COMING TO TEACHING IN THE 21ST CENTURY: A RESEARCH STUDY CONDUCTED BY THE GALILEO EDUCATIONAL NETWORK

Patricia Clifford, PhD and Sharon Friesen, PhD
The Galileo Educational Network

Jennifer Lock PhD
University of Calgary
ACKNOWLEDGEMENTS

Coming to Teaching in the 21st Century was created through the support of Alberta Learning, and in collaboration with representatives from Alberta Learning and the province’s five universities, each of which prepares teachers for their work with the children and youth of this province.

Research was conducted by Dr. Sharon Friesen and Dr. Patricia Clifford of the Galileo Educational Network, with the support of Dr. Jennifer Lock of the University of Calgary. Appreciation is extended to Galileo team members for their assistance in the videotaping, transcription and the production of an accompanying DVD that lets you visit the classrooms and offices of teacher educators, teachers and teacher candidates. This video tour of the report is available on the Galileo website (www.galileo.org).

The study would not have been possible without the support of the five faculty members who generously allowed us to interview and videotape in their classrooms and offices, and who met regularly throughout the course of the research to discuss emerging findings and to provide thoughtful guidance and feedback concerning the recommendations that have emerged.

We are also grateful for the willing and thoughtful participation of the students we interviewed in person, and who were gracious in maintaining email correspondence with us throughout.
## TABLE OF CONTENTS

ACKNOWLEDGEMENTS ................................................................................................................................. 2

TABLE OF CONTENTS ......................................................................................................................................... 3

INTRODUCTION .................................................................................................................................................. 6

  THE IMPORTANCE OF ICT within TEACHER EDUCATION ............................................................................. 6
  DESIGN OF THE STUDY .................................................................................................................................... 12
  HOW THIS STUDY WAS CARRIED OUT .......................................................................................................... 13
    The objectives of the study were to .................................................................................................................. 14
    Methodology .................................................................................................................................................... 16
    Interviews ....................................................................................................................................................... 16
    Data ............................................................................................................................................................... 17
    RESEARCH COMMITTEE ............................................................................................................................... 17
    Videotaping ..................................................................................................................................................... 18

REVIEW OF THE LITERATURE .......................................................................................................................... 19

  INTRODUCTION .............................................................................................................................................. 19
  TECHNOLOGY AS COMMONPLACE IN THE STUDENT WORLD ................................................................. 19
    Connectivity ................................................................................................................................................... 19
  NET GENERATION AND USE OF TECHNOLOGY OUTSIDE OF SCHOOLS .................................................. 21
  DIGITAL TECHNOLOGY AND CONNECTIVITY IN CANADIAN SCHOOLS .................................................... 23
  COMPUTER USE IN SCHOOLS .......................................................................................................................... 24
    ICT Supported Pedagogical Practices ............................................................................................................. 28
  TECHNOLOGY IN CANADIAN FACultIES OF EDUCATION ............................................................................ 32
  THE ALBERTA CONTEXT ................................................................................................................................. 32
  CHALLENGES IN INTEGRATION TECHNOLOGY IN TEACHER EDUCATION ........................................... 33
    What Needs to Change in Teacher Preparation? ................................................................................................. 37
  CHANGE – TECHNOLOGY INTEGRATION IN TEACHER PREPARATION PROGRAMS ...................................... 40
    Themes .............................................................................................................................................................. 43
  BRIDGING FIELD PLACEMENT AND TEACHER PREPARATION PROGRAMS .............................................. 46
    Field Placement ............................................................................................................................................... 47
    Partnerships .................................................................................................................................................... 50
    WHERE TO NEXT? ......................................................................................................................................... 52
    SUMMARY .................................................................................................................................................... 55
    CONCLUSION .................................................................................................................................................. 57

OVERVIEW OF THE INNOVATIONS .................................................................................................................... 58

  INTRODUCTION ............................................................................................................................................... 58
  BECOMING AN ELEMENTARY SOCIAL STUDIES TEACHER ....................................................................... 58
    What Needs Was the Virtual Field Trip Designed to Address? ....................................................................... 59
      EFFECTIVE FIELD EXPERIENCES FOR STUDENTS .................................................................................. 59
        TECHNOLOGY INTEGRATION DEMANDS ................................................................................................. 61
    Design of the Virtual Field Trip .................................................................................................................... 61
      AUTHENTIC EXPERIENCES ............................................................................................................................ 61
        EXPLORING AND DOING ............................................................................................................................... 63
  FIELD IMMERSION IN A TECHNOLOGY-RICH ENVIRONMENT ..................................................................... 64
    What Needs Was the Cohort Approach Designed to Address? .................................................................... 66
      THE NEED FOR INQUIRY-BASED PRACTICUM PLACEMENTS ................................................................... 66
      THE NEED FOR TECHNOLOGY ENHANCED PRACTICUM EXPERIENCES ................................................. 67
    Design of the Cohort Experience .................................................................................................................. 67
    Who Supports the Innovator? .......................................................................................................................... 69
  EDUCATION 503 ............................................................................................................................................. 70
FINDINGS .......................................................................................................................... 88

1. THE EFFECTIVE INTEGRATION OF ICT IS PRIMARILY A PEDAGOGICAL, NOT A TECHNOLOGY ISSUE ...... 89
   Challenges to transmissionist pedagogies ................................................................. 89
   Challenges to shallow constructivism ........................................................................ 92
   Issues of Classroom Control ...................................................................................... 96
   Three Kinds of Digital Literacies .................................................................................. 97
2. FLUENCY WITH TECHNOLOGY DOES NOT TRANSLATE AUTOMATICALLY INTO THE ABILITY TO TEACH
   EFFECTIVELY WITH IT .............................................................................................. 103
3. CHANGES TO TRANSMISSIONIST OR PRESENTATIONAL PEDAGOGY AND CONVENTIONAL TEACHING
   APPROACHES ON CAMPUS YIELD SIGNIFICANT RESULTS. ....................................... 108
   Conventional Introductory Courses in Technology ....................................................... 108
   Compulsory Courses with a Strong Educational Context ............................................ 109
   Well-constructed Digital Environments Provide Engaging and Meaningful Interaction for Students114
4. DISCONNECTS BETWEEN CAMPUS AND PRACTICUM EXPERIENCES WITH TECHNOLOGY INTEGRATION
   IMPEDE THE EFFECTIVENESS OF TEACHER PREPARATION ....................................... 119
5. NEW APPROACHES TO PROFESSIONAL DEVELOPMENT PARTNERSHIPS AND TO FIELD PLACEMENT
   practices show promise in bridging the gap between campus and practicum experiences. 125
   CUCA Partnerships ...................................................................................................... 126
   Cohort Experience ....................................................................................................... 128
7. TECHNOLOGY, INFRASTRUCTURE AND SUPPORT STILL PRESENT CONSIDERABLE CHALLENGES ...... 139
   Introductory courses ................................................................................................... 139
   On campus technology infrastructure ......................................................................... 140
   Learner Focused Networks .......................................................................................... 142
8. INNOVATION IS OFTEN A LONELY ROAD ............................................................................. 148

CONCLUSION ..................................................................................................................... 153

ALIGNMENT BETWEEN RESEARCH LITERATURE AND FINDINGS ........................................ 153
GAPS IN THE RESEARCH LITERATURE ............................................................................. 155
   What can be done differently? .................................................................................... 155
   Evaluating Innovations ............................................................................................... 156
   N-Generation Teachers .............................................................................................. 156
   Partnerships ................................................................................................................ 158
   Digital Environments .................................................................................................. 159
   Policy Questions ......................................................................................................... 160
   Technology Infrastructure ........................................................................................... 160

RECOMMENDATIONS ........................................................................................................ 162
INCREASED NUMBERS OF FACULTY MUST ADDRESS MEANINGFUL TECHNOLOGY INTEGRATION ACROSS THE ENTIRE RANGE OF COURSES OFFERED IN PRE-SERVICE PROGRAMS. ......................................................... 162

Context: .............................................................................................................................................. 162
Implications for universities ............................................................................................................... 163
Implications for Government............................................................................................................ 164

CONTINUED PROVINCE-WIDE DESIGN RESEARCH..................................................................................... 165

Context: .............................................................................................................................................. 165
Implications for the universities ......................................................................................................... 166
Implications for government............................................................................................................. 167

THE EXISTING DISCONNECT BETWEEN CAMPUS AND PRACTICUM EXPERIENCES WITH TECHNOLOGY INTEGRATION MUST BE ADDRESSED. ....................................................................................................... 168

Context: .............................................................................................................................................. 168
Implications for government............................................................................................................. 168
Implications for universities ............................................................................................................. 170
Implications for schools and school districts ..................................................................................... 170

TEACHER PREPARATION MUST INCLUDE COMMITMENT TO THE PROFESSIONAL DEVELOPMENT OF EXPERIENCED TEACHERS. .............................................................................................................................................. 171

Context: .............................................................................................................................................. 171
Implications for government............................................................................................................. 172
Implications for universities ............................................................................................................. 174
Implications for schools and school districts ..................................................................................... 174

ROBUST, INNOVATIVE AND EFFECTIVE DIGITAL ENVIRONMENTS SHOULD BE DEVELOPED AND INCORPORATED INTO A WIDE VARIETY OF CAMPUS AND PRACTICUM EXPERIENCES. ................................................................. 175

Context: .............................................................................................................................................. 175
Implications for government............................................................................................................. 175
Implications for universities ............................................................................................................. 176
Implications for schools and school districts ..................................................................................... 177

REVISE INTERIM CERTIFICATION GUIDELINES ........................................................................................ 178

Context: .............................................................................................................................................. 178
Implications for Government............................................................................................................. 179
Implications for the Universities .................................................................................................... 180
Implications for Schools ..................................................................................................................... 180

REFERENCES ......................................................................................................................................... 181
Introduction

The Importance of ICT within Teacher Education

Preparing teachers today requires critical examination of what it means to teach and learn in increasingly networked, technology-rich classrooms. Most young people entering teacher preparation courses in Alberta have not, themselves, experienced such schools. By way of small example, the Web as most of us know it today burst upon the public only in 1995, by which time many of these students were already well into the education system. Demographically, they and many of the students who will follow them for the next ten years, have been shaped by an education system that is still struggling to make the transition to teaching and learning in a post-industrial era.

K-12 schools and universities are making progress in equipping and networking their institutions, and national symposia (Pan Canadian Educational Research Agenda 2002; Canadian Association of Deans of Education, 2004) have explicitly addressed issues of teacher preparation, technology and learning in order to develop clearer understandings of the “strengths, needs, opportunities, and challenges” (La Grange and Foulkes, 2004, p. 4) facing faculties of education as they acknowledge the ubiquitous presence of technology in all environments where people communicate, create and acquire knowledge. However, the process of teaching and learning with technology is still in early enough stages that teachers and university faculty are only starting to come to grips with the changes to pedagogy required to engage students in technology-rich learning environments. As Karsenti et al. (2002) note, “in just a few years, the Internet and the Web have become for many people a virtually indispensable fact of daily life.” They cite an October 2000 survey of Canadian students conducted by the Angus Reid group that reveals that “Canadian students have better access to the Internet than any others in the world except in Scandinavia” (Karsenti et al., 2002). Disturbingly, however, a study that situated technology use by faculty at the University of Sherbrooke within the context of national and
international research, discovered that the lowest level of technology use “occurs in faculties of education, where teachers are prepared to meet the challenges of the new millennium” (Larose et al., 1999). There, they discovered, education faculty displayed much less favorable attitudes to teaching with technology than their colleagues in other faculties, and experienced a significantly higher level of anxiety about technology use.

That is, technological change has been so rapid and its implications for teaching and learning so profound, that faculties of education have not yet “fully considered or understood the best ways to proceed in teacher preparation in a digital world” (La Grange and Foulkes, 2004, p. 4).

Living a transition of this magnitude, new teachers cannot depend neither on their own experience of K-12 schooling, nor yet on the widespread use of technology for teaching and learning in post-secondary programs to provide either the images or the expertise they will need to move their own practice beyond what is currently conventional in schools and universities. Thus, understanding the role of teacher preparation programs in creating intentional environments in which pre-service teachers can better explore and develop effective pedagogies for a knowledge era is essential.

The responsibility for preparing qualified and competent teachers … continues to rest primarily with teacher education programs at higher education institutions. Whether by design or by default, then, this means that teacher educators—those who teach the teachers—are now the linchpins in educational reforms of all kinds (Cochran-Smith, 2003, p.5).

Alberta’s Information and Communications Technology (ICT) Program of Studies has several features of particular importance to teacher preparation programs. While the ICT Program of Studies does not identify itself as an agent of educational reform, it clearly has the capacity to be so in terms of the implications of wide-spread and effective technology use in schools. (1) As technology is best learned within the context of applications, activities, projects, and problems that replicate real-life situations, the ICT program of studies is structured as a “curriculum within a
curriculum", using the core subjects of English Language Arts, Math, Science and Social Studies as a base. No living discipline outside schools remains untouched by the impact of ICT. What we know and how we know it have been forever transformed by technology. Practitioners in every field of endeavour outside schools do their work, make discoveries and challenge existing knowledge and structures in ways forever transformed by technology. Schools are not deeply connected to these changing knowledge bases and practices in the world outside their walls, nor yet to power of technology (whether for good or for ill) to do things teachers cannot even imagine. For many teachers, curriculum remains an unproblematically static body of knowledge that must be "covered", "transmitted" and tested. The genuinely creative and effective use of technology for learning challenges this basic mindset.

(2) The vision of the Alberta program of studies extends far beyond the acquisition of computer skills and competencies. It emphasizes technology as a "way of doing things" – the processes, tools and techniques that alter human activity. As a curriculum it specifies what students from Kindergarten to Grade 12 are expected to know, be able to do and be like with respect to technology. This ICT curriculum provides a broad perspective on the nature of technology, how to use and apply a variety of technologies and the impact on self and society.

Ethical considerations form a foundational part of the ICT Program of Studies. It acknowledges the cultural and practical impacts of ICTs both locally and globally, and makes explicit links between technology, the environment, economics, and politics. It raises specific questions about privacy, intellectual property, and personal ethical behavior in digital environments. Less explicitly, the foundational aspects of the Program of Studies also create spaces in which students can begin to experience and critique the capacity of ICTs to bring forward voices that have been silenced, and examine its capacity to marginalize and endanger others; to bridge or to widen the gap between those who have and those who do not; and to commercialize or to free human interaction.
Embedded in issues of a world that technology is, itself, changing, ICTs are a considerable force to be reckoned with. One of the strengths in current research identified by the Canadian Association of Deans of Education (CADE) in a 2004 report, is an emerging understanding in educational theory is that technology is a pedagogical matter, and that the impact of ICTs on teaching and learning have ethical, political, policy and research implications. Thus, seemingly straightforward questions about how best to design learning environments that actually do immerse students in applications, activities, projects, and problems that replicate real-life situations are themselves, complex, living and frequently disputed. For teacher educators, such questions require critical attention to the ways in which course and practicum experiences with ICT within the context of core curricula and pedagogy help or hinder the preparation of pre-service teachers to work in meaningful, creative, thoughtful and socially just ways with technology.

(3) Learning with technology, as distinct from learning about technology has the capacity to transform learning environments in ways that are difficult for most educators to imagine. Coupled with the struggle some adults have in using basic computer functions such as email, search engines, and presentation software is the much larger issue that the children in today’s schools have never known anything other than a digital world. For the first time in human history, the young are more confident and more fluent with the dominant technologies of the times than the adults charged to teach them. Prensky (2003) notes that:

there are important, never-before seen differences between the generation that grew up with digital technologies (Digital Natives) and the generation that grew up before these technologies….The new abilities, skills, and preferences of the Digital Natives are to a large extent misunderstood and ignored by the previous generation of educators….  

While acknowledging that there are demonstrably good things happening with technology in Canadian (and indeed, international) classrooms, Bereiter (2002) also emphasizes that schools are fundamentally stuck in their thinking:

Coming to Teaching in the 21st Century
Something is going on in elementary schools across North America that might strike the detached observer as insane. Millions of dollars are being poured into high-tech equipment that is used mainly to produce the kinds of ‘projects’ that in an earlier day were produced using scissors, old magazines, and library paste. At the same time, and in the same schools, a back-to-basics movement has teachers obsessively concerned with covering traditional content and preparing students for tests.

One very naive response to this situation discerns no inconsistency. The computerized cut-and-paste work is believed to be teaching students computer skills that will insure their futures in the 21st century.

That is, while the Alberta ICT Program of Studies rest on a multifaceted and compelling vision of the role of ICTs in society, in teaching and in learning, the translation of this vision into the reality of university and K-12 classrooms is a far more complex undertaking than the simple issue of how to train pre-service and experienced teachers in the use of computer applications.

The implications of this complexity are enormous. Currently, most faculty and most experienced teachers in Alberta (that is, the ones who would conventionally provide models of exemplary teaching for practicum students) are, themselves, only beginning to learn how to think and work in new ways with technology, and to consider pedagogical, social and ethical issues in their planning and teaching. *Computers in the classroom: Opportunity and challenge*, a report on computer use in Canadian schools released by Statistics Canada in September, 2004 paints this picture:

The majority of school principals (76%) reported that more than 75% of teachers possessed the required technical skills to use computers for administrative purposes - preparing report cards, taking attendance and recording grades. However, fewer than half of school principals felt that the majority of teachers had the necessary skills to
integrate computers into their lesson plans or to engage their students in the use of computers to enhance learning.

There was no real difference across elementary and secondary school teachers with respect to the percentages able to use computers for administrative purposes. However, a smaller proportion of principals of secondary schools (39%) felt that 75% or more of the teachers possessed the required technical skills to foster students’ effective use of computers, compared to 49% of principals of elementary schools. This may partly reflect the fact that computer applications tend to be more advanced at the secondary school level.

Private, small and rural schools were less likely to report that many teachers possessed the required technical skills for preparing report cards, taking attendance or recording grades than their public, large and urban counterparts.

Thus, the old “follow the expert” model of teacher preparation becomes troublesome in significant ways, contributing in no small measure to what Bereiter calls the insanity of common practice with technology, or that Papert (2004) describes as strapping the jet engine of new technologies to the horse and buggy assumptions of conventional schooling. In these cases, says Papert, one just ends up shaking the buggy to bits and scaring all the horses, and the job of curriculum designers becomes to keep the power of the technology engine down to a level at which it shakes nothing up at all.

Finding ways to bring educators’ attention to the implications of digital technologies for learning, to leverage rather than to dampen their power and to bring those technologies into classrooms in increasingly meaningful, effective, innovative and just ways is one of the tasks of teacher education programs.
Design of the Study

If the way we think of change is limited by imagining things very much like the ones we know (even if ‘better’), or by confining ourselves to doing what we know how to implement, then we deprive ourselves of participation in the evolution of the future. It will creep up on us and take us unawares (Papert, 2004).

Computers in schools are not a new phenomenon; they have been in labs and classrooms in increasingly large numbers for at least the past twenty years. However, their presence has been slow to translate into substantially changed practice or widespread use except in relatively straightforward applications such as email, word processing and presentation software, examples of what Norton and Wiberg (1998) describe as second generation technology use: applying applications to familiar problems and tasks. Familiar forms of teacher preparation are often focused

on the form of regulations meant to insure that teachers know how to use the technologies. For example, teachers may be required to demonstrate particular technological skills, such as those necessary for developing electronic portfolios and web pages (International Society for Technology in Education, 2000) There is little evidence that…teacher educators have examined the complexities of ongoing technological changes as they pertain to…teacher education.” (Hinchman and Lalik, 2004, p. 85)

As Papert suggests, if teacher educators confine themselves to doing what we currently know how to do in implementing ICT, and if we think of teacher preparation only in terms of ensuring that teachers know how to use unfamiliar technologies in largely familiar ways, the full force of our digital future is likely to creep up on us and take us unawares.

As Karsenti et al. (2002) demonstrate, there is genuine urgency to move ICT in pre-service experiences from the margins of an educational specialty to mainstream explorations of how people learn in increasingly varied digital environments. Their study of the motivation of future
teachers to integrate ICT into their teaching suggest five important factors in pre-service teachers’ ability and confidence to learn how to use technology in increasingly creative, robust and meaningful ways:

1. the pedagogical integration of ICT in the classrooms in which they are placed for practicum experiences;
2. the future teacher’s degree of computer literacy;
3. the pedagogical integration of ICT by instructors during university education of future teachers;
4. a future teacher’s expectations of success in integrating ICT;
5. the value placed on ICT by future teachers.

Two of these factors—practicum opportunities to integrate ICT effectively, and pedagogical integration of ICT during pre-service education—form the research context for this study. In particular, we will focus sharply on innovative teacher preparation projects in Alberta in order to understand more about how universities and schools are attempting to move themselves beyond current best practices in teacher preparation in ICT integration.

How This Study Was Carried Out

The Deans of faculties of education in each of the degree-granting institutions in Alberta—the University of Lethbridge, University of Calgary, University of Alberta, King’s University College and Concordia University College of Alberta nominated sites and/or environments in which they felt emerging practices in teacher preparation were particularly effective in preparing and supporting pre-service teachers to use technology for teaching and learning within the framework for ICT established by the Alberta program of studies. These sites and/or environments included university courses and experiences as well as field placements, and form the basis of a study of emerging practices in Alberta teacher preparation institutions and school jurisdictions that prepare and support pre-service teachers to use technology effectively for teaching and learning.
The objectives of the study were to:

- identify and describe emerging, innovative pedagogical practices that prepare and support pre-service teachers to integrate technology effectively in their practicum and pre-service education;
- situate these emerging practices within the context of the research literature;
- generalize themes from individual cases that add to the body of research knowledge and theory about the factors that contribute to the successful and sustained use of innovative technology-based pedagogical practices within teacher education;
- provide recommendations for future action in terms of teacher preparation.

As in all Canadian universities, institutions across Alberta illustrate “different stages of development, different methods of ICT integration and different issues with respect to technology and education” (La Grange and Foulke, 2004, p. 19). And as in all universities, each faculty has been engaged with issues of effective ICT integration for years, developing approaches to ICTs to serve the needs of their particular contexts. Smaller universities grapple with questions of how to introduce ICTs into existing programs; larger ones, with helping faculty make the shift from understanding technology as a specialized domain of educational psychology and “techies” to the more broadly based view that technology, today, has become every educator’s business.

This study was not designed to evaluate programs or participants, nor to describe the full range of existing ICT courses on any campus to determine how well Alberta teachers are being prepared to teach and learn with technology. That would be a study of a very different kind. The point of interest in this research is to understand the issues that universities are grappling with in courses or approaches they, themselves, identify as innovative, or as emerging practices.

At first glance, the implications of this approach may not be readily apparent. Why spend time looking at only one or two examples from each campus? Why have universities self-select and nominate programs? What can be learned, and by implication, what can be generalized?
First, while we have emphasized that the rate of change in technology in the last ten years has caught institutions struggling to understand the best ways to proceed in teacher education, we must situate that claim within the context that people have been thinking about, and working with, technology in education for a very long time. Computers have been in schools for decades, and faculties of education have cultivated technology specialties for even longer. That means that there are certain well-established ways of thinking about technology both within those faculties and in the minds of those teachers and teacher educators who feel that technology is not their domain. Thus, innovative practices in technology integration address both issues in a rapidly changing world and within commonly held understandings of what “computer literacy” or fluency with technology might mean for teaching, learning and teacher preparation. As odd as it sounds, there is a status quo even to this rapidly changing area: courses that departments have always taught; longstanding practicum arrangements; and approaches to teaching that individuals have always used.

In making a case for design research, Bereiter (2002) stresses that such a context presents inevitable challenges for innovation. How do new ideas take hold within the context of ordinary thinking that defines the very terms by which innovations must then defend themselves? Given that the call for research and practice demands new thinking, it is helpful, then, to understand something of the issues that innovations are designed to address. When people step out of their comfort zones to try genuinely new things, it is possible to understand far more than the new things, themselves. In both the motivation for innovation and in the specifics of implementation, one can gain insight into what is perceived to be working, and what is not. Furthermore, it then becomes possible to acknowledge, and not to repeat, the fate of so many innovative efforts - sporadic and discontinuous efforts that seldom win out against ideas that have a longer institutional history.

