52 The American Journal of Distance Education
53 Technical Communication
54 Journal of Geography in Higher Education
55 Teacher Education Quarterly
56 Journal of Career Planning and Employment
57 Journal of Computing in Teacher Education
58 American Annals of the Deaf
59 Foreign Language Annals
60 The Social Studies
61 Journalism and Mass Communications Educator
62 Journal of Computers in Mathematics and Science Teaching
63 Journal of Information Technology for Teacher Education
64 Internet Reference Services Quarterly
65 British Journal of Educational Technology
66 Journal of Mathematical Behavior
67 Teacher Education and Special Education
68 Human Communication Research
69 Italica
70 International Journal of Computers for Mathematical Learning
71 Philosophies of Reference Service
72 Journal of Applied Communications
73 EDUCAUSE Review
74 Educational Media International
75 Educational Researcher
76 Journal of Computer Mediated Communication
77 Journal of Science Education and Technology

SIZE Size of university

1 Small
2 Medium
3 Large
4 Unknown/Not Relevant

COUNTRY Country/Region

1 Canada
2 U.S.A.
3 United Kingdom
4 Australia
5 Europe
6 Indonesia
7 Unknown/Not Relevant
8 Many Countries
9 Africa
10 Asia

PERSPECT Perspective

1 Instructor
2 Learner
3 Researcher
4 Policy Maker
5 Graduate

ORIENTAT Orientation

1 Learning
2 Teaching
3 Learning and Teaching
4 Research
5 Administrative
6 Barriers
7 Teaching and Research
8 Teaching and Administrative
9 Admin/Barriers
10 Teaching and Barriers

THEORY Theoretical Framework

1 Constructivism
2 Social Learning
3 Self Efficacy
4 Mental Models/Symbol Systems
5 Instructional Design
6 N/a
7 Other
8 Diffusion of Innovations
9 Reflection
10 Adult Learning

COGNITIV Cognitive Outcomes/Achievement

1 Yes
2 No

AFFECT Affective & Motivational Factors

1 Yes
2 No

SOCIAL Personal & Social Factors

1 Yes
2 No

ATTITUDE Attitudes/Beliefs

1 Yes
2 No

INSTRUME Instruments

1 Survey/Questionnaire
2 Interviews
3 Observations
4 Reflection
5 Mixed
6 N/a
7 Lit/doc Review
8 Traces
9 Test/exam/assignment

COURSE Course?