Second, while each university in Alberta has its own approaches to ICT integration, each also acknowledges either implicitly or explicitly that some things have to be done in new ways. It is
those “new ways” that we report on here as emerging practices, trial balloons and more-or-less established niches within the larger approaches of each faculty. Because the use of ICTs for teaching and learning, itself, is changing so rapidly outside schools and institutions, we chose to pay attention to what each faculty identified as one initiative on the leading edge of their work with technology. Where was each devoting particular attention to innovation?

Each was asked to identify emerging and innovative practices from which themes and examples describing effectiveness, as well as related claims, concerns and issues could be derived. No a priori definitions of effective teacher preparation practices were offered. Instead, the research design assumed that an understanding of such practices, analyzed within the context of current literature on ICT integration and teacher preparation, would be one of the outcomes of the study itself. It is hoped that what emerges is increased understanding of the ideas, concerns and issues that lie at the leading edge of thinking in Alberta universities concerning innovative and effective ICT integration in teacher education.

Methodology:

Interviews

Each nominated faculty member was interviewed on campus, using a semi structured format. Interview questions for all participants may be found in Appendix A. These interviews were videotaped. Where appropriate, one or more classes were also videotaped.

Students from each class volunteered for semi structured, videotaped interviews, and we chose randomly from among each group that agreed to participate. On occasion, we interviewed participants separately, and on others, interviewed the students in small groups.

We were able to observe a small number of these students in their practicum placements, focusing on how students were able to draw upon, or extend, what they had learned in their courses as they integrated ICT in the learning experiences they created for children. Cooperating teachers for the practicum placements were selected by each university using their usual
processes for assigning student teachers. We contacted all school districts, principals and cooperating teachers who accepted these student teachers. Although we explained carefully that the study was not designed to evaluate the university programs, the student or cooperating teachers, nor the participating schools, some were suspicious that they were in some way being "checked up on", and refused to permit access to the classrooms. That suspicion in itself is a finding we examine in some detail later in the report. Others found that the processes required to obtain ethical approval from the school districts was simply too onerous, given time constraints. Students we were not able to observe in their practicum placements agreed to correspond with us by email about the ways in which their campus experience had helped prepare them for their student teaching experience.

Data

Data included:

- taped and transcribed interviews;
- videotapes and/or notes from direct observations in university/college and in practicum classrooms;
- artifacts of teachers and student-teachers planning and teaching such as: digital photographs, video clips, journal reflections; student teacher planning and implementation of studies;
- notes of Research Committee meetings;
- email and/or online communication with researchers and participants.

Research Committee

Participating faculty, Alberta Learning stakeholders and the primary researchers met and corresponded over the course of the study. Meeting during the course of the research, and online as required, this group helped provide a context and a methodology through which emerging themes, examples, claims, concerns and issues could be understood, subjected to critique, and taken into account. An important purpose of the group was to generate consensus...
with respect to as many of the themes and their related claims, examples, concerns and issues as possible. Any areas around which consensus was not achieved were designed to be flagged as possible questions for further research.

It was also hoped that the range of conversations and experiences afforded by the study would, themselves, be educative for participants, giving them perspectives on the work of all participating universities as well as questions or ideas for subsequent research.

**Videotaping**

Because the question under study involves effective practices involving ICT, we have used contemporary technologies as part of the research process. In its final form, findings are presented both in a written report and an accompanying DVD that comprises an edited videotape that demonstrates and interpret in detail the themes that emerge from the research.
Review of the Literature

Introduction

We live in a high-speed, wired world, where digital technology is interwoven into the fabric of our lives and our society. It is part of our homes, our businesses and our schools. Tapscott (1999) asserts that we need to look at youth in relation to how best to use technology in education. He refers to youth as the Net Generation or N-Geners. Our young people are the first generation “to grow up surrounded by digital media…Today’s kids are so bathed in bits that they think technology is part of the natural landscape” (p. 7). Prensky (2001) refers to students as Digital Natives for they are “all ‘native speakers’ of the digital language of computers, video games and the Internet” (p. 1). People who entered and adopted this networked, digital world and were not born into it are but Digital Immigrants (Prensky, 2001). Educators and teacher educators, who do not find technology as commonplace, are being challenged to think differently about teaching and learning with technology.

Preparing teachers for the 21st century requires a close look at what it means to teach and learn in increasingly networked, technology-rich, digital classrooms. Teacher preparation programs need to create intentional learning environments, where pre-service teachers can explore issues that are relevant and develop pedagogies that are effective for a knowledge era. They need to develop new images and expertise to design and facilitate meaningful learning with technology.

Technology as Commonplace in the Student World

Connectivity

Surveys conducted as part of the Pew Internet and American Life Project showed that, by 2002, “60% of America’s children, more than 43 million children under age 18, use the Internet. About 78% of those between the ages of 12 and 17 use the Internet …more than one in five households
with children (23%) have broadband connectivity through digital subscriber line (DSL) technology or cable modems” (Levin & Arafeh, 2002, p. 1). In England, a study of young people ages 5 to 18 and their parents found that, in 2002, 81% of homes had a computer, and the majority of the households accessed the Internet from home via a telephone modem. Of the young people, 92% used computers at school and 75% used computers at home, with 22% using computers only at school and not at home. On average, participants used computers 10 hours per week, with approximately one third of the time spent playing games. Researchers also found that 54% of parents who did not have a computer at home believed that, if their child had access to a computer at home, the child would achieve better results in school (Becta, 2002).

A study conducted by Statistics Canada (2001) of urban and rural Canadians aged 15 and over found that 52.8% of Canadians had access to the Internet and 42.2% had an Internet connection at home. Further, Statistics Canada (2002) reported that, in 2001, 7 in 10 households are online daily. 3 out of 5 households reported spending 20 or more hours per month on the Internet. In a 2000 study, Corbett and Willms (2002) reported that 88% of Canadian 15-year-olds have access to computers in their homes and 69% have access to the Internet. Their study indicated that 81% of them use computers in their homes daily. Corbett and Willms (2002) noted that, of the 32 countries that participated in the study, Canada ranked 11th in relation to student access to computers in their homes. Iceland and Netherlands have achieved near universal access.

Given computers and Internet access in their homes, what are Canadians doing with this technology? Statistics Canada (2002) reported that, in 2001, 25% of the households used the Internet for work-related purposes. This study also reported that 50% of regular home Internet users utilize the Internet for training and education. Further, they reported using the Internet to solve problems and to do research. Dryburgh (2001) reported that almost “84% of Internet users connect to e-mail, and many use it as a daily communication tool” (p. 10) and greater than “one third of Internet–users use it to play games...most common among 15 – to 19-year olds (63%)” (p. 8).

Coming to Teaching in the 21st Century
Dryburgh (2001) and Statistics Canada (2002) note that, in 2001, Alberta and British Columbia had the highest Internet use of Canadian provinces and territories. Statistics Canada (2001) found that 60.3% of Alberta people age 15 and over who participated in the study had accessed the Internet and 47.7% had Internet connection at home. In contrast, Corbett and Willms (2002) reported in 2000 that 91% of Alberta 15 year-olds had a computer at home and 73% had Internet connection at home. It is clearly evident that in Alberta a large majority of youth have access to computers and the Internet.

**Net Generation and Use of Technology Outside of Schools**

Growing up with digital media and the Internet has resulted in the Net Generation’s ubiquitous use of the new technologies. Youth do not necessarily approach digital media and network technologies as an add-on in their worlds. Rather, it is very much an integral component of their worlds.

Tapscott (1999) claims that youth use the Internet to:

- manage their personal finances; organize protest movements; check facts; discuss zits;
- check the scores of their favourite team and chat online with its superstars; organize groups to save the rain forest; cast votes; learn more about the illness of their little sister;
- go to a virtual birthday party; or get video clips from a soon-to-be-released movie (p. 7).

In *The Future of Children* (2000), 72 children ages 5 to 18 were surveyed from Plugged In and The Computer Clubhouse in late 1999 and early 2000. The children reported participating in a variety of computer-based activities. Such activities included traditional educational projects such as writing, researching school projects and using it for homework assistance. Their new hobbies included e-mail, online chats, programming and web-page development. They noted that drawing pictures, surfing the web, writing letters, and game playing were some of their favourite activities. The study also revealed that the children valued computers in their lives for
“entertainment, a tool to accomplish a goal, and a vehicle leading toward present and future competence, autonomy, and empowerment” (p. 187).

Another example of the creative use of digital technology with youth is the use of audio books. The *Calgary Herald* reported how teenagers are accessing audio book websites and digital books using MP3 technology (Harris, 2004). In addition to reading books, youth are listening to them. However, the richness of the multi-modality provided by the digital media extends both more deeply and more broadly, in the lives of children and youth today.

Clifford (2004) suggests that digital experiences that are a regular part of students’ lives outside of school are fundamentally different ways of thinking and interacting with others. First, hypertext, graphics and sound have created knowledge structures that are fundamentally 3 dimensional. Every kid who surfs the net knows about this, even if they cannot articulate what they are doing in these academic terms. So does every gamer. Second, students are far less interested in receiving information that others think they should have, and far more interested in creating personalized spaces where they can download what they want, when they want it, how they want it. They want to be immersed in environments, in which they can direct perspectives, request others to provide information they need and surround themselves with sound and pictures. They want to make things happen in these environments. As part of a remix culture, they expect to be able to re-use and re-purpose digital objects at will. Third, their literate world includes time as a crucial dimension. Late breaking news is reported to the tenth of a second; they like to cut and jump quickly between and among sequences; they multi-task. Fourth, they are increasingly creating a public, not just an audience, for their work. They contribute to fan fiction sites that invite others around the world to view episodes of favourite film and television shows through different lenses. They critique dominant power structures in phenomena called “culture jamming” or “sniggling”. Think of Adbusters as a mainstream version of what many young people are doing in their personal weblogs, or blogs. Fifth, they chat with one another in real time and maintain

Coming to Teaching in the 21st Century
complex asynchronous relationships in gaming and other digital environments. They wear computers, and they carry their handheld devices and cell phones everywhere.

If this is the world of youth outside of school, how are digital media and networked technologies being used within the formal school experience?

_Digital Technology and Connectivity in Canadian Schools_

Burns and Ungerleider (2002-2003), referring to the Pan-Canadian Education Indicators Program (PCEIP), report finding in 2000: “88 per cent of elementary and 97 per cent of secondary school students attend a school that has Internet access for instructional purposes” (pp. 27 - 28). This concurs with a Statistics Canada (2004a) survey conducted from October 2003 to January 2004, with a response from approximately 6,700 elementary and secondary schools. In the report, it was found that Canadian schools have near-universal access to computers and connectivity to the Internet. The _Connectivity and ICT Integration in Canadian Elementary and School Schools: First Results from the Information and Communications Technologies in Schools Survey, 2003-2004_ by Plante and Beattie (2004), reports a median of one computer for every five elementary and secondary school students in Canadian schools. Australia and the United States have the same ratio.

Plante and Beattie (2004) report that within Canada, the median varied among provinces and territories. For example, Quebec, Ontario, Prince Edward Island and British Columbia had the highest student per computer ratio (5 or greater than 5) and the Yukon had the lowest ratio with 2:9 students per computer. Alberta had a 4:1 student-to-computer ratio. Further, they found 5:5 students for every one Internet connected computer in Canada compared to 4:5 students per Internet connected computer in Alberta.
It is evident that access and connectivity issues have been addressed within various school systems within Canada. However, a serious concern reported by the majority (almost 67%) of principals was financing information and communication technology (ICT) in their schools. Aging of computers, obtaining copies/licenses of software, purchase and maintenance of computer technology, and training for teachers were identified as ICT challenges confronting Canadian school principals in 2003-2004 (Plante & Beattie, 2004). Given these challenges, a large majority of Canadian school principals slightly or strongly agreed that:

- ICT allows teachers to broaden and enrich the curriculum (96%);
- Overall, ICT enables the curriculum to be more challenging and enriching (93%);
- ICT enables students to go beyond the prescribed curriculum, thereby facilitating an increased knowledge base (92%) (Plante & Beattie, 2004, p. 28).

**Computer Use in Schools**

Given financial investment in ICT in schools and students commonplace with technology, what are they doing with ICT in schools? It has been found that a disconnect exists between youth use of technology in their personal lives and how technology is being used in schools. Technology tends to be marginalized and used in instrumental ways within the conventional educational framework. The nature of technology use by youth in their personal lives tends not to exist or not to exist to the same degree within the educational context.

Becker (2000b) reported from the 1998 *Teaching, Learning, and Computing* (TLC) U.S.A. national survey that word processing was the most common application used in schools and that analytic or product-orientated software used within specific academic areas was used less often. Corbett and Willms (2002) reported that in the year 2000, approximately one third of the students used computers to assist them in learning school materials and only a quarter of the "students
reported using a computer for programming; drawing, painting, or graphics; or analyzing data with spreadsheets” (p. 15). Plante and Beattie (2004) concur and note the three most frequently integrated technology applications into teaching practices according to Canadian school principals are word processing, using the Internet/Intranet to distribute information and using software for individualized learning by special needs students and/or remedial programs. The least frequently used applications were “software supporting creative works’ and ‘spreadsheets and database software for simple data manipulation and statistical analysis’” (Plante & Beattie, 2004, p. 23). Further, they found that, although the majority of teachers and principals had e-mail accounts provided by the school jurisdiction or school, most students were not provided with e-mail accounts. Students used school computers to access their own e-mail accounts, using such programs as Hotmail or Yahoo.

In the Statistics Canada 2004 study, school principals acknowledged that the majority of teachers have the “technical skills to use ICT for administrative purposes such as preparing report cards, taking attendance or recording grades, while fewer had the necessary qualifications to effectively engage students in using ICT to enhance their learning” (Plante & Beattie, 2004, p. 25). Creating technological infrastructure in schools and providing technical training for teachers are critical steps in supporting the integration of ICT and have been a focus of educational stakeholders. However, greater attention needs to be given to using technology as an aid for connection and expression by students and teachers as an integral part of the learning environment needs. In another study, Peck, Cuban and Kirkpatrick (2002), found “that teachers most frequently used technology to support, rather than alter, their existing teacher-centered practices” (p. 477). They found the use of technology in core academic subjects to be the exception and not the norm. It was not used in innovative ways and had limited impact on student school learning experience. Becker (2000b) argues “most schools could not yet be described as well-equipped because they did not permit routine integration of computer technology into the learning activities of most classes” (p. 46).
Becker (2001) found that the most frequent use of computers by students in school occurs within four contexts: “separate courses in computer education, pre-occupational preparation in business and vocational education, various exploratory uses in elementary school classes, and the use of word processing software for students to present work to their teachers” (p. 2). Becker (2000a) found the highest rate of frequent use in secondary academic subject areas was “reported by English teachers (24%). Only one out of six science teachers, one out of eight social studies teachers, and one out of nine math teachers said students used computers that often during their class.” Becker (2001) found in secondary science, mathematics, social studies and other academic areas where computer technology could have an impact on acquiring, analyzing and communicating information was used in “only a small minority of secondary school academic classes” (p. 2). Further, Becker (2000b) found that in elective courses (e.g., business, computer, and vocational education), students were given opportunities to “explore the newer, more sophisticated and creative, analytic, and product-oriented software” (p. 51). The technology tended not to be integrated in core academic areas.

The school context does not generally reflect students’ use of technology in their personal lives. Although they tend to use technology to augment traditional school activities and tasks, does this use have an impact on student learning? Levin and Arafah (2002) reported a study of 136 public middle and high schools students in the United States from 11 to 19 years old in the Washington, D.C., Detroit and San Diego areas. Five metaphors presented depicted teenagers’ thinking about and use of the Internet for school. They described it as “virtual textbook and reference library,” “virtual tutor and study shortcut,” “virtual study group,” “virtual guidance counselor,” and “virtual locker, backpack, and notebook” (pp. 6-7). From their experience with the Internet in schools, these metaphors demonstrate how technology in school is used mainly to make conventional activities and instruments electronic. Given the power and capacity of ICT, should the metaphors be different? Should they reflect a change in how students perceive the world of learning with the technology?
In a study conducted in the United States in 1999, Bennett (2002) found that, with a massive infusion of computers into schools (ratio of one computer for every six children) and teachers having received training, there was an expectation that there would be an improvement in education. When he examined the National Assessment of Educational Progress scores there were "no significant changes in reading, mathematics, or science for the three age groups tested – 9-year-olds, 13-year-olds, and 17-year-olds – from 1994 through 1999" (p. 622). Bennett makes the observation that "the power of the electronic interaction is necessarily diminished because of the way computers must be used in schools today" (p. 622).

Similarly, Wenglinsky's (1998) research based on the data from the National Assessment of Educational Progress (NAEP) in mathematics found that technology can have a serious impact on student learning, depending on how the technology is used. He found with eighth graders, teachers who reported using computers for simulations and applications (e.g., spreadsheets used to support problem solving) that is generally associated with higher-order thinking demonstrated a greater grade level gain than students whose teachers' used computers primarily for drill and practice activities, generally associated with lower-order thinking. From the results, Wenglinsky argues "the indicators of professional development and higher-order uses of computers seem positively related to academic achievement in mathematics, while frequency of use is unrelated or even negatively related to them" (p. 31). From these findings, what matters in relation to teaching and learning practices is how students and teachers are using computers and how the computers are used to foster the development of higher-order thinking skills.

Why is there a disconnect between student home use and school use of ICT and how ICT is currently being used in schools? Becker (2000b) believes that six factors affect how students use and experience computers in schools: "(1) availability of computers in the classroom, (2) teacher computer expertise, (3) teacher philosophy and objectives for computer use, (4) teacher collaboration and leadership, (5) teacher judgments of class ability, and (6) school SES level" (p. 53). These factors reveal a number of challenges that impact meaningful integration of technology in various subject areas. For example, the issue of ease of access for just-in-time use
of computers is a challenge given school computer laboratory configurations and conventional schedules (blocks of time) for access to school computer labs.

**ICT Supported Pedagogical Practices**

Becker (2000a) would agree with Larry Cuban that computers have not changed the teaching practices of many teachers. However, he argues that, under certain conditions, computers will become “a valuable and well-functioning instructional tool.” He identifies three right conditions. First, teachers having moderate skill level and comfort in using the technology. Second, within the school structure, students having access to enough equipment and have daily class time using computers as an integral component of completing assignments. Third, teachers’ philosophy should support a learner-centered, constructivist approach to learning that values student interests in creating meaningful learning environments that integrate technology.

Teachers’ personal comfort and confidence in using technology and their own technical expertise affect how they approach the use of technology (e.g., add-on, integrated or infused) and how they design lessons and learning environments for student use of computers. Becker, Ravitz and Wong (1999) argue,

> what makes a good computer-using teacher is more than any one thing: technical knowledge about computers helps, so does experience in using computers professionally, and it also seems reasonable to expect that an exemplary teacher has the kinds of objectives for student computer use and employs the types of software that most likely result in student engagement and thoughtful effort, outside of class time as well as during class (p. 48).

Further, teachers’ philosophical approach to teaching and learning influences their use of technology. It was found that “teachers with the most constructivist teaching philosophies are stronger users of computers: They use computers more frequently, they use them in more...
challenging ways, they use them more themselves, and they have greater technical expertise” (Becker, 2001, p. 11). How they approach teaching and learning will determine the appropriate and effective use of technology. McKenzie (2000) argues we need to “stop seeing technology and networking as the goal”. Rather, we need to appreciate the “primary value of new technologies lies in their ability to enhance thinking, decision-making, and problem-solving skill.” Further, Laferrière, Bracewell and Breuleux (2001) indicate from the reviewed research literature, in relation to effects of online network technologies on student learning, that

…in elementary and high school classrooms the most innovative and promising practices center around authentic problem-solving, inquiry-based learning and collaborative knowledge-building. These findings imply that in order to meet the expectations of a knowledge society, the teaching profession has to rely less on teacher-centered methods such as lecturing, and more on learner-centered methods. Innovative teaching practices, however, must be closely linked to the school curriculum in order to reach any significant number of students (criteria of sustainability and scalability).

For sustainability and scalability in relation to innovative pedagogical practice to integrate technology effectively requires not only a change in practice, but a change in pedagogy. From the Second Information Technology in Education Study (SITES) research project that examined innovative teaching with technology in 28 countries, the Hong Kong research team was involved in two of its modules. The first Module (M1) focused on the extent that schools “adopted and implemented pedagogical practices that are considered important to education in the information society” (Kozma, 2003, p. 6). The second Module (M2) was designed to “identify and describe innovative pedagogical practices that use technology” (Kozma, p. 2003, p. 6). The Hong Kong SITES research team collected data for the Hong Kong cases and performed analysis in the local and international contexts in relation to innovative pedagogical practices using technology. What they identified is that technology can be quickly introduced into schools, but the “pedagogical innovations are generally incremental as these require changes at social, institutional and
personal levels” (Law, Yuen, Chow & Tong, 2003, p. 3). From the SITES Module 1 survey data, Law et al. (2003) found “it is much more difficult to change pedagogy than to change practice. Furthermore, it was much easier to ‘transfer’ practices, giving rise to very similar proportions of emerging practices around the world, but it is much more difficult to adopt new pedagogies, resulting in a much wider diversity in the proportions of emerging pedagogies in the different regions” (p. 10).

From the SITES-M2 research Owston (2003), as part of the research team, investigated 59 cases selected that would provide insight into “reasons why innovative pedagogical practices using technology are sustained and transferred” (p. 131). From this work, Owston (2003, 2004) developed a model for sustainability of classroom innovation that identified the following two sets of conditions need to occur: essential and contributions.

In his discussion of essential conditions, Owston (2003, 2004) acknowledges that teacher support is fundamental to sustaining the innovation. Teachers need to have a positive attitude and be enthusiastic about the innovation, take ownership of it and want to continue to develop teaching materials. Owston (2003) identified three factors that influence teacher support for innovation: “student support, the perceived value of the innovation, and professional development” (p. 137). Student support and enthusiasm impact teacher motivation and they too have a role in motivating teachers to sustain the innovation. Teachers need to believe what they are doing has merit and is worthwhile. “Teachers need to learn new skills and equally as important, they may need to unlearn beliefs about students or instruction that have dominated their professional careers. Thus, teacher professional development is at the heart of sustaining an innovation” (Owston, 2004, p. 5). In addition, administrative support is essential. Administration needs to be proactive in creating conditions in fostering the innovation, supportive and “frequently the visionary behind the school’s innovation, identifies personally with the innovation, often persuades and cajoles others into adopting his or her vision, and demonstrates ICT skills” (Owston, 2003, p. 45).
The minimum required to support the sustainability of the innovation is for the principal to be a gatekeeper who does not undermine the work.

Owston (2004) identified four contributing conditions for sustainability of innovations. First, there is need for support for others within the school who are not directly involved in the actual innovation. Second, the need for support from people outside of school, such as parents, community leaders, school district or Ministry of Education personnel. Third, funding plays a major role with innovations. Start-up funding is needed for many innovations and, when funding is withdrawn, over time stronger innovations tend to survive when essential conditions are met. Fourth, the presence of school, district and/or national policies and plans provide a framework of support for the pedagogical innovations.

Owston's (2003, 2004) model for sustainable innovations provides a framework for understanding the reasons why some technology-based innovations thrive and others fail. However, he argues that the process for sustainable innovation with technology begins by involving teachers and, if possible, administrators in the design of the innovation. They need to believe that the work has value and will benefit students. Further, “before and during the implementation teachers need regular professional development opportunities to share ideas with colleagues, reflect on implementation issues, and learn more about the innovation itself” (Owston, 2004, p. 9).

Given that this is what is occurring in schools and knowing what factors and conditions influence the development and sustainability of technology-based innovations, it is critical to consider this information when examining how post-secondary institutions are preparing pre-service teachers to integrate technology effectively. How are these institutions helping pre-service teachers to learn innovative pedagogical practice that effectively and appropriately integrates technology in support of meaningful learning?

Coming to Teaching in the 21st Century
Technology in Canadian Faculties of Education

In 2003, Industry Canada’s SchoolNet initiated an environmental scan to provide baseline information on the use of ICT by University Faculties of Education in Canada. In this study, Schad (2003) reported that 10 of 21 respondents did have ICT integration as a major faculty focus. The majority of the respondents indicated that, although it may not be a focus, it was important. 20 of the 21 institutions which participated in the survey indicated that they offer ICT courses. Ten institutions offered compulsory basic courses, three offered ICT courses as electives and three offered extensive programs. One institution indicated that it offers various elective courses, but was shifting to integrating ICT into methods courses (Schad, 2003).

In the Canadian University Faculties of Education study, four respondents indicated that there was extensive integration of ICT into courses offered across the faculty of education. Five respondents indicated no integration and seven indicated that integration across curriculum varied among instructors. Further, ten of twenty-one respondents indicated that their faculty was not planning to incorporate other ICT courses in their programs. However, seven respondents noted that their courses were under review and that further integration was a possibility. Only three respondents indicated that they were planning to include other ICT courses (Schad, 2003).

Therefore, it is evident from this environmental scan that there is a lack of continuity in relation to policy or philosophy and priority given to ICT in teacher education in Canada.

The Alberta Context

Through legislation, the Alberta Learning Ministry is committed to and supports technology-enhanced learning experiences for K to 12 students that directly impact teacher preparation programs. First, the Information and Communication Technology (ICT) Program of Studies mandated in September 2000 emphasizes "(1) the seamless relationship between technology and subject disciplines, (2) the process nature of technology itself, and (3) the co-existence of..."
KSAs (knowledge, skills, and attributes) for technology alongside those for the subject areas” (Jacobsen & Clark, 1999, p. 2). Second, a Ministerial Order requires all Alberta teachers who hold Interim Professional Certificates to demonstrate they understand:

j) the functions of traditional and electronic teaching/learning technologies. They know how to use technologies and how to engage students in using these technologies to present and deliver content, communicate effectively with others, find and secure information, research, word process, manage information and keep records (Alberta Learning, 1997, p. 2).

From their research, Fulton, Glenn, and Valdez (2003) claim the “most important driving force for technology integration has been the push of state mandates that require that all teacher preparation graduates either demonstrate technology competence or have fulfilled a certain number of course hours in technology use” (p. 4). The Alberta Learning Ministerial mandate has established a framework for innovative technological learning environments in schools. It pushes curriculum design and requires teachers to be responsible for designing learning that allows for the implementation of the ICT learning outcomes. For this to occur, according to Jacobsen (2001), it is “more about the fundamental changes to teaching and learning that are enabled and required by the new medium” (p. 3). Therefore, pre-service and in-service teachers need to grapple with how to design learning environments that integrate technology in a way that enhances the learning experience. Thus, what is the role of teacher preparation programs in preparing pre-services teachers to learn to do this?

**Challenges in Integration Technology in Teacher Education**

A number of researchers and research institutions (e.g., Duhaney, 2001; The CEO Forum on Education & Technology; Moursand & Bellefeldt, 1999; Pierson & McNeil, 2000; Schad, 2003) have identified various challenges and shortcomings that impact the integration of technology and learning. From the literature, six critical inadequacies have emerged. First, technological...
infrastructures, access to digital and network technologies within programs and in field experiences, maintenance and availability of current hardware and software and limited funding for training and technical support impact how pre-service teachers are prepared to integrate technology (Duhaney, 2001; Grabe & Grabe, 2001).

Second, stand-alone introductory technology courses do not adequately prepare educators for the classroom (Pierson & McNeil, 2000). This approach tends to be limiting, non-context-specific, provides little to no ongoing support and fails to provide opportunities for teachers to reflect on their beliefs and practices. Further, teaching educators basic technology skills does not sufficiently prepare them to appropriately integrate technology in the classrooms (U.S. Congress, Office of Technology Assessment, 1995). Abbot and Faris (2000) concur that successful technology training without pedagogical grounding tends not to lead to the integration of technology in teaching practice.

Third, ICT tends to be marginalized within teacher education programs (Karsenti, Brodeur, Deaudelin, Larose & Tardif, 2002). Modeling of how objectives can be accomplished using technology for instruction is rare (Pierson & McNeil, 2000). Grabe and Grabe (2001) claim that teacher educators may not be able to use appropriately and effectively technology in their teaching “because of their own lack of preparation, anxiety, or disinterest” (p. 22). Further, Cheryl Lemke, Executive Director of the Milken Exchange on Education Technology argues, “'There is inconsistency between what teacher-training faculty know about technology and what they are training teachers to do in their courses,'…'We can be confident that there is more technology awareness and experience out there, but it is not being used in teacher training to the extent nor in the manner we think necessary’” (Milken Family Foundation, 2003). Marginalization, lack of models, and lack of awareness of clients’ technological knowledge and skill set may have a negative impact on how pre-service teachers learn how to use and how to integrate technology in new and innovative ways.
Fourth, teacher educators need professional development opportunities to learn how to effectively integrate technology into their teaching practices and curriculum strategies (Pierson & McNeil, 2000). Schad (2003) reported that professional development tended to be technology training in how to use specific software through to course development. It is evident that faculty development needs to shift away from ‘one-size-fits-all’ workshops or ‘just-in-case’ training. There is a place for skill development. However, these types of training events do not provide the necessary time or opportunities for educators to reflect on their teaching beliefs and practices and to explore how technology can be woven into the learning environment and within their own contexts as they begin to implement new pedagogical approaches to teaching (Sprague, Kopfman & de Levante Dorsey, 1998).

Fifth, pre-service teachers want to learn appropriate strategies for integrating technology into teaching and learning (Pierson & McNeil, 2000). The CEO Forum on Education and Technology (2000) claims that studies in the United States have shown “less than half of the nation’s teacher preparation institutions require students to design and deliver instruction using technology. Even fewer require technology use in the student teaching experiences” (p. 1). In a Canadian study of Faculties of Education the question was asked, *What focus on ICT can your pre-service teachers expect in their program?* Three of 21 respondents indicated “no focus or minimal focus” (Schad, 2003, p. 9). Some of the other participant responses to this question, Schad (2003) reported are the following: “Several faculty members encourage students to gain an understanding of ICT by designing assignments that incorporate ICT and skill development” (p. 9); “Varies with the program and instructor” (p. 9); “Ten workshops, access to email, web space and a home directory during first education course” (p. 10); “One mandatory course plus an elective or expectations to use ICT in assignments” (p. 10); “Integration into methodology courses” (p. 10); and “ICT is not an end, but one of many solutions to be used” (10). From this research, it appears few of the faculties in the study as a whole have developed a focus and/or a commitment to the integration of ICT within and across their programs.
Sixth, in field placements, pre-service teachers expressed frustration over the lack of effective technology utilization and proficiency (Pierson & McNeil, 2000). Schad, (2003) reported that 5 out of 21 Canadian teacher preparation programs did not take into consideration pre-service teachers interest in ICT when placing students in their practicums. The other respondents indicated that ICT was one of a number of factors discussed in a cooperative process in determining pre-service teacher placement. Further, one respondent indicated that ICT was a factor of consideration for middle and high school but not for elementary placements.

Moursund and Bielefeldt (1999) argue that pre-service teachers may have access to technology in their field placements, but may not regularly use the technology during their field experiences. They may not be placed with classroom teachers and/or supervisors who can effectively advise, guide or mentor them in the use and integration of technology. Further, pre-service teachers may not necessarily have opportunities to observe or engage in technology integration or infusion with children in their field placements. From an Alberta Learning (2002) study conducted in 2001 of teacher preparation programs in Alberta, it was found that many participants indicated that schools were not using technology or using it in meaningful ways. One participant noted, “The school that I did my field experience in did not follow the ICT curriculum and had limited understanding about how computers enhance student learning” (p. 19). Other participants commented that they did not use computers in their placements and technology was not in the classroom. From the response to the study, “it appears that both faculties of education and school sites selected for practicum placements need to examine how they may enhance education students’ confidence in using technologies” (Alberta Learning, 2002, p. 20). Mullen (2001) concurs that pre-service teachers need to have opportunities to observe and engage in learning and teaching with technology in their field placements.

In conclusion, Tom Carroll, Director of Preparing Tomorrow’s Teachers to Use Technology project, states, “It is not enough to propose a new course in technology and except teachers to become technologically proficient” (Gale Group, 1999, p. 28). Rather, he proposes a systemic
reform in “teacher education so that technology is infused in every aspect of instruction” (Gale Group, 1999, p. 28). Willis, Tucker and Gunn (2003) concur, stating that the educational system tends to replicate itself. “For change to happen, perhaps pre-service and in-service teachers need to experience alternative teaching and learning models and strategies as part of their own education” (p. 10). In the research literature, various proposals on how to improve the use of technology and the integration of technology in teacher preparation programs are found. The challenge is not only in developing a vision and mission for change, but in implementing it in ways that lead to successful teaching and learning with ICT.

**What Needs to Change in Teacher Preparation?**

It is not simply a matter of adding technology to conventional practices in teacher preparation programs to achieve the goal of technology integration. “No important impact can be expected when the same old activity is carried out with a technology that makes it a bit faster or easier; the activity itself has to change, and such a change cannot take place in a cultural vacuum” (Salomon, Perkins & Globerson, 1991, p. 8). Educational stakeholders, especially teacher educators need to change how they approach and use ICT, change the routines (e.g., ICT as an elective, taught in isolation), change how they and the pre-service teachers think about teaching and learning with technology and change the pedagogical approach in relation to technology use. Jacobsen, Clifford and Friesen (2002) claim, “Learning how to teach and learn in new ways with technology requires imagination, intellect, creativity, and no small courage” (p. 368).

Strong leadership with an informed vision for technology integration and an ability to provide needed support are required both from senior administrators in teacher preparation programs and by departments of education. Fulton, Glenn and Valdez (2003) from their investigation into how teachers are prepared to effectively use technology in classrooms found the following:

Strong leadership from the dean or university administration, external funding, technical support for faculty and students, and incentives and recognition for faculty continue to be
foundational elements for a program that effectively integrates technology into the preparation of new teachers. These conditions are requisites for a teacher education program that seeks to prepare candidates to use technology effectively and they must be maintained over time (p. 5).

Creating and supporting such a vision, requires buy-in by all educational stakeholders. Developing policy and providing opportunities for people to discuss, debate and develop common understandings around programs that support innovative approaches to foster greater technology integration and/or infusion within and across the program.

To meet the challenges of supporting necessary changes, one strategy is to create an infrastructure framework to guide the conceptualization, implementation and institutionalization of such an approach to technology integration. In their examination of ICT in European countries, Hakkarainen, Lakkala, Rahikainen, Seitamaa-Hakkarainen and Leinonen (2001) found that fostering pedagogical and cultural changes within institutions and with individuals is difficult and requires time. They found the challenge could be met by creating four infrastructures of change: 1) technical infrastructure - access to new and emerging technologies and for educators to have the necessary ICT skills set; 2) pedagogical infrastructure - pedagogical models to guide meaningful learning with technology through such strategies as problem solving, collaboration, and inquiry; 3) social infrastructure – new technology should be a core component used in the educational process; and 4) epistemological infrastructure – educational stakeholders need to develop greater epistemological awareness to foster greater appreciation and understanding of the value of deep inquiry. In many situations, they found that the absence of some of these factors had a negative impact on the implementation of ICT. Therefore, stakeholders who are working to foster change in the integration of ICT need to carefully consider elements of each infrastructure framework and use that framework to guide the change process.
The Canadian Association of Deans of Education (CADE) hosted a national symposium in February, 2004 at the University of Calgary where faculty of education leaders discussed ICT integration. 32 of the 52 invited universities sent representatives to the symposium, along with representatives from Canada’s SchoolNet, symposium sponsors, guest speakers and a staff member. As a result of the symposium, LaGrange and Foulke (2004) reported the following five Basic Principles that emerged to serve as a conceptual framework for further dialogue:

Principle 1: “Approaches to curriculum and pedagogy in teacher education should respond to changing learner needs created by fundamental transformations in the world being brought about by the pervasive availability of ICTs, and the increasingly influential role of ICTs on how knowledge is accessed, produced, extended, and transferred” (p. 7).

Principle 2: “ICT integration should be inspired by precepts of social equity and justice” (p. 8).

Principle 3: “Educators’ experience with ICTs should be embedded within their professional preparation experiences, their professional practices, and within their future professional development activities” (p. 9).

Principle 4: “Teacher education should lead both in the educational uses of technology and in thinking critically about the use of technology in support of novel, inventive and imaginative forms of teaching and learning that transform or enhance learning environments” (p. 10).

Principle 5: “The use and practice of educational technology should be informed by critical research” (p. 11).
In addition, to these five principles, the symposium members identified Proposed Strategies that focus on “(A) ongoing national discussion; (B) research and funding; (C) advocacy; and (D) teacher education programs” (LaGrange & Foulke, 2004, p. 12) and seven recommendations to guide this work. This national consultation on ICT in faculties of education has provided Canadian faculties of education with a framework to guide future decisions and actions in relation to ICT integration.

Change – Technology Integration in Teacher Preparation Programs

From a program perspective, for ICT integration to be a major focus and/or interwoven component in the teacher preparation program, a number of factors need to be addressed. First, a more holistic approach that fosters the integration of technology within the program requires educational stakeholders to think differently about ICT. There has to be a shift away from thinking about it as a subject taught in isolation. Rather, it needs to be approached within a more ecological framework that supports and enhances the learning environment. From their research, Mills and Tincher (2003) confirmed that “technology integration is a development process” (p. 398). They claim that to prepare teachers to be technology integrators requires “a professional education curriculum that is infused with opportunities for teacher candidates to learn with technology and model technology use throughout their professional preparation” (p. 398). LaGrange and Foulke (2004) concur, stating “ICTs should be infused in a wide range of experiences throughout pre-service teachers’ professional preparation (i.e., from introductory and foundations courses, to practicum experiences, to continued professional development)” (p. 8).

According to Eifler, Green and Carroll (2001), the shift from a stand-alone technology course to an infusion model, from a faculty perspective involves three factors. One, resources need to be allotted to support the implementation of change. Two, sharing concerns and insights by faculty members about the new model influences the transition. Three, faculty members’ philosophical
orientation and differing attitudes toward technology affect the change process. These factors need to be seriously addressed, if change is to be effectively implemented and sustained.

Second, a shift in the learning paradigm needs to occur. Willis, Tucker and Gunn (2003) believe the “learning paradigm frames learning holistically, recognizing that the chief agent in the process is the learner” (p. 15). Intentional learning environments need to be designed to empower pre-service teachers to develop pedagogical and technological strategies concurrently. Abbott and Faris (2001) argue that technology integration into teaching practice not only requires technology training but must be grounded in pedagogy. Further, La Grange and Foulke (2004) report, “Implications for use of ICTs must be examined within the context of broader approaches to teaching and learning (e.g., inquiry-based and problem-based pedagogies and constructivist epistemology)” (p. 10). The success of this shift in the learning paradigm requires changing beliefs about teaching and learning. “If technology is to be used to improve student learning through collaboration, inquiry, and interactive learning, then teachers’ beliefs must be consistent with this kind of learning and teaching” (White, Ringstaff & Kelley, 2002, p. 6). Therefore, consideration needs to be given to the learning philosophy practiced within the program.

Third, designing learning from a constructivist perspective does not necessarily lead to deep, rich learning. In their examination of shallow versus deep constructivism, Scardamalia and Bereiter (in press) argue that a shallow approach has students engage in activities where “ideas have no overt presence but are entirely implicit” (p. 4). In contrast, deep constructivism involves

...practices such as identifying problems of understanding, establishing and refining goals based on progress, gathering information, theorizing, designing experiments, answering questions and improving theories, building models, monitoring and evaluating progress, and reporting are all directed by the participants themselves toward knowledge building goals (Scardamalia & Bereiter, in press, pp. 4 - 5).
Within this range, learners are “engaged to a greater or lesser extent with ideas and they have
greater or lesser amounts of responsibility for achieving goals, but the overarching responsibility
and means for advancing the frontiers of knowledge are either absent or remain in the hands of
the teacher or project designer” (Scardamalia & Bereiter, in press, p.5). Therefore, in designing
learning opportunities, consideration should be given to modeling for students and to giving them
the experience of a deep approach to constructivist learning with technology.

Fourth, curriculum and technology should not be treated as separate entities and consideration
should also be given the order of priority. Burns (2002) found that when working with teachers
and helping them to create an academic project using technology, the curriculum was an adjunct
and technology became the focus. In the minds of teachers, this resulted in technology
manipulation becoming more important than curriculum content. Further, Sandholtz and Reilly’s
(2004) research with in-service teachers found that assisting them to be innovative in their use of
technology is to begin with their strength in relation to instruction, learning and curriculum, with a
lesser focus on the more technical or mechanical parts of the technology. Gunter (2001) claims
that faculty need to provide pre-service teachers with technology skills, but they also to learn how
to teach with technology. In accord, members of the CADE symposium acknowledge “tension
exists between development of technical skills and development of the capacity to embed those
skills in professional practice” (La Grange & Foulke, 2004, p. 9). Therefore, pre-service teachers
need to observe and learn how to design learning around teaching, learning and curriculum
where technology is appropriately integrated to foster meaningful and pedagogically sound
learning experiences.

Fifth, pre-service teachers need to have curricular experiences that allow them to “examine the
images of the teacher role, the learning process, the specific subject matter, and the goal of
schooling our society” (Mullen, 2001, p. 462). Within the program, opportunities can be provided
where pre-service teachers and teacher educators grapple with critical issues. Experiencing
dissonance for the purpose of stimulating dialogue and as a catalyst for further investigation into
teaching, learning and technology integration may be one strategy to use within a program. Through critical reflective pedagogical discussions pre-service can develop a greater understanding of their role in the classroom and what fosters deep, rich learning with technology. From the literature, a number of themes have emerged that can form a foundation for such focused inquiry.

**Themes**

First, pre-service teachers need opportunities to explore and confront philosophical issues associated with teaching, learning, technology and the changing roles of educators and learners. For example, Laferrière, Bracewell, Erickson, Lamon, and Owston (2001) acknowledge that in networked classrooms, where both teachers and students have access to computers and the Internet, the classroom is no longer an isolated workspace. Communication beyond the classroom walls opens a new learning forum and collaborative opportunities for teachers and students in other countries (Law et al., 2003). The roles of teachers and students have changed. Using a constructivist approach alters the nature and types of academic activities and places responsibility for learning in the hands of learners. The ever-changing nature of technology and people’s relationship with technology are serious issues to be confronted, because of the impact they have on pre-service teachers’ attitudes and behaviours. Further, social justice, equity and ethical issues influence teachers’ beliefs and can impact their actions in relation to ICT integration. Part of this investigation relates to the foundational operations, knowledge and concepts outcome (F) category of competencies of the Alberta ICT Program of Studies (2000 – 2003).

Second, the notions of literacy and multiple literacies have a bearing on preparing teachers for knowledge era classrooms. Unsworth (2001) claims students in classrooms “need to understand how the resources of language, image and digital rhetorics can be deployed independently and interactively to construct different kinds of meanings. This means developing knowledge about linguistic, visual and digital meaning-making systems” (p. 8). To achieve multiple literacies
Coming to Teaching in the 21st Century

through a computer literacy program, Selber (2004) argues students need to have functional literacy – “students as users of technology” (p. 25), critical literacy – “students as questioners of technology” (p. 25) and rhetorical literacy – “students as producers of technology” (p.25). Using such a lens provides different perspectives on ICT in terms of the learning context and meaning making.

Third, how do teachers come to view and use technology in meaningful ways? Glenn (2002) argues it is not sufficient to focus on ICT as an object of study that results in teaching about computers. As stated earlier, it is much more than basic computer literacy skills. This may have been the experience many pre-service teachers had when they were in school. Rather, when ICT is an integrated component of the learning environment, teachers need to have a different skill set, aptitudes and knowledge. A critical starting point is self-efficacy for technology integration. Wang, Ertmer and Newby (2004) claim teachers’ self-efficacy “may be a significant factor in determining patterns of classroom computer use” (p. 231). Further, Mills and Tincher (2003) claim that as teachers work through the development process of technology integration “they begin to realize that technology is more than a teaching tool and then they start using technology to create learning environments that augment student learning” (p. 397). Ertmer, Conklin, Lewandowski, Osika, Selo and Wignall (2003) argue that, for teachers to effectively leverage the power of technology in meeting needs of students, they have to be given opportunities “to develop their own visions for, or ideas about, meaningful technology use” (p. 96). Further, they believe lack of information on the why and how of technology integration can “significantly decrease the potential impact that these powerful resources might have on student learning” (p. 96). They found that, as teachers develop more ideas about what is successful integration of technology, their confidence increases for the implementation of ideas. Opportunities for them to apply their knowledge and skills and learn from their experiences are important to their learning.

Fourth, one strategy to foster the development of new ideas is for pre-service teachers to have opportunities to experience alternative models and innovative strategies for teaching and learning.
that effectively model technology integration in education (Willis, Tucker & Gunn, 2003; Gunter, 2001). For example, Mullen (2001) argues, teacher educators “must demonstrate a critically reflective pedagogy in relation to how technology is presented in classes by having explicit rationale for the role of the technology in their instruction” (p. 462). Greater modeling by teacher educators within the program, as well as by partner teachers in the field placements will benefit pre-service teachers.

One proposed CADE strategy is networking for faculty members, pre-service teachers and in-service teachers. Specifically, they encourage pre-service teachers to access classroom electronic forums, view multiple models (e.g., multimedia and face-to-face access) of practice and participate in online communities of learners where they “engage in collaborative reflective practice with in-service teachers and education faculty members” (La Grange & Foulke, 2004, p. 13). Networking provides opportunities for expert and novice teachers to engage in discussion and learn from the activities using the various models and modes. Both novice and expert teachers can co-explore innovative pedagogical approaches in relation to designing meaningful learning environments that are supported through technology integration.

As noted earlier, there are issues in relation to students being able to observe exemplary models in innovative practice with technology. One solution is the use of teacher models presented as multimedia cases. Ertmer et al. (2003) state that multimedia or Web-based case “examples can be incorporated into an educational environment for self-paced exploration, as a small group reflection tool, or as an instructor-led activity” (p. 109). They note in the use of video, pre-service teachers “agreed that it was beneficial to hear the teachers in addition to seeing them. Exploring teachers’ beliefs helped students understand why teachers made the decisions that they did, and provided cognitive modeling of the integration tasks” (p. 107). Whether modelling occurs in a face-to-face situation or is conveyed through a medium, exemplary modelling can help pre-service teachers to appreciate new possibilities to further their understanding of the how and why
of learning with technology and can help them build their own vision of learning with technology in the classroom.

**Bridging Field Placement and Teacher Preparation Programs**

What occurs in teacher preparation programs within institutional classrooms in fostering the innovative use of technology to support meaningful learning should complement and help support the academic work within pre-service teachers’ field placements. Fostering the connection between campus and field is necessary to support the linking of theory to practice in relation to technology integration. Pre-service teachers need to observe and to learn technology integration in the field and to have opportunities to practice innovative approaches and engage in critical reflective discussion around their work. Bullock (2004) claims this gives them the “opportunity to transfer the knowledge they gain through their courses and modeling. It is an opportunity to see whether or not they can apply what they have learned in the university classroom to real life situations, as an essential part of their preparation” (p. 234).