1 Yes
2 No

TIME Time

1 Yes
2 No

SUPPORT Support

1 Yes
2 No

FUNDS Funding

1 Yes
2 No

REWARD Rewards

1 Yes
2 No

ACCESS Access

1 Yes
2 No

EQUIPT Equipment

1 Yes
2 No

TRAINING Training

1 Yes
2 No

CULTURE Culture

1 Yes
2 No

CLIMATE Climate

1 Yes
2 No

PEDAGOGY Pedagogical Approaches

1 Yes
2 No

EVIDENCE Evidence/Advantages with respect to learning

1 Yes
2 No

PSYCH Psychological Factors

1 Fear/Anxiety
2 None
3 Interest/Relevance

LEADER Champion/Leadership

1 Yes
2 No

FEEDBACK Feedback for Improvement

1 Yes
2 No

ETHICS Ethics

1 Yes
2 No

STRATPLN Strategic Planning

1 Yes
2 No

USEABLE Useability

1 Yes
2 No

PARTICIP Stakeholder Participation

1 Yes
2 No

STUDENTS Student Pressure

1 Yes
2 No

HABIT Habit/Tradition

1 Yes
2 No

STANDARD Standardisation/Standards/Prestige

1 Yes
2 No

POLICY Government or other policy

1 Yes
2 No

ECONOMIC Economic arguments /Scalability/Competitive Advantage

1 Yes
2 No

Appendix 4

Complete List of Journals

Academic Medicine
Action in Teacher Education
American Annals of the Deaf
British Journal of Educational Technology
Business Communication Quarterly
Canadian Journal of Educational Communication
Canadian Journal of Higher Education
Canadian Journal of Information and Library Science
College and Research Libraries
College and University Media Review
Computereducation
Computers and Education
Conference proceedings
Distance Education
Educational Media International
Educational Research
Educational Researcher
Educational Technology Review
EDUCAUSE Review
ERS Spectrum
ETR&D
European Journal of Teacher Education
Foreign Language Annals
Human Communication Research
Indian Journal of Open Learning
Information Processing and Management
Information Technology and Libraries
Innovation in Education and Training International
Instructional Science
International Information and Library Review
International Journal of Computers for Mathematical Learning
International Journal of Education Management
International Journal of Instructional Media
Internet Reference Services Quarterly
Italica
Journal of Applied Communications
Journal of Career Planning and Employment
Journal of Computer Assisted Learning
Journal of Computer in Mathematics and Science Teaching
Journal of Computer Mediated Communication

Journal of Computing in Teacher Education
Journal of Documentation
Journal of Educational Computing Research
Journal of Educational Technology Systems
Journal of Geography in Higher Education
Journal of Information Technology for Teacher Education
Journal of Interactive Instruction Development
Journal of Mathematical Behavior
Journal of Research on Computing in Education
Journal of Research on Technology in Education
Journal of Science Education and Technology
Journal of Technical Writing and Communication
Journal of Technology and Teacher Education
Journal of Technology Studies
Journal of the American Society for Information Science
Journal of Vocational Education and Training
Journalism and Mass Communications Educator
Learning Environments Research
Medical Teacher
Open Learning
Philosophies of Reference Service
Reports
Research Strategies
RQ
Science and Technology Libraries
T.H.E. Journal
Teacher Education and Special Education
Teacher Education Quarterly
Technical Communication
Technology and Learning
TechTrends
The Alberta Journal of Educational Research
The American Journal of Distance Education
The Profession
The Quarterly Review of Distance Education
The Social Studies
Vocational Education Journal

Appendix 5

Ethical Consent

Summary Protocol Form **SPF #** .

Date: February 4, 2002 .
Do you recommend that this form receive an expedited X or full review?

Part One: Basic Information

1. Principal Investigator:
   Cindy A. Ives, PhD candidate, Educational Technology
   Department of Education, Concordia University
   (514) 938-8728
   cives@videotron.ca

2. Title of Research Project:
   Technology Integration in Universities (a PhD dissertation)

3. Granting Agency or Contractor:
   N/A

4. Brief Description of Research:
   This study will investigate the process of technological change on organisational culture and behaviour in the education sector. Specifically the study will use a comprehensive review of the literature on technology integration in universities to identify the factors necessary to successful institution-wide adoption of teaching and learning technologies. The study will identify and analyse three types of technology integration models currently available to universities. Semi-structured interviews with selected individuals in universities engaged in technology integration initiatives will be conducted by the researcher as validation checks on the results of the integrative literature review. The interviews will explore the integration process as it developed or is unfolding at the particular university. Questions will relate to what the integration plans were, how they were developed, what is working, what isn't working, and what suggestions participants have for what could have been done better or what lessons have been learned that could be shared. Pulling together the literature in this way and combining it with the experience of practitioners will provide multiple perspectives on university-wide efforts to integrate technology and lead to the development of an institutional-level model. This study will thus offer possible answers to real questions that are troubling people from various constituencies within the university sector.

5. Scholarly Review of Proposed Research:
This study is not funded and involves less than minimal levels of risk.

Part Two: Research Participants

1. Sample of Persons to be Studied:
Several representatives of universities involved in technology integration projects will be interviewed. These individuals will include faculty members, administrators, and technical support staff. They will be or will have been responsible for aspects of the planning, design and/or implementation stages of the integration process at their respective institutions.