Careful and intentional planning that links the philosophy and practice of the field and the teacher preparation program is critical if innovative pedagogical and technological approaches are to be fostered and supported. In Kovalik’s (2003) research, the school selected for pre-service teachers had adequate technology resources and had teachers with the technology skills. Pre-service teachers were required to create instructional units that integrated technology. Results from the study indicate that pre-service teachers were not able to “effectively transfer and apply knowledge and skills learned from their education courses to the project and thus were hindered in their ability to produce high-quality, technology-enhanced instructional units” (p. 81). From the study, three issues were identified as contributing to this situation. First, the difficulty pre-service teachers had in transferring to the project their knowledge and skills gained in prior education courses may result from the program offering isolated and separate courses, rather than using a more integrated approach. Second, the task of critiquing student work was difficult, especially...
when pre-service teachers offered excuses rather than carefully analyzing their work in relation to the critique. Teachers may need to learn how "to participate in constructive dialogues..." (Breuleux, 2001, p. 8,) so that they learn from the work and build upon it. Third, barriers such as inadequate specifications for the unit; working on the assumption that pre-service teachers knew how to plan and to learn later that technology application courses did not teach them how to develop effective lessons or units; limited guidance on group work and developing effective working relationships with collaborating teachers; and the reluctance of pre-service teachers to go to schools to observe in the classroom and gain knowledge of the learners all had a negative impact on the project. However, the study does demonstrate the need to foster greater campus and school partnerships that cultivate and nurture dialogue among the various stakeholders in relations to innovative pedagogical approaches involving technology integration, as well as the sharing of resources and exemplary teaching as part of a more intentional and integrated approach.

Field Placement

Expanding courses and providing more content-based technology courses is but one component of strengthening the technology experience pre-service teachers receive. Doering, Hughes and Huffman (2003) argue that a critical component of educational technology preparation is pre-service teacher’s placement with a cooperating teacher. They suggest the following should be considered in the field placement:

Seeking more experienced technology-using teachers, placing students in decision-making scenarios, providing more access to technological tools in media laboratories, teaching about cooperative learning, and modeling technology supported teaching by instructors who are ‘technology experts’ are all ways that we think pre-service education programs may better prepare students” (p. 358).
To address the frustration expressed by pre-service teachers in relation to a lack of technology utilization in field placements, teacher preparation programs need to examine current placement practices. They must determine if different strategies and policies should be used to provide greater opportunities for pre-services to observe and experience innovative approaches to technology integration in their field placements.

In their study, Strudler and Grove (2002) reported on a two-pronged approach to integrating technology in pre-service teachers’ field experiences. In their study, 63% of pre-service teachers asked to be placed with partner teachers, who were technology-using teachers. To meet this demand, four expectations were communicated to schools in relation to the technology being used as: "(a) a teacher presentation tool, (b) a teacher resource, (c) a tool for student skill development, and (d) a tool for student projects" (p. 35). In addition, “site visits were initiated, an online forum was established, and information booklets with frequently asked questions were developed to address the concerns of the teachers and support them in their role of mentoring student teachers” (p. 35). Workshops were provided to field supervisors to enhance their technology skills and field-based videos were “used to provide a framework for understanding and ‘seeing’ what technology use looks like in K – 12 classrooms” (p. 35). Further, they used a cluster school model for pre-service teacher placement and a field-based cohort program. It was apparent from the data that pre-service teachers did receive sufficient opportunities to teach with technology; they were enthusiastic about using computers and were supported by their partner teachers. Interview data suggest that pre-service teachers “were more likely to teach with technology when they were afforded greater access, flexible scheduling, and support and encouragement from school staff” (p. 37). From their study, it is evident that being “more proactive in selecting partners at the ‘front end’ who support the goals of the program” (p. 37) is needed for the success of the pre-service teachers’ experiences.

One of the implications identified in Laffey’s (1998) study is for pre-services to have hands-on experience with children successfully using technology. Further, they need to be involved in the
planning of these experiences, managing the technology in the learning, but they also need to talk about their field experiences and reflect on the use of ICT and the conditions that make the work possible and desirable. Reflective pedagogical discussions provide opportunities to interrogate issues and factors that impact teaching, learning and technology integration.

Having clear expectations, access to technology, providing positive experiences with technology and, on a regular basis, having opportunities to apply what pre-service teachers have learned in teacher preparation courses in their field placements are key components in their preparation to be effective technology users in their classroom. Adding to this list, Bullock (2004) argues that teacher preparation programs:

need to know which mentor teachers will best serve as good models, and which school environments can provide access and support. Assuring positive experiences with technology is a littler more difficulty. Faculty can help by encouraging collaboration between mentor and pre-service teachers, and guiding pre-service teacher as they develop their plans (p. 236).

Effective modelling and mentoring are required and need to be supported both by the post-secondary institution and the school in order to give pre-service teachers positive experiences with technology integration and innovation. From Bullock’s (2004) study, one difference that was identified was the “level of encouragement and support they [pre-service teachers] each received from their mentor teachers” (p. 235).

One needs to ask, how are partner teachers and field supervisors prepared to mentor pre-service teachers in relation to technology integration? The mentoring model may need to change to better support teachers as they transform their practice. According to Hargreaves and Fullan (2000), mentoring needs to move “from hierarchical dispensation of wisdom to shared inquires into practice” (p. 55) and “from being an isolated innovation to becoming an integrated part of broader improvement efforts to re-culture our schools and school systems” (p. 55).
Partnerships

From Laferrière, Breuleux, Baker, and Fitzsimons (1999) examination of multidimensional characteristics of professional development initiatives and models used across Canada to support in-service teachers with the integration of ICT (e.g., Alberta’s Project Pegasus), they concluded that this professional development work can also be used in teacher preparation programs. They believed that the following four elements should be included in teacher preparation programs:

1) partnership and collaboration: between schools and other organizations such as faculties of education;
2) inclusiveness: of teachers in the design of their own development, and of all students in the expectation for improvement;
3) inquiry: long-term reflection and research on practice;
4) renewal: an openness to inventing new ways of doing (p. 35).

In preparing teachers to use technology, “strong links to the local school community” (Fulton, Glenn & Valdez, 2003, p. 4) needs to be fostered. Establishing partnerships between educational institutions based on common goals and visions for technology integration can help to address and create strong relationships between the two levels of education. For example, Breuleux, Baker, and Pagliaroli (1998) describe a partnership between McGill University’s Faculty of Education and schools in Montreal. The Faculty offered site-based in-service technology courses to teachers. This was one strategy in the “development of teacher knowledge in the renewal of information and communications practices” (Breuleux et al., 1998, p. 13). By providing in-service to teachers, it enriches the learning environment in which pre-service teachers are placed. Further, new teachers who are “steeped in constructivist, learner-centered, inquiry learning techniques and philosophy, find themselves in schools that require them to teach in more didactic, narrowly focused ways…” (Fulton, Glenn & Valdez, 2003, pp. 7 -8). Here is a potential opportunity, where faculty and schools can work together in providing professional development
and support to facilitate a shift in learning paradigm within the school and foster ongoing support for both pre-service and in-service teachers to help them better leverage the power and capacity of technology through various pedagogical approaches to enhance the teaching and learning experience.

It is important to consider that partner teachers and teacher educators who, in the traditional modelling systems, were the experts, but now this may not be the case. The traditional modeling systems may not be appropriate, given that these individuals are also grappling with what makes for effective integration of ICT and what innovative pedagogical approaches need to be used to support meaningful, deep learning. In-service teachers and teacher educators are in a situation where they too are learning, just as the pre-service teachers are learning. Therefore, the traditional modelling (e.g., by the expert) systems may need to be replaced with a new image, where both pre-service and in-service teachers and teacher educators are learning together as lifelong learners and co-inquirers.

Cochran-Smith and Lytle (2001) believe that, like all learners, teachers “bring prior knowledge and experience to all new learning situations, which are social and specific” (pp. 45-46). They argue that a constructivist orientation provides the foundation for a new approach to professional development that has teacher learning occurring over time and not in periodic, isolated events. Based on this premise, they propose a “knowledge-of-practice” (p. 48) approach using an inquiry stance. In communities, both pre-service and in-service teachers can engage in cooperative knowledge construction. Through conversation and collaborative analysis, they “pose problems, identify discrepancies between theories and practice, challenge common routines, draw on the work of others for generative frameworks and attempt to make visible much of that which is taken for granted about teaching and learning” (Cochran-Smith & Lytle, 2001, p. 53). Through this inquiry stance over the “professional life span – from very new to very experienced - make problematic their own knowledge and practice as well as the knowledge and practice of others and thus stand in a different relationships to knowledge” (Cochran-Smith & Lytle, 2001, p. 49).
Working from this inquiry stance changes the perspective of professional development as an event and opens the work to that of being examined as scholarship.

**Where to Next?**

From the literature, it is apparent that questions about technology in schools and approaches used with technology have changed over the past number of years. Developing only computer literacy skill is no longer adequate. Teaching an introductory computer course in teacher preparation programs is not adequately preparing tomorrow’s teachers to use innovative pedagogical approaches that support well-designed, meaningful inquiry learning environments. As part of the next step in the change process, both educators and policy makers who support the sustainability and scalability of innovative pedagogical approaches need to address four overarching themes: vision, disposition and capacity building, professional learning communities and scholarship.

First, the vision of what it can be should not be defined as the end point. Rather, according to Breuleux (2001):

> …it is about defining, recognizing, shaping stages toward that goal, and not dismissing as unsuccessful everything that falls short. This is not a proposal to embrace the status quo; it is about encouraging a discipline and a capacity to see the present, to see in it where lies the beginning of tomorrow, the potential for change (p.6).

When preparing teachers to teach in the 21st century, consideration needs to be given to vision and how that can be addressed both with on- and off-campus work within education. With such a vision, teacher preparation programs in conjunction with the field can focus on how to enhance technology integration throughout the program in a meaningful way that will provide the
necessary support and resources for the various key stakeholders (e.g., teacher-educator professional development).

Second, both on micro and macro levels, attention needs to be given to nurturing a positive disposition of educators toward innovative approaches supported by technology and the fostering of capacity building. One initial step in changing current practices is to stop viewing technology as a set of skills to be acquired, which is done through teaching isolated courses. Rather, there is a need to begin by appreciating the perspective of lifelong learning “with teacher education faculty and pre-service teachers developing self-concepts of themselves as technology users” (Howland & Wedman, 2004, p. 242). Within their study, Howland and Wedman (2004) acknowledge the challenge of the professional development of faculty in relation to effective ICT implementation within courses and programs. However, providing necessary opportunities, resources and supports can lead to faculty being able to successfully model and infuse technology into curriculum based on sound pedagogical methods. Further, intentional and informed professional development supporting innovative pedagogical approaches needs to occur at the faculty and school levels to change dispositions and to effectively support the work.

In relation to building capacity, Breuleux, Laferrière and Lamon (2002) argue it “is both a process and an outcome” (p. 2). Using Cheema’s (1997) four levels of capacity building, Breuleux et al. (2002) explored the characteristics of each level in relation to effective use of ICT. First, building capacity at the individual level requires skill development. Decisions about ICT are based on pedagogy and responsibility for lifelong learning has shifted to the individual learner, which means teachers are also learners. Second, at the meso level, building capacity requires teachers having the necessary resources and support to fulfill the vision and goals of the school. Further, at this institutional level, capacity building is “about the alignment of school governance and pedagogical practice” (Breuleux et al., 2002, p. 14). Third, building capacity needs to occur through interrelationships between entities (school, school jurisdictions, or the whole educational system). Fourth, at the macro level, building capacity occurs through the creation of an enabling
environment. According to Cheema (1997), “Sustainable capacities for individuals, entities and systems require a positive enabling environment for addressing cross-sectoral issues relevant to all parts of society-the state, civil society and the private sector.” Therefore, a systemic approach to capacity building is required if innovation is to be initiated and sustained over time.

Third, there is a critical role in educational change for professional learning communities. Hargreaves (2002) claims that “strong professional learning community is a social process for turning information into knowledge. It brings together the knowledge, skills and dispositions of teachers in a school, or across schools, to promote shared learning and improvement.” Further, the use of networked technologies are transforming the conventional, insular work environment that teachers have experienced. They are now beginning to use opportunities in the networked professional learning communities to share resources and expertise, discuss pedagogical approaches, reflect on practice and provide support for their colleagues as part of the community experience. Using networked communities of inquiry as an integral component, educators can work in a collaborative, collegial space to question and investigate ideas and engage in pedagogical conversation around their own work and practice. With this transformation, both pre-service and in-service teachers and teacher educators will experience new roles and responsibilities as they begin to work in a collaborative public forum that allows them to interact with groups of people within larger communities.

Fourth, in CADE’s fifth Basic Principle, they acknowledge that “use and practice of educational technology should be informed by critical research” (p. 11). There is a need for public recognition of the scholarship involved in taking up of the work of innovative pedagogical practices that support pre-service teachers in integrating technology effectively. Scholarship of teaching involves what Hutchings and Shulman (1999) refer to as “kind of ‘going meta,’ in which faculty frame and systematically investigate questions related to student learning-the conditions under which it occurs, what it looks like, how to deepen it, and so forth – and do so with an eye not only
to improving their own classroom but to advancing practice beyond it" (p. 13). Further, Breuleux (2001) suggests that:

Learning and teaching with technology becomes a collective, collaborative socio-technical architecture, similar in a sense to democratic governance or collective gardening. And it becomes everyone’s responsibility to document and report relevant findings. For the teacher, reflective practice is a crucial starting point for this contribution to understanding how ICT can be used (p. 7).

Hutchings and Shulman (1999) identified four challenges to scholarship which can be directly applied to this particular study. First, they caution "not to assume that credibility means a traditional social science model of inquiry" (p. 14). If the innovation of pedagogy and technology is to be taken up in a scholarly way, then critical, deep questions about teaching need to be asked. Further, the credibility of the knowledge and the rigour of the work need to be addressed. Second, they recommend “the need to keep the scholarship of teaching open to a wide set of inquiries” (p. 14). The scholarship of the teaching needs to foster inquiry into inquiry that advances this field of work in relation to technology integration. Third, “there are issues about the most appropriate forms, media, and ‘genres’ for making the scholarship of teaching available to the field” (p. 15). This can be achieved with technology in a variety of ways. Fourth, “there is the issue of sustainability, which matters since the impacts of a scholarship of teaching will be achieved only over the long haul” (p. 15). Infrastructure, resources and support need to be in place to support the work over time. Sustainability of educational change takes time.

**Summary**

After examining how technology is used in education, shortcomings in the integration of technology in teacher preparation programs and exploring what needs to change to better prepare teachers to integrate technology effectively, seven gaps in the literature have been
identified. First, research has identified challenges in technology integration in teacher preparation programs and a number of recommendations have been put forth to address these inadequacies. Based on the recommendations, what is being done differently in programs and in field placements that better prepares pre-service teachers to teach in the 21st century? Second, technology is a commonplace for students, but not necessarily for teachers. As more of the N-Generation, who have technological proficiencies and routinely use technology in their personal lives enter teacher preparation programs, how will the program leverage this new knowledge and skill set in fostering innovative, technology-based pedagogical practices within teacher education? How will pre-service teachers learn how to appropriately use the technology to foster meaningful, deep learning? Third, a number of studies cited specific recommendations that need to be tested and further explored. How will these innovations be evaluated to determine the degree of success and impact they have on preparing people to teaching in a knowledge era? Fourth, fostering stronger partnerships between the field and campus has a critical role to play in addressing a number of identified shortcomings. Further investigation is needed into the formation of partnerships, the ongoing professional development and sharing of resources and the nurturing of effective mentoring practices. Fifth, doing innovative technology-based work within education can be lonely work. Individuals or small groups of individuals may lead this type of work within schools or faculties, which may not be acknowledged and/or supported as being innovative or scholarly. What types of supports and resources need to be in place for expert and novice teachers to work and to learn together in this new space, where they are designing a learning environment that effectively integrates technology? Therefore, how can such work be recognized has having an impact on student learning? What types of support and resources need to be in place to grow communities of inquiries among educators? Sixth, we are now in a situation where traditional modeling systems are not appropriate, as both expert and novice teachers are working and learning together in relation to innovative pedagogical approaches involving technology integration. What needs to be considered when mentoring the next generation of teachers? Seventh, issues surrounding policy development in this area need to be
explored further, if technology initiatives are to be sustained over time. These areas and questions suggest additional research topics.

Conclusion

In this literature review, a broad spectrum of topics has been examined. To begin, technology has changed the way we live and the N-Generation has grown up in a world where technology is pervasive. However, a disconnect exists between how today’s youth use of technology in their personal lives and how they are required to use it in the formal educational setting (e.g., in teacher preparation programs and in school placements). One of the factors that influence this disconnect is how teachers come to understand and use technology in their own personal and professional lives. When technology is used as an add-on, rather than in a holistic fashion, the degree to which it is used to enhance and extend the learning experience is restricted. Therefore, how are teacher educators, and pre-service and in-service teachers, learning how to effectively integrate technology in meaningful ways into their teaching and learning experiences and practices? What opportunities exist to observe and to engage in thoughtful, reflective discussion about the exemplary models and innovative strategies and approaches? How has mentoring helped to create effective pedagogical integration of ICT in the classroom? What needs to change in terms of mentoring approach to better suit this work? How has the teacher preparation program created intentional learning environments that foster a philosophy and an opportunity for technology integration within courses and across programs?
Overview of the Innovations

Introduction

This research study addresses gaps in the research literature in a number of ways. In this section of the report, we approach the question, what is being done differently in programs and in field placements that better prepares pre-service teachers to teach in the 21st century? What follows is a description of the five programs nominated by Deans of each faculty of education in Alberta.

Becoming an Elementary Social Studies Teacher

The Faculty of Education at the University of Alberta has a required technology course (EDIT 202) which is a general survey course that focuses on computing as an educational tool for productivity and problem solving and includes an introduction to the Alberta technology learner outcomes, hands-on lab practice with all of the productivity tools mentioned in the ICT curriculum, and many guest speakers including in-service teachers who relate current practices in the field. Also subject specific curriculum/instruction courses in elementary and secondary education and other required courses throughout the BEd program are being enhanced with appropriate technology components working towards complete coverage of the provincial K-12 ICT curriculum. The program also addresses the more extensive ISTE National Educational Technology Standards for Teachers, which provide a framework for integration of technology in a teacher’s overall professional practice. It is intended that student teachers benefit from modeling by professors and frequent in-context exposure to a variety of ICT resources and their application in student-centred learning environments. Mobile wireless computer labs are provided to enable technology-based class sessions.

The course selected for study by the University of Alberta is the second of two courses in elementary social studies curriculum and instructions offered to students with a particular interest in teaching social studies. For this course, Dr. Gibson created an online Virtual Field Trip
designed to capture the real-life experience of teaching social studies in a school where she had previously taken students on live visits. The field trip is created in a WebCT environment using interactive multimedia combinations of video, text, sound and computer graphics designed to provide:

- video clips of teachers talking about and demonstrating practice,
- children's voices and perspectives about their understandings of social studies,
- web links to useful social studies sites for teaching ideas, materials, resources, and curriculum documents,
- opportunities to discuss issues related to teaching social studies with experts from across the country,
- a conferencing tool to permit students the opportunity to interact and work collaboratively with peers,
- flexibility in making learning resources available outside class time, from diverse locations,
- the opportunity for students to use technology in meaningful ways in order to learn how to be good social studies teachers.

What Needs Was the Virtual Field Trip Designed to Address?

Effective field experiences for students

Dr. Gibson had been teaching social studies methods to undergraduate students at the University of Alberta for ten years prior to designing the Virtual Field Trip. In this course, which follows a prerequisite course on social studies curriculum and lesson and unit planning, there are two main goals: to assist pre-service students in setting their own teaching goals; and to prepare them to make sound decisions about how and what to teach in social studies. For many years, a central feature of this course were partnerships with local elementary schools that enabled Dr. Gibson's students to visit classrooms and observe small groups of elementary children and their teachers working with the social studies curriculum.
Pre-service teachers value such partnerships and the opportunity to experience what they often describe as “the reality” of teaching, but over time, two key difficulties emerged from the live visits to school sites:

- They became increasingly difficult to arrange, given the complexity of students’ programs and limited timetable flexibility at the university and in the schools;
- Dr. Gibson had no control over what her students engaged in while working in various classrooms. Frequently, the students themselves complained about the unevenness of the experiences they had in the schools, particularly when they felt they had been placed in classrooms where teachers were not working with social studies in the ways they were talking about at the university.

The first difficulty was purely pragmatic, requiring serious attention, but not troubling in the way that the second became:

When pre-service teachers observe in real classes the teacher education program often has no control over the type of teaching they see. Furthermore…‘when [pre-service] teachers observe real classes, they misinterpret or fail to notice many of the features and clues experienced teachers use to make sense of the classroom environment’ (Barron and Goldman, cited in Gibson, 2002, 97).

Describing difficulties with the pragmatics of scheduling and what she calls “lack of control” of the experiences students encountered in the schools and the quality of observations that they were able to make even when they were in classrooms that exemplified good social studies practice, Dr. Gibson was drawn to the power of technology to permit her to create a more intentional environment for instruction.

Coming to Teaching in the 21st Century
Technology Integration Demands

As Dr. Gibson considered the requirement that her students be well prepared to use ICTs in their teaching to address outcomes mandated by Alberta Learning, she considered two main questions: (1) how could she contribute to her students’ knowledge of and skill with, digital technologies; and (2) how could she do this in a way that was consistent with the constructivist philosophy of teaching and learning that underpinned her entire approach to the teaching of social studies? Thus, she searched for a way to incorporate technology into her own practice so that students were required and enabled to become fluent with a number of possibilities for learning with digital technologies.

The extent to which teachers use a range of technologies in their own professional lives influences the degree to which they are willing to incorporate a wider range of applications into their teaching (Becker, 2000), but as both the research literature and Dr. Gibson, herself, note, increasing fluency with computer use in her students’ lives outside school do not immediately transfer into an understanding of the pedagogical possibilities for ICTs. She saw this as a prime objective in designing the Virtual Field Trip. How could she use a virtual environment consistent with constructivist uses of technology, which require opportunities to learn through:

- authentic tasks and environments,
- exploring and doing,
- feedback and evaluation.

Design of the Virtual Field Trip

Authentic Experiences

The design of the virtual field trip was based on a vision of the learner as a constructor of his/her own meaning. Because the constructivist orientation holds that adult learners need opportunities to learn from real-life authentic problems and practice, Dr. Gibson wanted students to be able to see teachers and children in action and to listen to them talk about their experiences as they worked with social studies. Consequently, video clips were created of teachers and children in
their classrooms engaging in social studies; samples of lesson, unit and yearly plans; school newsletters and assessment rubrics; and audio clips of one-on-one interviews with children, teachers and the principal.

Because adult learners learn from opportunities to reflect, there are built-in checkpoints to engage participants in group debriefing and personal reflection on their learning about the problems under investigation. Third, because adult learners make meaning through collaboration, students are engaged as a community of learners in which they interact regularly, both in person and virtually, with Dr. Gibson, with their peers and with outside experts in the field of social studies both during and outside of class time. Weekly face-to-face seminars supplement the virtual conversations and to debrief the virtual field trip experiences.

One approach to teaching that supports constructivist learning principles is the problem based learning approach. This approach was used to organize the course content around authentic problems related to teaching practice. Using significant questions or problems as organizers can assist in the development of higher order thinking skills and interpretive learning experiences. As well, introducing problems for student investigation using computer technologies allowed students to experience a shared context for their learning. The five key problems used to organize the content of the virtual field trip and the course in general were:

- why is social studies taught in elementary schools,
- how do you choose content and plan for instruction in social studies,
- what resources are available to support your teaching of social studies,
- what approaches to social studies teaching would best help you to meet your goals, and
- how do you assess children’s learning in social studies?

These questions were typical of those generated by students at the beginning of previous versions of the course when they were asked what they felt they needed to know about teaching social studies. In order to enhance their understanding of the problem as it applies to their own

Coming to Teaching in the 21st Century
teaching, students were encouraged to examine each of the five problems through a number of
different lenses. Included in these lenses were the views of teachers, children, curriculum, other
student teachers (peers) and social studies experts.

The course is organized into two, 80 minute classes each week. One class is devoted to the
exploration of the problems through small and large group discussion. The other class is held in a
computer lab, and is devoted to working on the Virtual Field Trip website. Students spend two
weeks exploring each question. At the end of each two week exploration, students submit a
reflective paper about the ways in which their thinking about the problem was changed or clarified
as a result of classroom discussions and the Virtual Field Trip environment. A final assignment
requires students to design a learner-centered, computer based project that supports
constructivist learning theory and that could be used to teach an actual social studies curriculum
topic in an elementary classroom. In previous years, students were offered a wide range of
choices for the final assignment. In the 2003 course, Dr. Gibson required students to create a
social studies Web Quest 1.