2. Method of Recruitment of Participants:
Participants will be recruited using a purposive sample of individuals with knowledge of the process of technology integration and the problems faced by groups involved. They will be identified from the literature, publicity material (including websites), or by referral, and contacted by email (see sample email message, which introduces the research project to potential participants and my purpose in talking to them, attached). It is expected that the original sample will refer the researcher to other knowledgeable individuals as well.

3. Treatment of Participants in the Course of the Research:
Most participants will be interviewed face-to-face in their own offices using a semi-structured interview protocol (see sample attached). The interview is not expected to exceed one hour. A few participants may be interviewed by email or on the telephone. Telephone and face-to-face interviews will be recorded and transcripts will be shared by email with the participants for correction or further clarification. It is possible that follow-up contacts will be made by email to clarify specific points. The consent form further describes the research project and participants will be encouraged to ask questions about it at any time during or after the interview. Other than the researcher no one will have access to interview data.

Part Three: Ethical Concerns

1. Informed Consent:
The nature of the research project will be described as part of the process confirming interviews. Participants will also read about the purpose of the research project on the consent form, just in advance of the interviews, and sign to indicate their free and informed consent (see enclosed sample consent form). Questions and discussion about the purpose of the interviews will be encouraged.

2. Deception:
There will be no deception in this research project.

3. Freedom to Discontinue:

The consent form indicates that participants will be free to discontinue their involvement at any time. Contact information is provided as well.

4. Assessment of Risk:

There is less than minimal risk to participants. Individual comments will not be identifiable. The purpose of these interviews is to elaborate on the barriers and incentives to effective technology implementation identified in the literature, not to discredit particular models or institutions. Although the results of the research will lead to the development of a new model that addresses weaknesses in current models, there will be no implied or direct criticism of specific institutional policy.

5. Addressing Risk:

N/A

6. Post-research Debriefing:

As all arrangements for the interviews will be made by email, participants will have the researcher's contact information. The consent form also includes this information. Participants will sign two copies of the form and keep one for their records. This shows participants where to reach me for follow-up discussion if necessary. Any quotations to be used in the dissertation will be checked with participants for accuracy of inferences made. When the dissertation is complete, I will send a notice to those interviewed offering an electronic copy for their information.

7. Confidentiality:

All information will be kept confidential. Interview tapes and transcripts will be kept in my home, to which no one has access beyond my immediate family.

8. Any Other Ethical Concerns:

No

Signature of Principal Investigator:

Cindy Ives

Date: **February 14, 2002** .

Sample Consent Form to Participate in Research

This is to state that I agree to participate in a research study being conducted by Cindy A. Ives, PhD candidate, Educational Technology, Department of Education, Concordia University, 1901-1350 rue du Fort, Montreal, Quebec, H3H 2R7, (514) 938-8728, cives@videotron.ca.

Purpose

I have been informed that the purpose of the research is to investigate the impact of technological change on organisational culture and behaviour in the education sector. Specifically the study will use a comprehensive review of the literature on technology integration in universities to identify the factors necessary to successful institution-wide adoption of teaching and learning technologies. The study will identify and analyse three types of technology integration models currently available to universities. The researcher will conduct interviews with selected participants in universities engaged in technology integration initiatives. The study will provide multiple perspectives on university-wide efforts to integrate technology and lead to the development of an institutional-level model. This study will thus offer possible answers to real questions that are troubling people from various constituencies within the university sector.

Procedures

The researcher will interview selected members of various stakeholder groups in the comfort of their own environments. Participants will be selected on the basis of their active participation in some aspect of the technology integration process (e.g. planning, decision making, or implementation). The primary purpose of the one-hour interviews is to explore the experience of each participant. A written copy of the questions will be provided for each person interviewed. Interviews will be tape recorded where there is agreement to do so, or conducted by email. There is less than minimal risk to participants, as only general data will be reported. Any quotation to be used in the dissertation will be checked with the person who made it for accuracy of inference. The interview tapes or transcripts will not be shared. but they will be returned by email to the participants so they can make corrections or further elaborations to their remarks. Any follow up contact will be done by email.