**Exploring and Doing**

Guided by constructivist principles for the use of technology, Dr. Gibson created an environment
in which her students were both enabled and required to become a community of learners.
Through email and computer-based conferencing, the students talked with one another and with
her as they worked through the problems. The weekly face-to-face seminar supplemented the
virtual conversations, and encouraged everyone to debrief their Virtual Field Trip experiences.
Many of the students worked collaboratively to create a Web Quest.

---

1 A WebQuest is an inquiry-oriented activity in which most or all of the information used by learners is
drawn from the Web. The model was developed San Diego State University by Bernie Dodge with Tom
March,. Retrieved 01 15, 04 from http://webquest.sdsu.edu/
Field Immersion in a Technology-rich Environment

The Master of Teaching Program in the Faculty of Education at the University of Calgary is a two-year Bachelor of Education degree program. In the Master of Teaching Program an understanding of the complex qualities of teaching is developed through three central themes; learning to become a teacher requires experiences which are learner-focused, inquiry-based, and field-oriented. Through inquiry-based learning, the program emphasizes strong preparation in subject matter knowledge, development of pedagogical skills, and acquiring the ability to make good judgements in practice.

Right from the start of the program, student teachers work with partner teachers in schools, educators in community and workplace sites, and with faculty members of diverse backgrounds on campus. Students in the program are also encouraged to participate in many collaborative learning and inquiry activities. Student teachers work alongside experienced educators in the schools for two days per week during the entire first year (two semesters). In their second year, student teachers complete an extended field placement in a school during which they are expected to assume a full teaching load in a gradual and graduated manner.

Dr. Michele Jacobsen at the University of Calgary worked with a cohort of 15 student teachers assigned to one elementary school with a teaching staff of 27. These students were in their third semester of their program, where practicum placements involve 4 days in the school (field experience) from mid September until mid December, plus one day on campus for coursework (case seminar). Generally, students are placed in schools according to the numbers of willing cooperating teachers. Schools who accept more than one student teacher may have more than one field supervisor, and students generally come to their case seminar from a wide range of practicum situations.
Thus, it is unusual for:

- a complete cohort of 15 students to be assigned to a single school,
- all students in the school to be supervised by the same person,
- students to have the same field and case seminar instructor,
- students to be supervised by faculty rather than sessionals or University Associates (teachers seconded for two year terms),
- case seminar to be conducted in the school building rather than on campus, and
- a specialist in Educational Technology (Dr. Jacobsen) working “hands on” in field placements to help design and supervise meaningful experiences with technology for pre-service teachers.

Dr. Jacobsen spent two full days a week in the school with her students, conducting the case seminar on Tuesday afternoons in the building.

An additional feature of this innovation was that at the same time as student teachers were involved in their practicum experiences, the professional staff of the school was committed to ongoing, job embedded professional development from the Galileo Educational Network to address issues of ICT integration and inquiry-based learning. Three of these teachers were also taking a graduate class in inquiry and technology integration that complemented the professional development work in the school. Dr. Sharon Friesen, who was directing the staff’s professional development, team taught the case seminar with Dr. Jacobsen.

This experience was new for the school, which was accustomed to:

- the conventional placement of student teachers with assigned partner teachers on a one-to-one pairing,
- professional development as separate from mentoring student teachers into the profession,
- having opportunities for graduate studies that directly drew upon their school-based experiences with inquiry and ICT integration, including their work with student teachers, and

Coming to Teaching in the 21st Century
• having supervising faculty in the school for two days a week.

The experience was also new for Dr. Jacobsen who, like most of her colleagues, had previously supervised practicum students in a number of different settings, widely dispersed in both urban and rural environments. Dr. Jacobsen, herself a specialist in Educational Technology, took a scholarly interest in the ways in which fundamental changes to field placements could help pre-service teachers think and work differently with technology.

What Needs Was the Cohort Approach Designed to Address?

The need for inquiry-based practicum placements

As an inquiry-based, field-oriented program, the MT program depends heavily on the quality of practicum experiences for students. This becomes a particular challenge around preparing students for the effective integration of technology in two main ways: (1) providing inquiry-based practicum experiences; and (2) providing practicum experiences in schools which are well provided with a range of ICTs and whose teachers use technology to support genuine inquiry.

First, inquiry-based approaches to teaching and learning are not well understood in schools. Thus, campus based explorations of inquiry do not always translate easily into student teaching situations. Experienced teachers, themselves, are often just beginning to work with inquiry. Thus, the old practicum assumption that the expert teacher will provide a model for the student to emulate becomes problematic. If students happen to be placed in an inquiry-based classroom, the work they do on campus forms a coherent support for the practicum. If the placement works at odds with the assumptions of inquiry, students’ experience in the school often undercuts the efforts of faculty to create a deep understanding of inquiry.

Teachers in the school in which Dr. Jacobsen and her students worked for the third semester had been heavily involved with The Galileo Educational Network the previous year to learn how to integrate ICTs into core curricula. The school expanded that work in the 2003 school year to
focus more sharply on inquiry and ICT integration. The whole staff worked with a Galileo mentor in face-to-face professional development and planning sessions and online in IO, a fully mentored environment in which they planned inquiries, engaged with one another in online discussions, and contacted other mentors from Galileo around specific issues as they designed inquiries for their students.

**The Need for Technology Enhanced Practicum Experiences**

The second major challenge that the MT Program faces in supporting its students to use technology in inquiry-based teaching is the unevenness in schools of students’ access to technology and teachers’ understanding of how to integrate technology in meaningful ways. Students who are encouraged and enabled on campus to explore the effective use of ICTs might find themselves in practicum placements where they have little or no opportunity to experience their effective use. Often, students who came together from diverse settings for their weekly class in semester three experienced the same difficulties as Dr. Gibson and her students: they had no common base of experience on which to draw in exploring issues in teaching, learning and technology.

**Design of the Cohort Experience**

Placing a complete class of practicum students in one school in which the staff was itself, committed to finding ways to integrate technology in inquiry-based teaching and learning was the first crucial element of design. The second was to be intentional in partnering students and partner teachers around a mutual interest in the work that would be undertaken with children. Within the program requirement that students who completed their first practicum in Division One now work in a Division Two classroom and vice versa, students and the teachers in the school were given two weeks to come to know one another before final matches were made. Students were required to participate in a number of classrooms, and both they and the teachers negotiated the ultimate pairings on the basis of mutual interest. Some students, ultimately placed in one classroom, maintained a connection with a classroom in which they had done their first two
weeks’ exploration, thus breaking down the conventional pattern that a practicum student “belongs” to and thus must model the practice of, one teacher for the duration.

In becoming the field supervisor for one group of students who would become resident in a school that was well equipped with hardware and software, and whose teachers were working with intention to become collectively more able to integrate ICTs effectively, Dr. Jacobsen partnered with Dr. Sharon Friesen and Kelly McKie-Grenier of the Galileo Network to make sure that the professional development initiatives and conversations among staff were directly related to the course and classroom work of the practicum students. Dr. Jacobsen spent two days in the school each week, interacting with staff and with her students in myriad informal ways, as well as becoming directly involved in the teaching and planning decisions her students were making. Although Fridays of the third semester practicum are generally reserved for class work on campus, the students and Dr. Jacobsen decided to hold their weekly class in the school building. Organized around three major topics—classroom management, assessment, and instructional design—these courses were held Tuesday afternoon. The school principal often engaged with the students in these classes, providing the schools’ perspective. In addition, teachers volunteered to speak to the class when they felt they had particular contributions to make. As the term progressed, teachers and groups of practicum students structured additional noon hour sessions to address questions that were important to them.

Dr. Jacobsen used IO as an environment in which to plan the third semester course, as well as requiring that each student purchase and use IO to plan their work with children. Using this environment, she was able to view and comment on emerging plans; communicate with her students in Private Discussions; communicate with staff members in Private Discussions; and direct her students to engage the larger IO community of about 700 teachers in conversation around the work they were doing. Through IO, the student teachers and their partner teachers had access to Galileo mentors for the practicum experience and beyond.
The University of Calgary has a number of faculty members who are specialists in educational technology. It has traditionally been the case here, as in many universities, that matters pertaining to technology generally "belong" to this specialty rather than to the faculty as a whole. For a number of years, there have been initiatives to try and break down the conventional silo of educational technology and explore ways in which to raise pertinent questions regarding the integration of technology more broadly throughout the faculty. Faculty and students have access to a wide range of technologies and to full time technical support for their use in the Doucette Learning and Teaching Centre. Faculty also has access to support from colleagues who are educational technology specialists if they request help redesigning their approach to teaching with technology.

One of Dr. Jacobsen’s main research and teaching interests is in integrating technology into teaching and learning. Specializing in educational technology in the Faculty of Education, she is an accomplished user of technology in her own practice. Thus, for her, the issue of support for the innovation is not framed in terms of the assistance that enabled the development of her own skills, fluency and interest. Rather, the issues cluster around:

- how to develop and maintaining leading edge practices in pre-service education that themselves become the object of her own and others’ design research,
- how to encourage and support colleagues to use technology more frequently in their own teaching, and
- how to disrupt conventional assumptions that issues pertaining to ICTs belong mainly to the educational technology specialty.
Concordia University College of Alberta has developed an approach to technology integration with the support of Innovative Teachers Grants from Microsoft, Corp and the American Association of Colleges for Teacher Education (AACTE). Six years ago, when Dr. Margaret McVea came to Concordia from her position of school principal, she understood the urgency of preparing pre service teachers for the coming ICT Program of Studies. In order to do that, she redeveloped the computer lab and provided the latest Windows Operating System and Microsoft Office software through a three year Innovative Teachers Grant. Without this grant, the cost of much needed upgrades would have been burdensome for a small institution.

In their first year curriculum planning course, all students at Concordia are introduced to the Alberta ICT Program of Studies, and to basic productivity software provided through the grant to help them create electronic year plans, unit plans and lesson plans that take ICT outcomes into account. In their second year, students experience a second planning course, Education 503, an advanced curriculum-planning course combining methodologies of teaching with the Alberta Program of Studies and the Program of Studies in Information and Communication Technology.

The overall goal of the course is to ensure that students will engage in the design and development of teaching and learning resources and will be able to demonstrate selected outcomes from Alberta Learning’s Information and Communication Technology curriculum. Furthermore, students will better understand the appropriate knowledge, skills, and attributes for Interim Certification in Alberta.

The knowledge, skills and attributes related to Education 503 emphasize that students will understand:

*Education 503*

Coming to Teaching in the 21st Century
Education 503 consists of lectures, labs and school visits that will elaborate on and model different aspects of effective teaching methodologies within the context of the Alberta Program of Studies. Most components of the course will also introduce and teach a particular productivity process that will be required for the follow-up project(s)/assignments. Classes will address a particular outcome from the Information and Communication Technology curriculum regarding teaching with technology.

**Project TNT:**

Education 503 also incorporates an externally funded technology project, Project TNT, for which Concordia University College (CUCA) has been granted an Innovative Teachers Award from the American Association of Colleges of Teacher Education (AACTE). As part of the funding for this award, CUCA and its three partner schools Anne Fitzgerald, St. Boniface and Annunciation, have each received Microsoft licenses for both their operating system and software needs in their respective labs. In order to fulfill the funding requirements of Project TNT, students enrolled in Education 503...
make visits to the above schools to test-drive their technology projects with elementary teachers and children. The college students will have an opportunity to share their ideas and expertise both at the school level and in Virtual Classroom Tours posted to the Microsoft AACTE site as part of the Promising Practices aspect of the grant.

Project TNT is primarily focused on the integration of technology in the elementary curriculum program of studies. The overall goal is to ensure that Concordia Education students preparing to be teachers have engaged in the design and development of teaching/teacher resources that are able to demonstrate selected outcomes from Alberta Learning’s Information and Communication program of studies.

In Education 503, Planning and Integration of Technology in the Elementary School, students plan and design lessons and technology projects using the Virtual Classroom Tours (VCT) template and Microsoft Office productivity software such as PowerPoint, Excel, Word, FrontPage, and Access. After completing their VCT, students are required to implement it at one of the three Project TNT partner schools: Annunciation Elementary School; St. Gabriel Elementary School; and Anne Fitzgerald Elementary School. Although it has a similar name, the Virtual Classroom Tour completed by CUCA students is very different from the social studies Virtual Tour completed by Dr. Gibson’s students at the University of Alberta.

Each of the Education students teaches their VCT to a class of elementary students, sometimes with the help of their teacher. The Concordia students are matched with age-appropriate classes of elementary students on computers, and are able to observe and coach the children as they progress through the different learning events. Each project takes at least one half day in an elementary classroom with a commitment to meet with the class teacher before and after the teaching.

There are four projects in the course, three of which will be tested at the school level. All are described in detail below:

Coming to Teaching in the 21st Century
Education 503/TNT Projects

1. Project #1 requires CUCA Education students to design an interactive learning event that will introduce elementary students to use of the Internet to access quality information of a new concept. In the form of a web quest for an area of the Alberta Elementary Program of Studies, this web integration tool demonstrates the Education students’ expertise in selecting appropriate content for a particular subject area and matching learner outcomes with that content. They then are encouraged to design a web quest with hyper-links to the Internet that will be learner-centered and curriculum appropriate. Following the school test-drive, the information and ideas gathered from the elementary student will be adapted to improve the final web quest product. The web quest is then shared with the certified teachers in Project TNT.

Outcomes to be met:

- Students will organize and manipulate data;
- Students will use communication technology to interact with others;
- Students will use technology to investigate or solve problems;
- Students will use electronic research techniques to construct personal knowledge and meaning;
- Students will understand the subject discipline that they teach with an in-depth understanding of content knowledge in one or more areas.

2. In their second project, the education students design a lesson plan using PowerPoint to support both their teaching of a new concept and the students’ learning of it. The project must be designed in a presentation format and delivered in PowerPoint. The expectations for elementary students completing the TNT project will be to create a presentation project demonstrating what they have learned using PowerPoint. The project is designed to be used as part of a lesson that will support elementary students using this software.
Outcomes to be met:

- Students will compose, revise, and edit text;
- Students will communicate through multi-media;
- Students will know the purposes and some strategies for evaluation and assessment;
- Students will use communication technology to interact with others.

3. In the third project, Education students design a research question or scenario that will provoke elementary students to develop a data management project using Microsoft Word and Excel as productivity tools. Education students pose a problem that is relevant to elementary students, and that is aligned with the curriculum as well as with the nature of data collection and display.

Elementary students generate data and complete a spreadsheet with appropriate titles and information. They also display the data using several choices of appropriate graphs, their titles and correct labels. The project is completed when students have responded to the original problem and drawn accurate conclusions.

Outcomes to be met:

- Students will organize and manipulate data, display data, integrate graphing tools;
- Students will know the purposes and some strategies for evaluation and assessment.

4. The final TNT project is a culmination of the three previous projects. Education students will be expected to design a simple web page outlining the work they have completed in Project TNT. Students will use FrontPage to design their web page and include on their site any relevant learning and teaching materials and a short resume or vitae. These web pages are posted on the Concordia Faculty of Education web site and are available for students and teachers anytime, anywhere.
In the Winter 2004 semester, Concordia University students created and submitted 23 VCTs for the Innovative Teachers project. The topics covered by these VCTs ranged from lessons on Ancient Greece to lessons on bridges, bugs and the Canadian north. All of these innovative lessons combine a “WebQuest-like,” technology-supported lesson component with a “data management” component that combines live data collection with data analysis using Microsoft Excel.

Several of these VCTs were used to deliver content in one of nine classrooms and in some cases, were introduced to existing “technology-hesitant” teachers. In many of these cases, the classroom teacher involved in the implementation lesson was surprised by the ease with which technology can be integrated into the learning process. It was evident that the meaningful application of these technology-infused lessons helped enhance student learning and strengthen the bond between pre service and in service teachers.

After participating in the “Best Practices” Professional Development Day in March, 2004 the classroom teachers from the three partner schools were “floored by the outstanding examples of technology supported lessons presented by the Concordia students” and were more receptive to the thought of using technology to delivery instructional content. Winning over the hearts and minds of these teachers made a significant step towards better acceptance of technology-infused classroom activities.

Designed to extend the work with technology that students do on campus to more intensive involvement in elementary schools, a second Innovative Teachers Grant permitted Education students to work closely with teachers in three Edmonton elementary schools through a Community of Practice and Expertise (CPE) partnership. Project TNT, developed through this partnership, assists pre service teachers to design integrated technology units in a variety of curriculum areas and “test drive” them with children.
What Needs Was TNT designed to address?

Practical Application of Planning Ideas

Students come to the course in their final semester, after completing their nine week practicum. The advantage of this scheduling is that they have had extensive experience with how students learn. Thus, issues of ICT integration can be held more deeply within the context of their actual experience with children, and not simply within hypothetical experimentation with technology, or “just-in-case” surveys of possible computer applications. The frustration that Education 503, and TNT in particular is designed to address is that when an in-depth technology integration courses come so late in the university program, students usually have no opportunity to take what they have learned into the classroom, and experienced teachers have no opportunity to learn from—and with—these student teachers as they try out new ideas. The Community of Practice and Expertise (CPE) partnership assists pre service teachers to design integrated technology units in a variety of curriculum areas and “test drive” them with children even when they have completed their final practicum.

Professional Development for Experienced Teachers

As Dr. McVea notes, one of the reason many teachers accept student teachers is that they value the opportunity to learn new things, to try fresh approaches, or to think about teaching issues and questions in ways they had not considered before. Given the apparent difficulty that many teachers have in implementing ICT in their classrooms, experienced teachers and their principals in this project valued the professional development opportunity to pair up with pre-service teachers who are exploring technology, designing units, and who are willing to demonstrate how to do new things. Schools we visited through this project are in much the same situation as schools throughout Alberta: teachers are in very different places in their own thinking about technology and their confidence that well planned units that integrate technology can actually address curriculum effectively. It is our experience that few schools in North America have
achieved high levels of sophisticated technology integration on a school-wide basis. At the moment, innovations tend to happen in pockets and questions of how to influence teacher practice in significant ways continue to have the kind of urgency that Dr. McVea described as she considered technology integration from the perspective of a principal six years ago. How do you bring an entire staff on board, and how do you move practice throughout a building?

One teacher interviewed as her students were working on the final project with the Education students, commented that she really liked being in a situation where both she and the Education student were learners, together. She said:

I have something to learn from them and they helped me a lot. It was the best. I helped them think about what they needed to change to make this work for Grade Two. We were learners with each other.

Children, often delighted with the opportunity to do something different from textbooks and worksheets, reported that they liked the Education students’ projects, and enjoyed doing them on the computer. They enjoyed the committed attention of one or two Education students with one group, and found the materials engaging and fun to explore. Education students, themselves, valued the opportunity to try out the ideas they had worked hard to design.

Communities of Practice

In background provided for the Innovative Teachers Virtual Classroom Tour (the publishing venue for selected Innovative Teachers’ projects), Microsoft says this:

The Virtual Classroom Tour model is premised on the understanding that teachers learning from teachers in situ is a powerful catalyst for school improvement. The model is guided by the work of Michael Fullan on the power of school visitations for knowledge sharing in teacher learning and school improvement. In this program, teachers gain the opportunity to reflect and inquire into their profession alongside expert mentor teachers.
They will produce knowledge of their own practice and share that knowledge with colleagues.

**The Power of Information**

For teachers to see and understand their role in school improvement, they need to understand the process of change. In most schools the information is available; teachers need opportunities to interrogate that information, discuss it, and share their understanding with their colleagues.

Underpinning the Virtual Classroom Tour model is the sharing of information: sharing why a unit was developed in a particular manner, the motivation for using technology for student learning in a certain way, what was successful, and so on.

It is hoped that these projects will act as catalysts for others to understand the role of technology in learning, to provide another way to create a “look in” at classrooms, to create opportunities to interrogate ideas and to develop an understanding of the change process. Concordia University College is the only Canadian university participating in this program.

As the students and teachers in TNT discovered, there is great power to working side by side with trusted colleagues when you are learning new things. In this project, the sense of collegiality included not only experienced and pre-service teachers, but also school principals and Dr. McVea. That is, there were significant and ongoing connections between classrooms, schools, and the university. The close relationships develop through these connections acknowledge that learning is actually a profoundly social undertaking in which meaningful relationships provide the motivation, support and inspiration for growth.

It is our observation that the Microsoft rationale for the Virtual Classroom Tour is a compelling one, and that the vision of such connection was enacted in tangible ways in the TNT project at Concordia.

Coming to Teaching in the 21st Century
**Who Supports the Innovator?**

In Dr. McVea’s case, technological support is available from the IT department at the University. If technology problems arise, particularly when students need help, this person is available, generally by telephone. However, on a daily basis Dr. McVea finds that maintaining the lab, and most troubleshooting, has become her domain. She has a course release to support faculty and sessionals as they work with technology in teaching and learning.

**Online Learning**

The University of Lethbridge Program offers students two routes to achieve an Education degree. One is a 5 year Bachelor of Education combined degree program which sees students complete 3 years in their subject major, and four semesters in Education classes and practicum situations. At the end of five years, students will have completed a Bachelor of Education degree plus a Bachelor degree in Arts, Science, Fine Arts, Music, or Management. The second route is to complete a first degree followed by a four semester education program.

The Bachelor of Education degree consists of three Professional Semesters, which are a mixture of on campus studies and teaching experiences in schools throughout Southern Alberta. In Professional Semester One (PS1), all students complete a Communications Technology module as part of their required suite of PS1 courses. Throughout the other years of the program, students are also offered the opportunity to take a number of more advanced technology courses. It is, however, this introductory course that is the focus of our attention in this report. Offered as an example of innovative and effective practices at the University of Lethbridge, the course addresses a common question in North American teacher preparation programs: should all students receive a similar foundation in ICT? And if so, in what should it consist? Conventionally,
foundational programs in ICT have dealt mainly with the instrumental issues of ICT: how to use applications and fundamental functions of computers. This continues to be the image many people have of "computer literacy". Students generally report that such survey courses are not especially effective in helping them learn to think about teaching with technology, nor do students tend to remember the skills they learn in courses in which there is no significant context for use.

**What Needs Was the Course Designed to Address?**

The University of Lethbridge *Communication and Technology 3508* course, first offered online in the Fall 2003, was designed to be consistent with current research on web based learning, and to address the need for all students both to understand the demands of the Alberta ICT Program of Studies and to explore larger issues of technology in society. Data from a report documenting the University of Lethbridge approach to technology integration, and the course website ([http://classes.uleth.ca/200203/educ3508jk1/Outline.shtml](http://classes.uleth.ca/200203/educ3508jk1/Outline.shtml)) outlines the goals and anticipated benefits of an online approach to a foundational course in ICT.

The course is designed to address the need for pre-service teachers not only to learn about a range of technology applications, but also to understand what technology *means* for their future classrooms. Thus, the course focuses on process-oriented instruction, teaching students to learn how to learn within constantly changing technological environments.

**Teaching and learning with technology**

First, the course is designed to afford all students a range of opportunities to explore features of various software tools, woven into discussions, exemplars, and/or assignments: Discussion Boards, Concept Mapping, Internet, Data Bases, Spreadsheets, Presentations and Web Awareness. Second, the course is designed to engage students in explorations and reflections concerning the appropriate use of various technologies in teaching and learning. Third, through the design of a unit of study using University of Lethbridge curriculum guidelines, students are
required to explore practical methods to integrate these basic technologies into their teaching and learning.

The intent of this Communication and Technology module is not necessarily to help students develop a high level of expertise with communication technology tools, although there is scope for more advanced use of applications by students who wish to pursue them, the primary objective of the course is to have students develop basic ideas and methodologies for integrating technology into their lesson plans. Higher levels of expertise for integrating technology is the focus of optional technology elective courses available later in students’ program if they choose to pursue an advanced interest in technology.

The following structure was used in designing the course:

<table>
<thead>
<tr>
<th>Be Attentive</th>
<th>Be Intelligent</th>
<th>Be Reasonable</th>
<th>Be Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Observe</td>
<td>• Question</td>
<td>• Connect</td>
<td>• Commit</td>
</tr>
<tr>
<td>• Recognize</td>
<td>• Probe</td>
<td>• Evaluate</td>
<td>• Act</td>
</tr>
<tr>
<td>• Reflect</td>
<td>• Understand</td>
<td>• Judge</td>
<td>• Account</td>
</tr>
</tbody>
</table>

To current innovations in technology.

To the pedagogical implications of innovative computer technology.

<table>
<thead>
<tr>
<th>To current innovations in technology.</th>
<th>What are the specific features of this innovation?</th>
<th>Is this new technology actually innovative?</th>
<th>Should I integrate this technology across the curriculum?</th>
</tr>
</thead>
<tbody>
<tr>
<td>To the pedagogical implications of innovative computer technology.</td>
<td>How are they designed?</td>
<td>Is my teaching better with the technology?</td>
<td>How should I use this technology in my own classes?</td>
</tr>
<tr>
<td></td>
<td>How might I teach with this technology?</td>
<td>Are my students learning better with the technology?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What strategies might I best use with this technology?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Students were guided through a fundamental process with each application they learned:

- What is the new technology? What can it do? How does it affect teaching/learning? What are varying views on its impact for education?
- How does this fit in my curriculum area? What teaching strategies can utilize this technology? What can I find out about this technology? What online tutorials and tools are available for me and my students?
- Coming to Teaching in the 21st Century
As students were exposed to new technologies, they explored the thinking behind the technology. What was it designed to do? Then they were asked to think about ways in which that technology could be used in classrooms, and to make informed judgments about its benefits and its drawbacks. They were then expected to use online materials to learn more about the technology as part of becoming informed about its pedagogical possibilities.

This process formed the explicit structure of the course. Students were encouraged to see that they could use it any time they heard of a new technology—and to understand that they could use technology to learn about technology

**Effective online learning**

In offering the course in an online environment only, certain key design features guided course development:

- engaging pre-service teachers in various learning styles,
- encouraging reflective thinking,
- providing timely and frequent interaction,
- accommodating individual needs, and
- presenting course content enriched with resources.
Instruction is designed to be intensely student-centered, providing personalized learning opportunities oriented to meaningful issues in teaching and learning with technology. Further, the online environment is designed to permit a high degree of interactivity both with content of various kinds (links with databases, and information sources) and with people (experts, other students, and the instructors). It also creates a technology culture of use, in which students must use technology tools and environments to work with one another, arrange their schedules, submit assignments, and meet other course requirements. In this way, some of what students learn about technology is a direct result of their immersion in a technology-rich learning environment.

Through meta-teaching, however, students are also required to make explicit connections about technology both as prospective teachers and as learners. After each lesson, students and instructors critique both what went on in the lesson, and why. Students are encouraged to ask important “why” questions about technology: Why did we ask you to do that activity? How is that activity enhanced with the use of technology? How could you improve the lesson or the technology use? How could you modify the activity for use in the K-12 classroom?

Who Supports the Innovators?

At the end of the 2003 implementation year, students (N=144) completed a course evaluation that established that:

- 91% of students agreed that the course provided them with a good introduction to the ICT program of studies;
- 90% of the students agreed that the course helped them to develop strategies for integrating technology into their teaching; and
- 92% of the students agreed that the course helped them think critically about the use of technology in teaching and learning.
It is clear that the overall course design worked extremely well for students. The section was offered by four instructors, who had a common syllabus but different ways of approaching the course. Dr. Beaudin had release time for course development and the support of a team who would implement the course in parallel. Dr. Beaudin, herself a confident technology user with a specialized interest in educational technology, felt both constrained by, and free to modify, certain elements of the common design. It was intended that WebCT be the course environment, but she found its structures too limiting, and designed her own class space by making significant modifications to the WebCT shell that better accommodated an environment for meta teaching. Evaluations from her section of the course indicated that all students felt the course should be online, while 70% of students in other sections felt this way. That is, very quickly her students lost all sense of online as a foreign or uninviting place for learning, and came to appreciate its unique features: being able to learn at one’s own pace, and having access to content, instructors and other students on an as-needs basis. Students in this section did not feel there was a need for the face-to-face component of the course, indicating that they had created an online classroom that really worked for everyone.

In September 2004, the course will be taught with a special emphasis placed on integrating technology across the entire range of PS1 courses. Students will be introduced to a new technology and then be required to complete assignments in other courses using that technology. For example, concept mapping using Inspiration software will be taught and then students will use Inspiration to complete an assignment for their Evaluation course.

The format continues to be modularized with common starting places that will branch in many directions so that students can increasingly follow directions and points of interest of importance to them. The following diagram outlines the program and its connection to other courses. Here, one can see the ways in which students will be able to use technology in other courses without those instructors, themselves, needing to be fluent in the applications.
Dr. Beaudin also identifies the need for experiences that better prepare students to teach in lab environments, since that is what so many encounter in their practicum experiences. Such a project might involve a virtual field trip in which students explore issues of teaching in labs from a number of perspectives: how to set things up; how to manage instruction; how to foster student discussion and interaction; debating issues about the strengths and weaknesses of lab-based technology experiences.

Coming to Teaching in the 21st Century
Technology access is not an issue at the University of Lethbridge, although the Mac platform caused some disconnect for students, 80% of whom use PC’s. In the online environment, students were able to use the platform of choice. Students noted the prevalence of Macs in comparison to their largely PC based personal experience. Some appreciated the opportunity to figure out how to work across platforms, even if it was hard, since they may well have to do that in schools. For others, as one student noted, “the never-ending compatibility thing…[can] stop you dead in your tracks.” As a confident technology user herself, Dr. Beaudin identified technology support on campus as “awesome”, particularly if you know how to ask the right questions.

*Four Day Module Taught by a Classroom Teacher*

At King’s University College, technology is addressed through an intensive four day module offered each winter in the second semester of a four semester after-degree Bachelor of Education program. It is one of a number of other curriculum areas such as elementary school Biblical Studies, Language Arts, Math, Art, Social Studies, Physical Education and Health, Science, and Music taught using the same approach: identified Master Teachers from Christian schools provide instructional modules demonstrating approaches used by practicing classroom teachers. Five years ago, the technology module was optional. Today, it is mandatory.

*What Needs is the Module Designed to Address?*

The intent of each module is to help students acquire basic familiarity with the methods and materials of teaching subject areas such as ICT. The course is coordinated with the Introductory Practicum (EDUC 351). Pre-service teachers are generally very responsive to opportunities to work with practicing teachers, and in this particular module, to learn how and why actual classroom teachers use technologies in the ways they do. Students at Kings vary in their comfort levels with technology, although most are fluent with email and word processing. A compulsory
module ensures that each student has the opportunity to work with a variety of applications, some of which may be unfamiliar to them, with a constant focus on how teachers use these applications in real classrooms.

**Design of the Module**

The technology module is offered during the university’s reading week when the computer lab is available for dedicated use by students in this module. The Master Teacher, David Vriend, has all the machines ghosted to his requirements. Technician support is also readily available at this time. While there are not quite enough machines for a one-to-one student to computer ratio, and students and teacher find the lab somewhat cramped, they have generous access to computers throughout the duration of the module. In addition, there is a conventional classroom space available for the class’s use.

Mr. Vriend is the technology co-ordinator and classroom teacher in an elementary school. He is a graduate of The King’s University College, well versed in the program’s philosophy as well as a confident teacher with technology in his own practice. He uses technology extensively in his own professional life, and integrates technology applications with particular attention to age-appropriate distinctions and the development of research and other technology skills within the context of curriculum. Before he teaches the module each year, he involves other teachers in his school in helping him refresh his thinking about technology integration.

Mr. Vriend invites King’s students to complete assignments using technology that he gives his own Grade 3 students, such as creating a variety of maps or using draw programs to create artwork inspired by Ted Harrison. In that way, students are given the opportunity to see how an experienced teacher might use technology, and also to learn some computer applications through specific use. In addition, his students conduct research into teaching issues such as devising a scope and sequence for teaching computer skills. He emphasizes that the module is about more than computer training, or introducing technology simply for its own sake. It is designed introduce
new ways to teach by integrating technology, and it is designed to help boost the confidence of students who might previously have had little or no experience with technology.

**Who Supports the Innovators?**

Responsibility for addressing technology integration in education rests with Mr. Vriend, with good technical assistance to make sure equipment is organized in ways that he needs, and that technical problems are addressed promptly so that students can do their work effectively.

**Findings**

Eight themes emerged from a close examination of practices offered for study and analyzed within the context of current research literature, which it is hoped will provide guidance to faculty, policy makers and subsequent researchers as they consider:

- what innovative practices with pre-service teachers currently look like at the universities and colleges;
- under what practicum conditions pre-service teachers are well supported in learning how to use ICTs effectively;
- what kinds of impediments and struggles teachers at all levels (faculty, experienced and pre-service) encounter in integrating technology effectively for teaching and learning;
- presumptions and premises that underlie apparently different surface manifestations of effectiveness;
- what might be done to make such effective teacher preparation practices more widespread.

These themes are:

1. Teaching and learning with technology is, fundamentally, a pedagogical rather than a technical matter;

**Coming to Teaching in the 21st Century**
2. Fluency with technology does not translate automatically into the ability to teach effectively with it;
3. Changes to transmissionist or presentational pedagogy and conventional teaching approaches on campus yield significant results;
4. Well-constructed digital environments provide engaging and meaningful interaction for students;
5. Disconnects between campus and practicum experiences with technology integration impede the effectiveness of teacher preparation;
6. New approaches to professional development partnerships and to field placement practices show promise in bridging the gap between campus and practicum experiences;
7. Technology, infrastructure and support still present considerable challenges on campus and in schools;
8. Innovation is often a lonely road.

1. The effective integration of ICT is primarily a pedagogical, not a technology issue

In Alberta, ICT is embedded in each curriculum area, marking a movement away from thinking of technology as an isolated program of studies to an understanding that the meaningful integration of technology lies at the heart of each curriculum area. In this study, one of the issues of great interest and concern to innovators was to push the edge of a general awareness of the importance of ICT across the curriculum and to ask deeper questions about the character of learning, itself, in a digital age.

Challenges to transmissionist pedagogies

Participants generally acknowledged what the research literature supports: that transmissionist or presentation pedagogies need to be replaced by theories of learning that place inquiry based approaches, knowledge building and/or "It's the same thing when I go out to schools. I'm continually frustrated that so little is going on out there that I would call meaningful learning, effective learning with...[technology]. It's such an expensive thing, and yet people are not giving that kind of thought to what they would do differently, to what they could do that would be rich."

Faculty member

Coming to Teaching in the 21st Century
constructivist principles at the heart of classroom practice—whether or not technology is involved.

The magnitude of the change in teacher thinking required for effective technology integration is enormous. The shift from industrial age practices of knowledge transmission to more constructivist understandings of the ways in which learners build understanding through active engagement with ideas, materials and one another is paradigmatic in scope, calling into question many of the most familiar routines and practices of teacher-centered classrooms.

As well documented as this research finding is, and as clearly as many of the innovators we interviewed saw the issue, there remained a huge disconnect between this kind of thinking and the teaching practices in many of the classrooms in which pre-service teachers worked. Here is a story condensed from our interviews which illustrates a number of the facets of the problem of reinforcing conventional pedagogy even when technology would permit new thinking:

**Pioneers**

A pre-service teacher, herself a fluent and enthusiastic technology user, was deeply immersed in thinking about how a study of pioneers could call upon web based resources to make decisions and problem solve. She knew she wanted to go beyond the "copy, paste and put it into my report" use of technology that she had seen in other places. She knew children would have no problem with the technology skills the study would require: they could search from a number of sites she would provide; navigate links; import images; download audio clips. What she was interested in was how would they think with these skills, not just demonstrate that they had acquired them?

In designing the study, she wanted juicy questions for children as they worked with internet sources, classroom books and field trips to relevant local sites. She wanted them to wrestle with important issues of why people settled where they did; how the impact of their settlement changed the local environment; and how they depended on
one another as settlements grew. Confident about her own ability, she began to create a working site for children that would permit them to explore, to add new information to the space, and to record and analyze findings. The work she envisioned for the students was challenging, deeply engaging, and made excellent use of technology as a space for thinking.

The trouble came when she showed her work to her co-operating teacher, who openly acknowledged that he had little experience with technology. While he found that the student's unit was really intriguing, he expressed strong doubts about whether it would work. Setting out to be helpful in explaining what was developmentally appropriate for children in Grade 3, he stated that the Internet is not a good place for children to access information because everything changes so fast, and expressed concern that Grade 3's were not capable of following more than one link without getting confused. He challenged the student about what she would do if children got conflicting information from these sites. And he added that the mixture of books and field trips made the whole thing too large, too potentially confusing.

Going away to redesign the study, the student pulled her ideas way back, creating a PowerPoint template for the children. Now, rather than following a number of links to internet sites, each child could click on one link to a summary of information about each pioneer that she had written for them. Each page had a picture on it. Children were provided with a hard copy of all digital text, and they were asked to create their own PowerPoint presentation by making three slides about one pioneer: who they were, how they came to the province, and one or two interesting facts. They could copy and paste the picture from the teacher's site, but not the words. They were asked to write the information in their own words.
Several things are notable in this example. First, what could have been a lively investigation that would require conversation, decision making, problem solving and deep inquiry was converted to an instantly recognizable version of “do research and write a report on”. These are the kinds of pedestrian practices that the literature identifies as troublesome. They leave no role for technology as an environment for thinking in new ways; rather, the new PowerPoint template became a way to continue to teach in essentially the same ways as before and for children to do essentially the same kinds of school assignments as before, with only the added novelty of presentation software.

Second, because the student herself had little classroom experience, she was very vulnerable to this teacher’s opinions about developmental appropriateness, and what students supposedly could and could not handle. She never questioned for a moment what her own experience outside school had shown her: that children could do, and could learn to do, an amazing number of things with ease and with enthusiasm. Instead, she accepted gratefully the criticism that she didn’t properly understand who her audience was. Given the research picture of Net Gen children and their confidence and fluency with digital technologies, the automatic assumption that the more experienced but less technologically competent teacher best understands what Grade 3 students can “really” do with technology cannot pass without challenge, exploration and debate. Assumptions such as the ones held by the experienced teacher help underwrite the current disconnect identified in the literature between students’ use of technology in their personal lives and how technology is often used in schools.

**Challenges to shallow constructivism**

There was a sharp awareness among the faculty we interviewed that technology has great power to advance the ways in which educators think about learning environments for children and youth, and that divorced from...
these epistemological and pedagogical commitments, technology had little likelihood to change anything for students. Their experience supports findings throughout the research literature: constructivist or inquiry-based practices and philosophies were far more promising than conventionally transmissionist ones.

However, what became evident in the schools was that it was not only conventionally teacher-based practices that stood in the way of meaningful technology integration. Sometimes teachers who identified themselves as constructivist, inquiry or project-based in their approaches also demonstrated the kinds of weak approaches to teaching and learning with technology that Bereiter and Scardamalia call shallow constructivism. Here, students engage in a range of activities in which ideas have no overt presence. Typically, “students describe the activities they are engaged in (e.g., planting seeds, measuring shadows) and show little awareness of the underlying principles that these tasks are to convey” (Scardamalia and Bereiter, in press, p. 4). Often student teachers encountered and were expected to mimic weak practice in both conventional and constructivist classrooms.

In many classrooms we visited, or in correspondence we had with pre-service teachers, it appeared that both experienced and student teachers tended to take conventional classroom practice (whether transmissionist or weakly constructivist) as unproblematic and looked mainly for ways in which technology could enhance or extend everyday activities and practices.

Faculty interviewed in this study tended to take a different stance about learning, itself, seeking to transform the kinds of experiences their students had in their campus experiences in the hope that they would have new images and understandings on which to draw in their practicum.

Student #1: We have gone into the lab in both math and science on Friday mornings and played around on the internet. And saw what was there. That was Math. And with Science, she gave us software that we could look at and explore to see if it was useful.

Student #2: There were all kinds of things from games to more elaborate things like, label the parts of a fish. And things like that
The experience of participants (including many of the pre-service students) make a point that is well known in the literature: effective technology integration is not a simple matter of introducing computers or adding a bit of group work or a PowerPoint assignment to the end of a conventional set of activities and assignments. Rather, their experience supports the position documented in the research literature: educators need to be looking at fundamentally philosophical issues. Can ICTs “support more powerful, more complete experiences of collaborative knowledge building” (Breuleux, 2001, p. 3), replacing both familiar teacher-centered practices and familiar “hands-on” activities with more robust and engaging learning environments? It can, says Breuleux (2001, p. 3):

> If we integrate well-designed technologies in the context of meaningful, mindful inquiry projects, non-presentational pedagogies, access to resources and tools, and adequate support for technological maintenance and pedagogical renewal.

In observing in classrooms and interviewing students, we found a range of ICT integration approaches and opportunities, more fully described in the Finding 6. The work of one student stands out as particularly illustrative of the kinds of knowledge building environments and practices pointed to in the literature:

**Survivor**

Several classes of Grade 5/6 children with whom the student teacher worked had tackled the question, how can I tell how fit I am? Couched within teacher concern about decreasing levels of fitness among Canadian youth, this study involved students in asking questions about what it means to be fit, and how their activity levels throughout the day had an impact on their fitness levels. As teachers and students (including the student teacher) began to explore the question, they decided that they needed a consistent, easy way to monitor fitness levels, and research led them to the Harvard Step Test. Students developed a method for establishing baseline data about their own fitness levels by administering the Step Test with care and attention to controlling variables.
They used digital heart rate monitors and also learned how to take their pulse with two fingers on the carotid artery.

An online database was developed that enabled students to enter their own resting, target and recovery heart rates, which they did during gym classes and after daily recess. On weekends and holidays, some also entered data gathered during their dance classes and soccer matches. The teachers involved in the project, the student assigned to the school, a first year education student from an entirely different class, and professional development mentors engaged in a lively online discussion over several weeks about what was emerging in the study: how children’s voices and vision for the project were directing meaningful engagement; how children were developing increased awareness of the importance of data collection protocols; how they debated issues of what 11 and 12 year olds should do with tests normed to fitness levels of 18 year old soldiers; how they search for students from other classes and other places to be involved.

Both the teachers themselves, as well as the children, were engaged in a knowledge building environment in which ideas about fitness were front and center, and where issues of how to manage the project and what to do next were generated within the context of emerging work in the classroom and the questions, challenges and suggestions that the teachers and student teachers had for one another. And thinking and working like this with one another, the teachers were supported as they figured out how to create the same kind of environment for children.

It is important to note that we saw few examples of work of this scope and depth in field placements, and then only when the professional development needs of experienced teachers were being systematically addressed through intentional field placements and strategic professional development partnerships.
Issues of Classroom Control

Student teachers identified an issue that dogs most attempts to change classrooms to more deeply constructivist or knowledge building environments, particularly where technology is concerned: teachers’ willingness to let go of some conventional assumptions about teacher control. And they noted, this willingness carries identifiable risks:

Student 1: You do want to show the kids that you do have that authority but then you don’t have that same computer skill like them and then are they going to respect you because you don’t have that knowledge?

Student 2: Maybe they will respect you more because you don’t know everything.

Student 3: That’s true. You can learn from each other as well.

Student 4: I found it embarrassing at first to have kids show me. But they were great…and that was okay for me after awhile …and I thought, why not learn from them?

It is often difficult for experienced teachers to release some of the conventional controls that make for orderly classrooms, and they are often fearful until they have re-oriented themselves to the new structures that they actually can take a strong teacher’s stance in these new learning environments. Student teachers were very open in sharing how anxious it made them feel not to appear to be in control.

Much rests on their co-operating teachers’ assessment of their abilities, and if that teacher is not yet in a place that questions and challenges conventional practices and images of competence, innumerable variations on the Pioneers scenario can potentially erupt. We explore this problem in greater depth in Finding 5.
Innovative on-campus environments can go a long way to help student teachers understand that their struggles with ICT integration may not only be about their individual competence. When university course work explicitly opens a place to address questions and fears as an integral part of any teacher’s move to different structures in the classroom, struggles no longer become evidence of failure. They become an expected part of the learning, itself. Our analysis of innovative and effective practices on campus highlighted the importance of student teachers’ opportunities to raise their fears and questions in the presence of experienced faculty who can help guide them through potential strategies, critique emerging thinking, and build a collective understanding of new ideas and methods.

Asked what it was like to be part of ongoing conversations where cooperating teachers were, themselves, learning to design inquiry-based learning environments, one student said:

Yeah, it was very nice to go through that process with them and for it to be such an open discussion so that you are not sitting there thinking, ‘I’m not really understanding this.’ It was really good to know that people who have been in the field for that long were having the same sort of difficulties and struggles.

**Three Kinds of Digital Literacies**

Selber’s analysis of three fundamental digital literacies is a helpful way to think about pedagogical issues universities and schools might address as they better prepare teachers to develop their understanding of digital meaning-making systems. (1) **functional literacy** is perhaps what most people think of when they hear the term “computer literacy”. Functional literacy is, in essence, competence with computers and applications. The development of confident and fluent use of hardware and software underpins many government mandates across North America that require that all teacher preparation graduates either demonstrate technology competence or have fulfilled a certain number of course hours in technology use.
Universities in Alberta have all made significant (if very different) moves to ensure that their graduates acquire technical competence to implement the ICT program of studies. Each university has established courses, technology infrastructures, support and access to hardware and software that make it possible for students to have access to technology on campus. It appears that universities have been successful in addressing many of the technological inadequacies identified in the research literature, although students report different levels of access available to them on campus, especially in the smaller institutions. As we will discuss in Theme 7, however, there remain important issues to examine and debate in order to align campus experiences more strongly with the pervasive, ubiquitous and highly mobile digital environments that are increasingly characteristic of life outside schools. In addition, innovative approaches to mandatory, introductory courses in technology integration that have been developed in some Alberta universities point the way to solving a problem identified in the research literature: that conventional approaches to such courses are not generally effective. This finding will be discussed in Theme 3.

Selber also identifies the development of Critical Literacy as a key issue in undergraduate education. Here, he says, students must become not only fluent technology users. They must also become critical thinkers who ask hard questions about the pedagogical, social and ethical dimensions of technology use. These are the kinds of issues addressed in the Foundations level of the Alberta ICT program of studies.

Taken as a whole, we would observe that faculty in the innovative courses we examined maintained a sustained focus on the pedagogical dimensions of technology use. This is in marked contrast to the way most students described their experiences in other courses, where instructors who mentioned technology at all tended to just

I had never touched the ICT before. I’ll be honest. There is a lot there. It is a lot more than research and more than word processing. ...there is ethics and ergonomics... and you have to integrate that into and that is hard. It is easier to integrate research..... And the ethics thing, I don’t think I ever got any of those things...like downloading music, I just did it. And if I had been told that it was wrong in school, I don’t think that I would have done it. If you had that knowledge before, then I think it would have made a difference.

Student teacher

Coming to Teaching in the 21st Century
indicate the need for students to consider technology when they designed units of study. Or if they used technology extensively in their teaching, it was identified as an enthusiasm particular to that individual instructor, not a systematic approach across the faculty. Their experiences in these courses aligns with the situation documented by Schad (2003) and CADE (2004): few education faculties as a whole have developed a focus on or commitment to the integration of ICT within and across their programs.

Faculty in this study engaged more systematically in what the University of Lethbridge call "meta teaching": the simultaneous examination of technology use and implications for practice. Given the enormity of the shift from presentational styles of teaching to more constructivist, inquiry or problem-based approaches, this systematic attention demanded enormous effort on the part of both faculty and students, at base because it calls for actual changes in teaching practice on campus and in schools, not just talk about change. The creative energy required to conceive, design and teach in the kinds of innovative environments described in this study are considerable if for no other reason that most of them involved the design of learning environments radically different from ones in which faculty, themselves, had been educated and in which they had formerly taught.

We also observe that other aspects of critical literacy, particularly those that help students to understand and to challenge the taken-for-granted assumptions both of schooling and of the role of technology in our society, did not surface in the classroom observations or discussions we had with pre-service teachers. This is not a criticism of the hard work we witnessed. It is, instead, to observe that the job of developing critical literacy cannot possibly be left to the responsibility of one course, or one faculty member, or even to subsequent optional specialties in technology. It
requires a pervasive commitment on the part of faculty colleagues and of classroom teachers to both learn and teach new ways of thinking with technology.