Conditions of Participation

- I understand that I am free to withdraw my consent and discontinue my participation at anytime without negative consequences.
- I understand that my participation in this study is strictly CONFIDENTIAL. My identity will not be disclosed to anyone, anywhere.
- I understand that data from this study may be published.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print)	WITNESS SIGNATURE
SIGNATURE	DATE

Sample email message to potential Acadia University participants

Hello:

I am a doctoral candidate in Educational Technology at Concordia University in Montreal. My supervisor, Dr. Dennis Dicks, who is involved with several laptop programs here, gave me your name as someone who was involved from the beginning in Acadia's laptop program.

My dissertation topic explores institutional-level technology integration models used by universities to plan their initiatives, with a focus on planning, design and implementation processes and policy formulation. I am very interested in Acadia's experiences, and would like to conduct short interviews with selected participants.

I am planning a trip to Nova Scotia next week and was wondering if it would be possible to meet with you on Tuesday, Wednesday or Thursday. If there are others you think I should contact, please don't hesitate to let me know.

Looking forward to meeting with you next week if possible.

Regards,
Cindy Ives

-- Cindy Ives
1901-1350 rue du Fort
Montréal (Québec)
H3H 2R7
(514) 938-8728 phone/fax

Appendix 6

List of Resources Used in the Case Study of Acadia University

Acadia University. (2001). Dr. Kelvin Ogilvie shares Acadia's strategic planning success at national conference. Wolfville NS: Acadia University, Office of Public Affairs.

Acadia University. (2001). ThinkPad and Network Basics. Wolfville NS: Acadia University, User Support Centre.

Acadia University. (2001). Dr. Kelvin Ogilvie chosen to share Acadia's strategic planning success at international conference. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2001/PlanningSuccess_July24.html [2001, November 14].

Acadia University. (2001). Shell Canada donates $150,000 to the Acadia Advantage Program. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2001/ShellCanada_Apr10.html [2001, November 14, 2001].

Acadia University. (2001). School technology vision focus of new program. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2001/GELeadersMar30.html [2001, November 14, 2001].

Acadia University. (2001). Vice-President of growth & operations appointed at Acadia University. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2001/VP_Growth&OperationsMar20.html [2001, November 14, 2002].

Acadia University. (2001). Acadia receives International Award. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2001/Pioneer_Mar16.html [2001, November 14, 2001].

Acadia University. (2002). Institutional Website. Available: http://www.acadiau.ca [2002, June 7].

Acadia University. (2002). Acadia University receives $3 million. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2002/3million_funding_apr02.html [2002, June 12, 2002].

Acadia University. (2002). Acadia University announces $1.1 million in funding for faculty innovation. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2002/faculty_innov_30apr02.html [2002, June 12].

Acadia University. (2002). Dr. Kelvin Ogilvie to step down in 2003. Wolfville NS: Acadia University, Office of Public Affairs. Available: http://www.acadiau.ca/whatsnew/newsrelease/2002/ogilvie_08may02.html [2002, June 12].

Advisory Committee for Online Learning. (2001, 2001-02-07). Committee Members - Kelvin Ogilvie. Available: http://www.schoolnet.ca/mlg/sites/acol-ccael/en/members_03.html#ogilvie [2001, November 14, 2001].

Bates, I., & McEwan, A. (1990). The Global library: Strategies for managing information at Acadia University. Wolfville NS: Acadia University.

Brown, M. (1996). Acadia students netted. Available: http://members.tripod.com/~MitchellBrown/samples/UK_acadia.html [2002, June 12].

Cutright, M., & Griffith, B. (2000). The "Acadia Advantage" and a new vision for education in Canada. The Technology Source (March/April).

Delaney, G. (1999). Acadia given world-class green centre: Irvings' gift is massive environmental research facility. The Halifax Chronicle Herald (March 27, 1999).