It was beyond the scope of this study to examine attitudes of other faculty to technology. However, we do know from our interviews that many current students in Alberta faculties of education engage systematically with technology in only one or two of their courses, or in clearly defined options. The final theme identified in this study—that innovation is a lonely road—examines in detail what is also documented in the research literature: innovative work with technology is often isolated and marginalized on campus. The literature addresses the problem that faculty who resist the integration of technology in their own practice often lack functional literacy, and identifies support to develop this literacy as important. Our study confirms that such support is usually available in Alberta universities.

However, we also suspect that many faculty resist technology use either because they are critical of the impact of technology in society, or do not engage deeply with the ways in which technology has transformed every subject discipline, quite apart from the identified specialty of educational technology. None of the students we talked to had had the experience of exploring how fields such as science have been transformed by digital technologies. None spoke about what they were learning about new literacies, or the role of simulations in the work of practicing mathematicians. Given the current state of affairs identified in this study—that educational technology remains largely the domain of this identified specialty (whether by design or by default)—there is often a “two solitudes” division between technology enthusiasts and technology critics on campus.

It does not seem to us widely understood or practiced that full digital literacy demands a critical stance and the commitment to social justice identified as crucial by the Canadian Association of Deans of Education. Nor does it seem widely understood that the most effective critique of
technology can come from only within a culture of committed engagement and understanding. Thus it is troublesome that so few of the innovators in this study have strong support from colleagues outside the identified area of educational technology. Critical literacy demands that curriculum theorists, philosophers, subject specialists, policy analysts and others also enter the picture. At the moment, it appears that they may not routinely do so. We will discuss the implications of this finding more fully in Finding 8.

(3) **Rhetorical literacy** requires that students design, compose and create in digital environments. That is, they need to become creators of technology, not just users. Rhetorical literacy demands what some call multiple literacies, or new literacies. These literacies beg the question, what is the character of literacy in multimedia, hyperlinked environments in which sound, text and graphics can combine to create three dimensional structures for learning? What does it mean to be literate in synchronous and asynchronous environments such as chat rooms or fan fiction sites? What’s different when you read a newspaper on line, play a multi-user game or explore a mathematics simulation?

And what’s different when you build one of these, yourself?

Schools are predominantly oriented to the linear logic of text. As the *Pioneers* example demonstrates, the simple presence of presentation software doesn’t mean that children will get to engage with technology in any but the most superficial way. What is required is a very different teaching mindset. We observed two courses in which pre-service students were either encouraged or required to create Web Quests they could use in a classroom. These students found it a real challenge to create their Web Quests, and were enthusiastic about the possibilities for

Coming to Teaching in the 21st Century
learning that they presented. Three things are important here. First, even though most of the students used technology in their own lives, they needed to learn how to think about what and how children might learn in a Web Quest environment. And they found this required hard and sustained effort on their part, as well as the creative efforts of faculty to design the courses in which Web Quests became a meaningful experience.

Second, because these students encountered so few other opportunities to design, compose and present in a full range of digital environments, we have some concern that they will come to equate Web Quests with technology in the way that less experienced teachers frequently equate Power Point with “doing technology.” With the exception of the school in which pre-service teachers were placed with experienced teachers learning to create meaningful inquiries with technology, we saw no examples of rhetorical literacy other than the use of Web Quests, Power Point and word processing other than one student teacher who reported using video extensively. Some students had the opportunity to learn in online and other digital environments with experienced teachers and/or their instructors. Few had the opportunity to create simulations, program robotic probes, make films, create zines, databases or blogs. Only one worked in an online environment with students. Few used peripherals beyond data projection.

Third, there is a world of difference between using digital environments that others have created, and learning how to build one, yourself. And it is here that critical and rhetorical literacies converge. Designing and building in digital environment provide rich opportunities to help students understand and critique the philosophical and ethical assumptions that are built into systems that just seem “natural” or “the way things are.” That is, rhetorical literacy holds the possibility to turn unquestioned, or poorly understood, consumption into more incisive, creative and socially responsible engagement.

Thus, the pervasive absence of this literacy in course work and/or practicum experiences demands policy attention. This accords with the research literature that identifies the importance
of exploring and confronting philosophical issues associated with teaching, learning, technology and the changing roles of educators and learners, and the Plante and Beattie (2004) Statistics Canada findings that fewer than 10% of Canadian students have the opportunity to use software that supports creative works.

Again, it is important to emphasize that this is not a shortcoming of courses examined in this study. In these courses, students reported working very hard to accomplish what had been set out for them to master, and faculty exerted enormous and on-going effort to design these courses and keep them running. It is, instead, a comment on the necessity for higher levels of technology infusion in most, if not all, courses in education programs. If other faculty do not take up issues of rhetorical and critical literacy, it cannot be assumed that one or two courses alone will be enough to build deep understanding and confident preparation to teach.

2. Fluency with technology does not translate automatically into the ability to teach effectively with it.

Students are arriving in faculties of education with increasing fluency and confidence with technology in their personal and professional lives. They told us that they routinely use email and word processing. They frequently access, and sometimes create, websites; use PDA’s, create and edit videos, and use their cell phones as portals to everything. One owned a multimedia company, and another had studied computing at a technical college. Those who do not use technology confidently, identified themselves as frightened, or attributed their reticence to age. That is, it may be the case that not using technology is no longer perceived to be the normal state of affairs, the default to which introductions to technology have conventionally been set. In this sense, Alberta pre-service teachers may increasingly fulfill a necessary condition for teaching with technology: they actually use it in their everyday lives.

I was a really good computer user before I came. In my previous job, I was the go-to computer person, before I came back to school but I think that the thing that I learned during the course is that even if you are an expert …there is so much more than that.

Student teacher

Coming to Teaching in the 21st Century
Sometimes universities and schools make an unwarranted next assumption: that the upcoming generation of young people will be so savvy that most worries about teaching with technology will disappear. That is, some look to these aspiring teachers as “digital saviours”, and assume that simply waiting for their arrival into the profession will be an adequate policy response to the challenges of technology integration.

This study demonstrates unequivocally that this assumption is unwarranted. First, we noted that ease of personal use is not at all the same thing as confident decision-making in planning and implementation. Students recognized the importance of their course work in helping them make the translation from personal use to pedagogical possibilities and issues. As explored in the previous finding (effective ICT integration is primarily a pedagogical, not a technical issue), this translation involves making curriculum connections and learning how to think about teaching in a more constructivist, or inquiry-based way. Most pre-service teachers were educated (1) in more or less conventional ways, and (2) with little access to technology in their own schooling. Students we interviewed for this study found the ideas presented in their courses to be quite different from the ways they had thought about teaching before they took the course. They were often eager to try out the new ways of teaching. Thus, it cannot be assumed that pre-service teachers automatically know how to create the kinds of learning environments for children and youth that they, themselves, have seldom if ever experienced. That’s what they were learning in the innovative courses.

The research literature identifies a significant issue in technology integration: when working with teachers and helping them to create an academic project using technology, the curriculum often becomes an adjunct and technology

With my partner, we did our project on Evidence and Investigation so we’ll take sort of a CSI approach and integrate sort of what is trendy on TV right now …It was very interesting to see the connections in the curriculum and be able to figure out how to make it so the kids can almost, with the WebQuest especially, almost teach themselves. They can go through the links and learn about things and learn about different detective work and figure out how to do it.

Student teacher

I always try to think about how the students can use technology for design, beyond text and graphics, which most of them are fairly good at…how can they represent their understanding to me about what they are grappling with in the classroom, or a project I've asked them to work on. I try to model ubiquitous use of technology to support teaching.

Faculty
becomes the focus. All faculty interviewed for this study spoke to this issue in one way or another. They acknowledged the challenges in keeping the curriculum cart and technology horse in something like the proper relationship, and they spoke of the same kinds of issues revealed in the literature: that learning how to teach with technology does not involve the straightforward transfer of technology skills into new environments. Students must be taught to plan with technology, to manage classrooms and labs, to critique their decisions, to collaborate with colleagues—to participate, as Breuleux (2001, p. 8) puts it, “in constructive dialogues” that permit them to learn from the work and build on it.

It is not the case (commonsense thinking aside) that having students simply observe even innovative teaching means they can interpret what they see, or ask the right kinds of questions from their experiences. The difficulty of noticing and interpreting the classroom environment in meaningful ways is not restricted to pre-service teachers. Jacobs and Morita’s study of how teachers interpret videotaped classroom sequences (2002) points to this issue as a feature of teacher professional development across the board. Given video clips of mathematics teaching to discuss, even experienced teachers focused on superficial or management issues rather than significant matters of curriculum and instruction.

From a pedagogical perspective, creating an environment in which pre-service teachers can be taught to interpret experiences, not just have them, is crucial. How can school visits be made more meaningful for pre-service teachers? This is the issue that the Virtual Social Studies Field Trip was designed to address, and it is very important to note that students experienced the virtual environment as presenting real teachers and real issues. Their professor also found that having control over the depth and breadth of experiences in the virtual field

I would never willingly have taken a computer class. Because I have just been so frustrated always. Even though I had grown up having to take computers in high school. It was just never enjoyable to me. There was too many of us. Like if we did get frustrated we would just help each other or do it for do it for each other. And I was most likely to get someone to do it for me cause I was never good at that stuff. So this course has been really good, just having to do it. And I feel like now I actually want to know more for the first time ever. For like … [another student] was saying there’s so many possibilities. But like before I thought, “I don’t care if there are possibilities." I’ll encourage the kids to discover what they are but for me, no. “

So now I am, I do want to know.

Student teacher
trip meant higher quality of instruction in her classroom. That is, the simulated field trip was actually superior in quality to the more usual visits to school sites so common in pre-service education. This finding will be explored in detail in Finding 4.

For the moment, we wish to return to findings documented both in the research literature and in this study: there does not seem to be wide-spread interest in seeing the effective use of technology as everyone’s concern. It is particularly noteworthy that the students we interviewed did not, themselves, see this absence as particularly unusual. What they did find unusual were those “techno geeks” who brought technology into methods or other courses. One group spoke about still feeling unprepared to work with technology, even though they had learned a great deal in their course. Another expressed some urgency that the introductory experience they had in their first year program be followed up with a similar course the next year, lest they lose the gains they felt they had made. Another student, identifying herself as previously terrified to use computers, felt that the experience she had just had in her course gave her confidence to seek out more technology courses, although none were offered in her program.

In the CADE report (2004), Canadian Deans of Education observe that few students seem to be asking for more experiences with technology. The Deans identified this as a problem requiring their attention. Our experience suggests that the question of whether students feel they need more experience with technology might best be posed after they have taken one effective course that introduces them to the complexity of teaching issues surrounding technology. It appears to us that education students may not initially be asking for more technology courses if they do not understand how challenging and how interesting it actually can be to think like a teacher with computers.

Industrial age structures of schooling may be so pervasive that students who have seen very little technology use in classrooms come to expect little in their on-campus courses and practicum experiences. Students

Coming to Teaching in the 21st Century
discussed the relatively infrequent opportunities to use technology with no apparent sense that they were being short changed by instructors or by cooperating teachers who stated outright that they did not believe in technology. One group of students observed that it would have been possible for them to have gone through their entire program without encountering technology use, had it not been for the innovative course in which they were enrolled.

These observations need to be held within the context of a final note, one that brings us back to the naïve assumption that the upcoming generation of teachers will automatically solve the problem of technology integration in schools. As we have seen, there is more to the issue of designing learning experiences for students that integrate technology in meaningful ways, not the least of which is that effective technology use demands significant pedagogical changes. Given that even confident technology users understood that teaching with technology is not at all the same thing as using it in their personal and professional lives, it is worth noting that in several cases, the pre-service teachers actually did provide leadership for their experienced cooperating teachers. One student spoke about how she and her cooperating teacher became partners in planning and teaching, learning each from the other about how to do new things in the classroom.

The deliberate partnering of CUCA students with three schools provided professional development opportunities for experienced teachers that the school principals valued highly. And the University of Calgary example demonstrates how the intentional infusion of faculty, of outside professional development mentorship and of an online learning environment helped pushed the thinking of both experienced and pre-service teachers. These findings will be discussed in detail in Finding 6.

"It was nice to contribute something to her classroom that she didn’t already have. Like I mean, any student teacher going into a classroom contributes something, but in a classroom like this where she doesn’t use technology a lot and I use technology for everything. Like I love the computer. So that was kinda nice to be able to give something to the class that she didn’t previously have very much experience with..."

*Student teacher*
For now it is enough to observe something of a two-edged sword in this phenomenon. Left to accident, it is by no means certain that student teachers can (let alone should be expected to) take responsibility for introducing technology integration to their co-operating teachers.

3. Changes to transmissionist or presentational pedagogy and conventional teaching approaches on campus yield significant results.

There is inconsistency between what teacher-training faculty know about technology and what they are training teachers to do in their courses” (Milken Family Foundation, 2003).

As we examined what students told us about the differences between the innovative courses in which they were enrolled and other experiences they had had with technology integration, three areas drew our attention: (1) the apparent disconnect between espoused interests in, or knowledge of, constructivist or inquiry-based approaches and widespread commitment within faculties of education to considering how these learning theories intersect with technology; (2) limitations of introductory technology courses as identified in the research literature and discussed by students; and (3) the ways in which some of the innovative courses introduced a much stronger educational focus to compulsory courses concerning the integration of technology.

We have discussed area (1) extensively in the previous two sections of the report. In this section, we will focus on the second and third areas.

Conventional Introductory Courses in Technology

The research literature indicates that stand-alone introductory technology courses do not adequately prepare educators for the classroom. Characterized as limited in scope and non-context specific, such courses typically provide little to no ongoing support and fail to provide...
opportunities for teachers to reflect on their beliefs and practices. Successful technology training without pedagogical grounding tends not to lead to the integration of technology in teaching practice. As we will see in a subsequent section of this report, this tends to be as true for practising teachers as those in for pre-service. Students we interviewed for this study experienced traditional survey courses in technology use as largely unsatisfactory, finding that they lacked opportunities for engagement, for developing understanding and connection, and for working with technology in ways that helped them remember what the applications to which they were exposed were actually good for.

**Compulsory Courses with a Strong Educational Context**

Three of the innovative courses nominated for this study are required courses in technology integration. The courses offered at the University of Lethbridge and Concordia, while differing significantly in their structure, are particularly instructive in directing attention to how universities might better think about the development of fundamental computer literacies within a context of pedagogical use. Details of these projects are described in earlier sections of this report. Several common threads differentiate these courses from the conventional introductory courses criticized in the research literature and dismissed by students. (1) They are designed and delivered within the context of teaching and learning. The first year course at Concordia is strongly focused on productivity processes, allowing students both to use frequently unfamiliar applications such as spreadsheets and advanced features of word-processing in order to create both year and unit plans. Introduced to the ICT program of studies at this time, students begin to understand how this curriculum can be infused into anything they wish to learn, or to teach. Drawing students’ attention explicitly and consistently to the relationship

Coming to Teaching in the 21st Century

I mean I took the [introductory] course …where we took a lot of things…but we never used them again after that. So when I came to this class I said, “I know I’ve made a website. I know I’ve made a PowerPoint and hyperlinks” but I haven’t done it. That was my first year and I don’t remember because we never had to use it. Yeah we learned it. But we never had to put any of that learning to any use through our time here.

Q. What’s the difference between …[the innovative] class and that class?

A. We’ll use it and even remember it. …the other class it was “do this it’s over”, “do this it’s over”, “do this it’s over”, okay you never see it again …but in …[this] class you learn more by doing.

Student teacher

You are not learning spreadsheet for the sake of spreadsheet or word document for the sake of word document. You are learning a spreadsheet in the context of something you would do with spreadsheets as a teacher.”

Student teacher
between technology and their own work as curriculum designers, the instructor introduces fundamental pedagogical connections from the outset. In the second year, students use whatever subject specialities they are interested in to create a unit of study that incorporates technology as a teaching and learning tool for others.

The students, themselves, gave an eloquent description of their experience across the two courses:

> Because the program is built in a layered manner where you start off in the beginning and I look back now and I am quite awe struck and the growth that has occurred because when I came in I used the computers in the school, but coming now I feel really comfortable and very at ease sitting down and creating something. Or when we were able to do our virtual classroom tour [for the TNT project] the more I found that we were exposed to the technology the more I wanted to know and add and create and personalize and refine myself. And I think that is reflective of how Concordia developed their programs so that they give you a starting point and then you integrate that with the prior skills that you have and from there you are able to build, create and add your collegial knowledge and your own personal ideas and create these wonderful classroom tours. I mean we saw some of them yesterday. They were just awesome. And I think Wow! We really can do this. This is just so great.

As an interesting aside, most of the students felt that they were not learning technology for the sake of technology, but one student identified an issue that was also a problem identified by the instructor, although he did not realize the full context for his observation. Noting that they were introduced to Microsoft Publisher in their Year One course, this student felt that there are actually better publishing tools that people could use, and expressed some frustration with having to spend time on this application. As the instructor notes, the deal with Microsoft that permitted the much-needed updates to the lab required a strong commitment to use Microsoft software, even though she, herself, is aware of the limitations of some of the applications, and would prefer to
use a broader suite. In Finding 7 we will explore more fully the problems that faculties have when limitations in funding require them to compromise important principles in the service of practical necessity.

Students at the University of Lethbridge also spoke about their experiences in learning about the ICT program of studies within the context of creating projects in their course that let them apply the program of studies to whatever curriculum areas they were interested in. They felt that the freedom to actually create something relevant to their interests was important, and it is clear that the focus on meta teaching served the same meta cognitive function that is at the center of the Concordia project. Students spoke in many ways about how they learned to think like teachers as they explored different applications. Like the Concordia students, they felt they emerged with a strong understanding of the ICT Program of Studies, its relevance to all curricula, and the potential relevance of a number of applications to subjects they might want to teach.

(2) Students at all universities were keenly aware that what they had received was only the tip of the technology iceberg. As one put it, the course “opened the door just a little”. We have seen in an earlier section that the relative absence of technology integration in other, non-technology courses in students’ programs may be problematic in terms of helping students develop both critical and rhetorical literacies. Or put another way, it may be that students are too often left with the impression that technology is something you apply to an otherwise static curriculum. When they had the opportunity, as did many interviewed for this study, to think in greater depth about designing interesting learning experiences, they raised interesting questions and were able to problematize some of the conventional teaching practice they saw in schools. We could see the potential for rich follow-up of these questions in other courses and contexts, would such opportunities be more routinely available.

Coming to Teaching in the 21st Century
The students, themselves, also pointed to a limitation of single courses in technology integration in terms of further developing their functional literacies. Here, there was an interesting split between students who had very little experience of technology, and those who knew that there were far richer things to be done with applications than were possible to introduce in one class. Sometimes it was students who identified themselves as very confident and fluent users who observed how much more there was to learn and to explore. And sometimes it was students who had had their eyes opened to the possibilities of technology for learning who spoke about knowing that they now needed to know more about the technology, itself before they could take next steps in thinking about new ways to teach.

Participants from the University of Lethbridge and Concordia programs identified the potential and actual benefits of including more compulsory courses to build on what they had begun here. At the moment, Concordia is the only university in which students are assured of two courses that explicitly focus on teaching with technology. Kings’ College has only one technology-specific module available for students, and at the universities of Calgary and Lethbridge, there are numerous opportunities for students to pursue an interest in educational technology in optional courses. Given the rate at which sophisticated new applications become available, and the use of technology that characterizes the lives of so many children and youth outside school, it must be asked whether a single introductory course is actually enough for all students, and how momentum gained in effective introductory courses can be maintained throughout the program.

(3)Some students entered their courses as either indifferent to, or terrified of, technology—and they acknowledged and appreciated how far they

I told my fiancé before coming to this class, “I can’t go. I just can’t go this week. I am going to throw a computer through a window. I just know it” He said, “You just go.” He was really excited to hear that I have changed. Before he would help me with everything. If I had to do a spreadsheet I would get to the point of frustration where I was almost crying and then I would phone him and he would come and do it for me and try to show me how to do it so that the next time I wouldn’t be crying. And I felt stupid that I can get to the point of crying over a computer. But I know that it is something that I should know how to do

Student teacher
came in a relatively short space of time. The words of one student are particularly illustrative of the “terror” end of the spectrum:

I was one of the students who came into …[this] class, I am nearly 40, I had never sent an email with an attachment and I thought, ‘Oh my god, this is going to be really hard. I’m not going to be able to do this’. And one of the first things…[the instructor] said in the class is, ‘You don’t need to be a techno guru to do this. Everyday people can do this. You just need to be a facilitator of technology for your students.’ And then I went! ‘I can be a facilitator. That I can do. I don’t need to know the software. I just need to know that it exists and be able to navigate through it a little bit or how I can integrate it into various parts of the curriculum.’ So I found that to be just wonderful and I am not intimidated at all.

This example illustrates two important points. First, as an instructor from a different university noted, students on the whole are coming into the university with markedly stronger technology skills and experience than they had five years ago. But not all of them. While some students identified their age as an inhibiting factor, other young students also identified themselves as deeply frightened by technology. Universities have an enormous challenge in addressing this reality in ways that are genuinely helpful both for confident users and for their frightened or indifferent fellows.

Second, however, is an observation not generally acknowledged in the research literature. No matter what the university or particular course participants experienced, they felt themselves to be deeply supported by faculty who understood their issues and who helped them accomplish more than they would ever have thought possible. They felt that the structure of their courses provided many opportunities for support from faculty, from...
one another and in some cases, from technical support people on campus and from partners involved in the professional development of teachers.

The strong emotional connections students described as they talked about their experiences in these courses is quite remarkable, and stands in sharp contrast to this description of something that happened in another course when a “techno head” came in to demonstrate software:

‘…it was look at this website and look at this website. It wasn’t how do you use these things…Click here and this does this…. When I woke up again and realized where I was… this isn’t the way I wanted to go about it.’

**Well-constructed Digital Environments Provide Engaging and Meaningful Interaction for Students**

Three of the innovations studied here point to the power of well designed online and digital learning environments to address many of the problems identified in the literature and in practice: the University of Lethbridge course for first year students; the University of Calgary pre-service/in-service immersion in a face to face and online community of practice; and the University of Alberta Virtual Field Trip as a digital environment for teaching elementary social studies.

In the University of Lethbridge online, introductory course studied for this report, students reported experiencing the online environment as so engaging and their relationship with their instructor so meaningful, that they felt there was actually little need for the face to face sessions that had been built into the program in order to facilitate the development of relationships. University of Calgary students experienced the opportunity for more seamless interaction between faculty, cooperating teachers and professional development mentors as they learned to plan for inquiry.

Those students who worked in classrooms that were more fully oriented

---

Rather than having lectures and too many class discussions that are dry… we were in the lab on computers answering the questions that she had set out and seeing videos from in the classroom and hearing other Education students talk about their experience. …it was almost as valuable as student teaching. Because you were, you weren’t there but you could see the kids interacting and hear other student teachers....

I found the virtual fieldtrip just a great source of resources and there were even, and you could even see how they were implementing. They discussed their ideas and then you could see them implementing it. So it gave you a better perspective on how to do that.

*Student teachers*
to inquiry reported higher levels of satisfaction with this environment. Students placed with cooperating teachers whose practice was less oriented to inquiry often experienced as problematic the disjuncture between what “their teacher” identified as good practice and what others around them were thinking and doing. This disconnect sometimes led to discomfort, but it also placed students at the authentic eye of the hurricane created by shifts to changed practice in schools. Students at the University of Alberta spoke especially highly about their work with video clips involving classroom teachers, categorizing these clips as opportunities to find out what real teachers think and do.

When participants cite such a range of experiences as deeply engaging and satisfying, we must pay attention to the design of those learning environments.

First, they have in common the opportunity for students to engage in sustained digital environments in which, in one way or another, they are relating issues of technology integration directly to issues of teaching and learning that are perceived as immediately relevant and meaningful. They learn about technology integration and explore a range of applications within a context of purposeful use that has something of the character of “just in time” in-service. This replaces the “just in case” structure of conventional technology courses and workshops of which they were generally quite critical.