Draper, G., McEwan, A., & Oliver, L. (1993). The Information intensive campus. Wolfville NS: Acadia University.

Green, J., & Protheroe, B. (2002). Building capacity for success: Learning by trial and evidence. Education Canada, 42(2), 4-7.

Greeno, C., & Nash, M. (1999). Acadia students up in arms over stalled contract talks. Available: http://www. [2002, June 12, 2002].

Landers, M. (2000). Acadia profs call for president's resignation: 'Either he goes or we go' cries university Faculty. University of Toronto Varsity News (November 26, 2000).

Lewington, J. (1998). Disgruntled professors put technology to work: Nova Scotia's Acadia University is feeling the high-tech effects of an electronic slowdown. The Globe and Mail, (January 16, 1998, p. A6).

MacDougall, G., Place, C., & Currie, D. (1998). Web-based testing: A form-based template for creating multimedia enhanced tests. Paper presented at the Ed-Media/EdTelecom 98 World Conference on Educational Multimedia and Hypermedia and World Conference on Educational Telecommunications, Freiburg, Germany (June 20-25, 1998).

MacKinnon, G. R. (1999). Electronic portfolios in pre-service science education (ED437029). Wolfville, NS: Acadia University.

Observations on campus, including casual conversations with students and staff, Acadia University, Wolfville NS. November 19-22, 2001.

Observations on campus, including casual conversations with students and staff, Acadia University. Wolfville NS. January 14-17, 2002.

Ogilvie, K. (2000). IT and the revolution in education. Toronto: Speech to the Canadian Club of Toronto (October 16, 2000).

Participant #1. (2001). Interview. Wolfville NS (November 20, 2001).

Participant #2. (2001). Interview. Wolfville NS (November 20, 2001).

Participant #3. (2001). Interview. Wolfville NS (November 21, 2001).

Participant #4. (2001). Interview. Wolfville NS (November 21, 2001).

Participant #5. (2002). Interview. Wolfville NS (January 15, 2002).

Participant #6. (2002). Interview. Wolfville NS (January 16, 2002).

Participant #7. (2002). Interview. Wolfville NS (January 17, 2002).

Provencal, V. (1999, October, 1999). Eat the peach: 'Studio' arts as the next great leap in computerised education. Paper presented at the Classical Association of the Atlantic States, Lafayette College, Easton, PA.

Retson, D. S., Williams, P. J., & Symons, S. The Effectiveness of computer-based studio teaching of physics. Available: http://aitt.acadiau.ca/research/ [2002, June 12]

Sacouman, J. (2001). Implications for workload. Paper presented at the Conference on Online Education, Montreal (November 2-4, 2001).

Shell Canada. (2001). Shell donates $150,000 to the Acadia Advantage Program. Available: http://www.shell.ca/code/library/news/2001/olnr_apr11_acadia.html [2002, January 3].

Smith, S. J. (2001). Profs in a wired world. Acadia University. Available: http://admin.acadiau.ca/fund/enews/june2001/backpage.html#wired [2002, June 12].

Staff. Acadia gets wired. (1996). UW Gazette.

ThinkTank (2002). Selected presentations by and informal discussions with participants at the conference, Quebec City, QC. (June 2-4, 2002)

Watters, C., Conley, M., & Alexander, C. (1998). The Digital agora: Interaction and learning in political science. Paper presented at the WebNet 98 World Conference of the WWW, Internet and Intranet, Orlando, FL.

Williams, P. J., MacLatchy, C. S., Backman, P. J., & Retson, D. S. (1997). Studio Physics at Acadia University. Physics in Canada, 53(2), 96-101.

Appendix 7

List of Resources Used in the Case Study of Wake Forest University

Brown, R. (1998). Notebook universities: Creating a technology-intensive learning environment. The Technology Source (May).

Brown, D. G. (1999). Always in Touch: A Practical Guide to Ubiquitous Computing. Winston-Salem, N.C.: Wake Forest University Press.

Brown, D. G. (Ed.). (2000). Teaching with Technology: Seventy-five professors from eight universities tell their stories. Bolton, MA: Anker Publishing Company, Inc.

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Glossary

Climate refers to inferences made by employees about organisational priorities, values and goals based on policies, practices, routines and behavioural standards.

Culture refers to the beliefs and values shared by members of a group. Each group and subgroup has its own particular culture or subculture, based on its assumptions about reality. Culture is communicated through language, symbol systems and behaviour. Changing the beliefs and values of the individual members can change subcultures.

Distance education refers to educational systems in which teachers and learners are separated in space and/or time. This can include traditional print-based correspondence and independent study courses as well as the range of technology-enhanced courses that use audioconference, videoconference, computer conference, telephone, facsimile, email, web-based materials and print packages in any combination.

Educational systems design is a systematic process of designing mission, goals, objectives and direction for implementation of learning and teaching activities to fulfil an educational organisation's mission and mandate for the benefit of society. It involves four overlapping spheres of activity: planning, design, implementation and evaluation.

Instructional design. A systematic process of creating and organising teaching and learning resources and identifying the strategies for using them effectively, instructional design (ID) can be adapted to a variety of learning theories and domain-specific content. ID is an iterative process but is usually expressed as a series of steps or phases of activity: analysis, design, development, implementation and evaluation.

Learning. Different learning theories define learning differently. Whether understood as a change in performance or as improved understanding constructed in a social context, learning happens within individuals and within communities of learners. Organisational learning depends on individual learning (Kim, 1993).

Models can be understood as abstract or symbolic representations of theories, processes or systems that help us to understand, explain and/or predict the phenomenon of interest (Valentine, 1992, pp.130-134). In soft systems modelling (Checkland, 1999) the parts of a complex system are often diagrammed as part of an iterative process of inquiry into human activity. As in a model airplane or house, models thus help to clarify our understandings about the parts of entities and how they relate to one another. This understanding can then lead to action for ongoing improvement of the system in question.

Online education is often erroneously equated with distance education. It is possible and quite common for online strategies (email, websites, Internet resources, and computer-mediated communication) to be added to face-to-face classroom environments.

Strategic planning is a systematic process of developing mission, goals, objectives and direction for implementation of priority activities to fulfil the mission of an organisation in society.

The notion of *successful practices* goes beyond that of *best practices* which according to Brown (1999) are examples of successful computer-enhanced course redesigns from which lessons learned can be used to inform technology implementation projects in other contexts. The advantage of using the term "successful" rather than "best" is that it minimizes the notion of a single "correct" way of doing things but capitalizes on the utility and feasibility of a strategy within a particular context.

Technologies for teaching and learning also referred to as *educational technologies* include a variety of media such as textbooks, black boards, library resources, pre-packaged course materials, video and laboratory equipment and the pedagogical strategies for using them. I am primarily concerned with computer-based information and communication technologies that are considered to have great potential for improving the educational transaction. These include productivity, presentation and simulation software, online databases, web pages, course management programs and computer-mediated communications systems (CMC). Educational technologies also include the processes involved in deciding how and why to use which medium for what purpose. The AECT defines instructional technology as "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (Ely, 2000).

Technology integration as compared to *technology implementation*. I use integration to mean institution-wide adoption of educational technologies. This meta-level of adoption implies that the major barriers to technology acceptance have been overcome, and that technologies for teaching and learning have become part of the organisational culture. Implementation refers to the use of particular technologies (e.g. CMC) by individual faculty members at the course level, or by departments at the program level.

Technology is not a synonym for "tool" (Evans & Nation, 2000). "Technology is the art, craft and science of how to use a particular tool for a particular purpose" (p. 8). The Association for Communications and Technology (AECT) considers technology to refer to the "systematic process of solving problems by scientific means" (Ely, 2000).