Second, each of the courses involved some kind of mentorship by faculty, and sometimes by others. The emphasis on meta teaching at the University of Lethbridge made students feel that their instructor was deeply involved in the particular issues, questions and problems that were important to them. They developed relationships with her, and with one another, through the work they were doing individually and collectively. At the University of Calgary, both face-to-face mentorship by the instructor and by professional development mentors...
was readily available to students on a “pull” basis as they and their cooperating teachers collaborated in constructing and teaching technology-rich inquiries. The social studies virtual tour immersed students in genuine problems of practice in social studies teaching, and the combination of resources available through the tour, carefully structured assignments and complementary course work created, for students, an experience they characterized as real and as deeply engaging. Both their instructor and the lab assistant were available easily for support, consultation and problem solving.

Third, each of the environments was both carefully structured and deliberately open-ended. None had the flavour of older versions of computer assisted learning in which participants move through static content and are tested for mastery. Rather, each was in some sense an immersive environment in which students made significant choices about the kinds of interactions they would structure for themselves. Faculty reported that it was not easy to turn dissatisfaction with conventional methods of teacher preparation into new ways of learning, particularly in online environments where conventional best practice still tends to replicate course delivery as its defining metaphor.

Changing this thinking was identified as one of the significant challenges each university encountered, and characterizes both the scholarly and the pragmatic nature of work that faculty must do in order to create new learning environments for their students. We were struck by how each environment, in very different ways, was designed to force students to encounter key problems of practice in a problem solving mode.

Fourth, each provided in different ways for students to move at their own pace, to engage more or less deeply in the environment or to “pull” what they needed, how they needed it. Both proficient and inexperienced technology users described this advantage, sometimes explaining that the course was designed to let you go as deeply as you needed, or to quickly get past required

Then with using /O being able to plan on that. That opened my eyes to what planning could be, assessment could be, forces you to integrate technology in ways that I think I have even resisted in the past but also gives you the courage and confidence in yourself that you can because there are models to look at and show you how. And then you start to understand the benefits for the students. But you have to get past yourself as a stumbling block and understanding how it can be used.

Student teacher

Coming to Teaching in the 21st Century
applications and ideas with which they were already familiar to try new and more difficult things. It was also acknowledged that if students wanted to accomplish only the basic standards set by the course, they could do that and direct greater attention to other courses or areas in which they did not feel so strong.

In a similar vein, the University of Calgary students and field supervisor reported that the addition of the online planning and communications environment enhanced communication between students and their field supervisor; between practising teachers and students around planning; between practising teachers, students and professional development mentors, and among students themselves. In this case, the work of experienced teachers to understand effective ICT integration in inquiry-based classrooms was openly acknowledged as a professional development initiative that paralleled the pre-service teachers’ coming-to-know. Here, educators working together addressed the issue that teachers must learn to make more deeply informed observations and decisions about curriculum design, classroom instruction, and ICT integration, not just superficial judgments about student and teacher behaviour or digital add-on’s that fail to meet the spirit of the C Level of the Program of Studies. In all three cases, digital environments of a particular character seemed well suited to help pre-service teachers learn to make those informed decisions and observations.

Many faculty in Alberta use products such as WebCT and Blackboard to create online versions of courses in which the environment is used primarily to house course notes, syllabi and assignments. Many instructors also organize grades, use the quiz feature, email and discussion forums. These are what Norton and Wiberg (1998) call "second generation" technology uses:

She had it set up so that we would do case studies and things like that and we would do those in an online environment, and have discussion groups through IO. So that was very interesting to use and I certainly wouldn’t have been able to do it in any other circumstance.... And one thing that is good about IO is that you can sit there and have those discussions and talk to others, talk to experts in the field, talk to, open it up to the public in general and talk to anyone about what I am doing. ...yeah, to open the question up to other teachers who are working in ESL.... And get good ideas. ...that was the really good thing about the project I did with ...[my CT’s], being able to go through that whole discussion period and you have one set of ideas in your mind and you talk to someone else and it totally switches your focus. It’s really interesting.

Student teacher
doing familiar things in digital ways. A study on successful faculty development for the use of WebCT at Purdue University (Hua Bai, Chuvessiriporn, Lehman, 2002) reports this picture of the ways in which the environment is often used for teaching and learning:

Most (59%) used WebCT for basic content presentation such as putting course notes, syllabi, and assignments online. Many (41%) posted and organized students’ grades and used the quizzes/survey feature. WebCT e-mail (71%) and discussion forums (82%) were among the most popular features. Few faculty members had experimented with the WebCT live chat feature.

The innovations reported in this study move significantly past this familiar use of online shells for enhanced course delivery. The social studies Virtual Field Trip was designed in WebCT, but significantly pushes the application to create an innovative environment that goes far beyond enhanced course presentation. In the University of Lethbridge innovation, WebCT was the agreed platform, but its restrictions ended up frustrating the instructor, who would have chosen quite a different environment based on her own experiences with online learning. She was a confident enough technology user that she modified the WebCT shell to permit what she felt to be a simpler and more flexible environment. IO provided a design studio approach to planning that could be easily integrated into a course structure without actually replicating what most people think of when they hear the word “course”.

That is, currently university faculties to point to online courses or to such environments as WebCT or Blackboard alone as demonstrations of innovative and effective practice in technology integration. Currently, these shells enhance transmissionist practice, and may end up reinforcing rather than challenging presentational models of teaching and learning. Faculty interviewed for this study whose innovative and effective practices involved the creation of new kinds of digital environments created learning experiences that provided access to authentic tasks, data and learning opportunities that stimulated thought, problem-solving, inquiry and reflection, including
complex problems and cases, access to experts, peers and other learners, media resources (particularly video clips) and tools that provided some opportunities for interactivity, browsing and authoring. These are the kinds of multimedia or web based case examples that Ertmer et al., (2003) suggest be incorporated into self-paced explorations, or used for small group reflections tools or as instructor-led investigations.

While none of the digital environments we studied developed all of these capacities fully, the successes we witnessed and point to directions that might prove fruitful for future development.

5. Disconnects between campus and practicum experiences with technology integration impede the effectiveness of teacher preparation

Even when great efforts were made to provide robust, innovative experiences on campus in which ICT was infused into curriculum in important ways, the practicum remained the kind of sticky problem identified in the research literature. Only the University of Calgary innovation directly addressed the importance of harmonizing student teaching with on campus experiences. For the most part, universities lacked the ability to influence what happened when students went out into the field, although some faculty have expressed an interest in taking this next step. At Concordia, the university is not yet able to integrate practicum placements into the issues raised in the technology courses, but the TNT projects created in conjunction with experienced teachers go some way to linking field and campus experiences in more meaningful ways. At the moment, however, students we interviewed often found themselves completing practicum experiences in schools with a low level of technology infrastructure (both human and technological); where teachers were not using technology at all; or were using technology in ways that make no significant impact on student learning.

Several issues emerge from this finding. Despite the mandated ICT Program of Studies, now infused in each curriculum area, many Alberta teachers remain at the beginning stages of implementation. They struggle to understand and to design the curricular and pedagogical
changes required to integrate technology in inquiry-based or constructivist ways. This study confirms the findings of the Alberta Learning 2002 study that schools are not routinely using technology in meaningful ways. As policy makers, administrators, teachers and even the popular press question the wisdom of extensive expenditures in ICT, given what some dismiss as relatively modest gains in achievement (Chaika, 1999; McKenzie, 2000; Rogers, 20003; Oppenheimer, 1997, 2003; Monke, 2004; Hesse, 2004) it is difficult to point to the value of investments in hardware, software and infrastructure if teachers continue to teach as they have always done, using digital tools to do what could be accomplished as easily—or even better—in other ways. Both academic researchers and popular commentators draw attention to pedagogically questionable practices prevalent in many schools, perhaps most effectively mocked in the dismissive phrase, "Power Pointlessness" (McKenzie, 2000). Breuleux (2001) suggests that the public of educators, policy makers, researchers and others, is deeply interested "what can be gained by using technology in schools, and at what costs". Committed to current and ongoing research that ensures that both the questions educators are asking and the answers that emerge about the role of computers in school remain valid, relevant and useful, Breuleux makes a helpful suggestion about how educators might deal with contested claims about whether technology does or does not have impact on student learning:

Focusing on emerging practice emphasizes a different set of questions and issues than focusing on 'impact'. For example, the question of 'vision' changes substantially: the challenge is much more than imagining the future, it is about 'imagining the present', seeing glimpses of the future beyond the trivial, within the ordinary, among the current. It is easy to discard the present as banal, to conclude that technology has had little impact, and wait for the ideal scenario; it is much harder to cultivate our perceptions so that we see the (perhaps small) accomplishments of today and measure how they may lead to a fuller realization of the vision.
In doing just this—cultivating our perception so that we may correctly interpret the significance of what is happening *today* in schools, educators can perhaps be guided by Eisner (2003/2004) in seeking to design "an education process that is genuinely meaningful to students, challenging them with problems and ideas that they find both interesting and intellectually demanding". In discussing their practicum experiences with students, we sought to interpret how, and where, the present practicum experience of pre-service teachers is helping to build their understanding of how to design engaging, intellectually challenging and meaningful experiences that integrate technology in robust ways. Approaching the innovations that began to make headway with the practicum problem in this spirit may go some way to addressing this observation from the Alberta Learning 2002 report: “it appears that both faculties of education and school sites selected for practicum placements need to examine how they may enhance education students’ confidence in using technologies.”

Within the parameters of this study, we note that few schools were actually willing to let us observe, film and interview in classrooms to gain a sense of what was ordinary, what was current in their practicum experiences. Sometimes the district as a whole refused access. In other cases, the superintendent was supportive, but the placement schools refused. And in still others, we were blocked at the level of individual classroom teachers. Sometimes the reasons involved the short turn-around for permissions and/or ethical approval, or the amount of work that would be required to secure these. In other cases, schools seemed uneasy about what they saw as intrusive interest in student teachers’ experiences with ICT in their buildings.

Follow-up email and telephone conversations with these students revealed three types of problems in the practicum situation. (1) Few were able to implement units of study they had planned at the university, even when they expected to be able to do so. (2) Some were able to use technology in only fairly ordinary ways: for keyboarding, internet research, PowerPoint presentations, word processing, basic functions

I didn’t get a chance to use technology much … because of the teacher I was with.

I didn’t get to use my plans, either of them. Both times I was really excited to use them. Not being able to see them doesn’t really give them any meaning.

- **Student teacher**

Coming to Teaching in the 21st Century
such as save, copy and paste, or utilizing CD’s that accompany textbooks. (3) Several were unable to use technology in any way in their student teaching. Sometimes their co-operating teachers did not, themselves, use technology. Sometimes access to computers was a problem, as was inadequate technical infrastructure in some schools. In other situations, schools had made decisions about technology that make the implementation of the mandated program of studies rather difficult. Here is a description of one such situation:

The computer lab was located in the junior high wing and was occupied by junior high classes in the afternoons. The lab could be booked for use by the elementary when not in use by the junior highs. We did take advantage of this one time. It was not to use the computers but to use the Proxima for a guest speaker to show us pictures via the computer on to the big screen. This set up was less than ideal for this purpose because students had to sit on the floor to see the big screen around the computer screens. The lab had an open end and was noisy because of junior high classes and class changes. We used a TV and VCR twice to show science videos to the class in the classroom. These are available in the library and must be signed out.

I had the idea of doing parts of the research essay as a class during science, but my CT checked with a couple of other staff regarding my idea and it was generally felt that the server could not handle a whole class research on similar sites at the same time. They felt the system would crash. Therefore, the essay was assigned as a homework project that I just checked the progress of at school.

The conventional model of student teaching sees novices practising under the guidance of master teachers who model exemplary practice. This model is extremely problematic when issues of ICT integration are concerned, because experienced... not a chance [there would be tech integration]...[Computers were] very localized in library and lab...no technology in the classrooms, nor was there a culture to support ICT, nor was there a disposition on staff to think that this was important. For example, two student teachers at one high school had difficulty accessing simple email. There was a firewall, and they couldn’t get to their webmail until they were at home at night. That was a big barrier because I do a lot of communicating through email...Student teachers didn’t build up a habit of using the technology because it wasn’t in the school where they needed it during the day.
teachers are often working with ideas, learning environments and technology tools that are very new to them, or over which they have less than ideal control. It cannot be assumed that a student teacher will receive the same quality of mentorship and modeling in ICT integration than they might experience in terms of more conventional areas of teaching practice. Indeed, even such conventional pedagogical concerns as curriculum planning, assessment and classroom management are fundamentally changed in classrooms in which technology has a vibrant, living presence. Experienced teachers are frequently wrestling with these changes as they accept student teachers into their classrooms, or sometimes even avoiding the changes that technology integration demands. Thus, while one might assume that a mandated program of studies is met with widespread and effective implementation, results of this study seem to confirm that the case may well be otherwise.

In their campus experiences, the students we interviewed did not experience access to computers or to technical support as an issue. We will deal with this aspect of their experience more fully in Finding 7. Their experiences in schools were quite different. There, many of them experienced the technical infrastructures as fundamentally untrustworthy. Would the computers work? Several had had experiences of the inevitable difficulties that required troubleshooting beyond the commonsense capacities of most confident users, and with the exception of the students placed at Meadowlands School, none reported experiences with the kind of on-site technical support that they encountered at the university. A troubling consensus among some was that in order to work with technology, you always had to have a "Plan B" that did not involve computers. When they spoke of having to have back-up plans, it was to comment that teachers really have to plan everything twice when they work with computers, "just in case". Of course, this leads to the sensible conclusion that it really is too time consuming to do this time and time again.

On a deeper level, it also reinforces a view of technology as fundamentally the same as, or replaceable by, pen and pencil. Thus, if planning for technology means thinking about taking the
whole class at the same time to do research on a given topic, then a sensible back-up is to have
carts of books ready so they could use the books if the network goes down. In either case, they
could just keep working in their notebooks.

This is not to say that computers should replace books in the research process. It is, however, to point to how pervasive is the idea that everyone in the class should be doing the same thing at the same time, and that work with technology should be a fairly straightforward mirror of conventional work: do Internet research; make a slide presentation of your findings; email a buddy in a class in a different location. When that model of planning and pedagogy dominate, new teachers cannot develop either the understanding or the practical skills to organize for learning in such a way that inevitable problems with hardware or software do not bring a whole class to a halt. Certainly, pre-service teachers need enough familiarity with troubleshooting to be able to make adjustments on the fly, and that can be addressed as part of technical literacy. But the larger issue remains the pedagogical one: what are children and youth being asked to do, and why is that a worthwhile use of their time—with or without technology?

We interviewed one cooperating teacher who had quite a different way of thinking about having a student teacher in her classroom. She spoke enthusiastically about how the opportunity to team with her student teacher, someone who described herself as "loving computers", had helped her learn. She was willing to plan with the student teacher to take advantage of this new expertise in her classroom, and to explore in an inquiry manner how they might work together with the children. In this classroom, the student teacher demonstrated an amazing maturity in dealing with a series of technical difficulties caused by district policies. Well supported by a cooperating teacher she trusted, this student had the chance to experience, to work around and to recover

Coming to Teaching in the 21st Century
from a crash that would have caused many experienced teachers just to give up and go back to what some call "the tried and true".

The glimpse we caught of the new relationship between mentor and student teacher makes us hope, first, that this kind of relationship is more common across the province than it was in the sample of students we interviewed, or that it could easily become so.

It took a particular disposition on the part of the experienced teacher to welcome change, to admit that she was not the expert, and to work with the student teacher as a team partner. It also took a willingness to embrace the inevitable bumps on the road that working with technology involves without blaming the student teacher for trying something that didn't work. These are not expensive or complicated changes to implement. But perhaps drawing cooperating teachers' awareness to the need for them could be a manageable first step as faculties of education orient cooperating teachers each year, or as they offer in-service programs or graduate programs. At the moment, this student teacher and her peers would regard her placement as good luck. Increasing numbers of such placements must become intentional.

6. New approaches to professional development partnerships and to field placement practices show promise in bridging the gap between campus and practicum experiences

It is likely that truly effective ICT integration will require practicum experiences in which both experienced and pre-service teachers adopt an inquiry stance (Cochran-Smith and Lytle, 2001) to ICT integration. Such a stance means providing better professional development support for experienced teachers to implement technology in genuinely effective ways; changing the mindset about how novices can best learn from and with experienced teachers; and connecting university faculty and researchers to practice in stronger ways. Cochran-Smith and Lytle call for a richer
conception of teacher learning across the professional life span than that implied by the expert/novice distinction. Learning from teaching through inquiry assumes that beginning and experienced teachers need to engage in similar intellectual work. Working together in communities, both new and more experienced teachers pose problems, identify discrepancies between theories and practices, challenge common routines, draw on the work of others for generative frameworks, and attempt to make visible much of that which is taken for granted about teaching and learning. From an inquiry stance, teachers search for significant questions as much as they engage in problem solving. They count on other teachers for alternative viewpoints on their work. In a very real sense, the usual connotation of "expertise" is inconsistent with an image of teacher as lifelong learner and inquirer. Expertise implies certainty and state-of-the-art practice. Lifelong learning, on the other hand, implies tentativeness, and practice that is sensitive to particular and local histories, cultures, and communities. The expert-novice distinction serves to maintain the individual in-the-head model of professional development that highlights individual differences among teachers. An across-the-life span perspective on professional development makes salient the role of communities and their intellectual projects over time.

We note that when faculties of education found ways to do this, schools were willing to step up in ways that practicing teachers found to be beneficial for the pre-service teachers, for their own professional learning, and for the children, themselves.

**CUCA Partnerships**

The TNT component of the Education 503 course at Concordia afforded an opportunity for professional development that partnering schools valued enormously. Three aspects of that opportunity are particularly noteworthy. First of all, the student teachers had prepared units of study based on careful work in their classes with the ICT Program of Studies, with various subject curricula, and with what they learned from the experienced teachers as they began and later modified their projects. They were able to bring to the teachers completed projects to try out with
the students. Often, teachers say they just don’t have time to do the work required to create such learning environments for students. While it is certainly true that such planning does take time, it is also true that teachers’ willingness to invest the required time is often directly related to whether or not they have a compelling picture of what students will be doing differently. A strong advantage of the CUCA partnership is that many experienced teachers got to see these carefully planned projects in their entirety. Thus, they did not have to move into unfamiliar territory on faith that they would end up with a robust project. They did not have to imagine that such projects would be inviting for children, nor how they might work.

Second, the CUCA students came to the school to introduce the projects to the children. They got the opportunity to practice their teaching skills in a lab environment and to see how the children responded to the work they had created for them. That brought a good sense of closure to the work for them. Moreover, the work they had done in creating the projects was not simply a hypothetical exercise in planning. The experienced teachers also got to see the kinds of things that the children were being asked to do and to see and hear their levels of interest and engagement with these new tasks. The children we spoke to during one of these sessions were really pleased to have new opportunities to work with computers and were deeply engaged in exploring the learning environments that had been created for them. Teachers who see their own students engaged in this way are often persuaded by the evidence of their own eyes that technology can make a difference. Such experiences become crucial elements of effective professional development. Furthermore, the teachers were left with the projects to work with if they chose, giving them the opportunity to experience what it would be like to have students work through all phases of a technology-based inquiry.

Third, CUCA students were invited to participate in a “Best Practices” Professional Development Day in March, 2004 by presenting their work. The usual picture of expertise was reversed, with student teachers assuming a role that is not often afforded beginners. We see great benefit in such opportunities to initiate the kinds of dialogue that Cochran-Smith and Lytle describe.

Coming to Teaching in the 21st Century
Moreover, classroom teachers from the three partner schools reported that they were “floored by
the outstanding examples of technology supported lessons presented by the Concordia
students”. They were more receptive to the thought of integrating technology, themselves, as
they thought of planning for the next school year. Winning over the hearts and minds of these
teachers was a significant step towards better acceptance of technology-infused classroom
activities.

**Cohort Experience**

The innovation that addressed practicum placements in a direct manner was the University of
Calgary pilot to place a cohort of 15 pre-service teachers in one school. Their faculty supervisor
worked on site with them for the 2 days a week generally allotted to field supervisors to travel
from school to school visiting student teachers.

Students were placed in a school (1) with an intentional commitment to move toward more inquiry
based ways of working. (2) Teachers had the on-going professional development support of the
Galileo Educational Network to learn how to design technology-enhanced learning environments
for students. (3) The school has a strong technology infrastructure, including an onsite technology
specialist. (4) The faculty member assigned to this cohort was a technology specialist committed
to working with technology as a pedagogical and as a scholarly matter; and (5) students who
wished could follow up this third semester placement with more in-depth experiences with
technology in their fourth semester.

Decisions about the structure of the Meadowlands experience for student teachers closely
resemble those reported by the 2002 Strudler and Grove study that result in more intentional and
more proactive support for meaningful use of technology in the practicum.

While the cohort structure of this particular innovation may not be readily applied in other places
(particularly small rural schools, for example), it is important to identify key principles that may be

Coming to Teaching in the 21st Century
applicable in other contexts. First, there was a commitment on the part of the school's administration and many of the teachers and to adopt an inquiry stance toward their own practice. That stance was not confined to the role of technology in teaching and learning, although that role was explored as one of many issues that teachers needed to confront. Recognizing that such a commitment does not mean (or ensure) that all teachers are at some mythically identical place in their practice, it does ensure that questions about teaching and learning become vibrant, open to discussion, challenge, and debate. Thus, even though some students reported that not all teachers in the school were enthusiastic about inquiry or about technology, there were also aware that many others were.

In discussing the sustainability of classroom innovations of any kind, including those that involve technology, Owsten (2004) notes that teacher support is an essential condition. In its absence, innovation cannot occur. He notes that:

> school reform leaders often assume that teacher support will always be forthcoming simply because they, themselves, are convinced of the value of the innovation they introducing. I have found that this definitely was not the case.

For teachers, the high levels of motivation needed to sustain an innovation in the face of the inevitable setbacks and difficulties that attend work with technology, depends on one main thing: they see value for their students. Increasing experienced teachers' level of motivation to try integrating technology was also a key factor in the success of the TNT project.

Successful technology integration makes two huge demands on teachers: (1) that they learn new skills; and (2) that they unlearn beliefs and practices that may have dominated their professional lives. As Owsten emphasizes, "teacher professional development is at the heart of sustaining an innovation." Harmonizing the efforts of faculty on campus with myriad opportunities for teachers to learn formally and informally how to teach with technology may go a long way both to providing
more enabled practicum environments for student teachers and to raising the level of technology use in the schools in which well prepared students are placed to teach.

An experienced teacher from another school whom we interviewed was clear that the conventional methods of addressing professional development for teachers did not work for her, although she had tried them all:

Well, our district has put on many, many workshops. But what happens in my case is, that unless you go back and use it right away and even if you can go back and use it right away...[you don’t learn it the first time]...It’s foreign to me, I didn’t grow up with computers, I just recently got mine at home, so you know it is a skill that you have to use over and over again. The kids seem to pick it up much easier than I do. I can show students and honestly they have no trouble remembering it. But I do. I don’t know what that is. Why that is. But technology doesn’t come easily to me. And that is the problem with many of our workshops. We go out and we come back and here we still have all of our daily work and we jump right back into teaching, we continue to teach and we think, “Okay, now, I want to integrate this as soon as I can and I want to start using what I learned at this workshop yesterday or on the weekend”. But most of our workshops are Friday or on a weekend and then you’ve got a couple of days off before you come back and you’ve forgotten some things and there you are alone—trying to figure them out. And it’s not like they don’t have handouts. I think with me it’s that I don’t practice it enough. Like it took me 6 or 7 times to get a handle on my email even. I think it’s me. I’m sure that nobody else has this problem.

Her remarks echo the comments of pre-service teachers about conventional survey courses to acquaint them with technology applications: conventional workshop structures just don’t work. The professional development literature on technology integration is also clear about that. We also catch sight of a phenomenon that is worth investigation in other contexts. Here, the teacher
is certain that there is something wrong with her, rather than with the approach conventionally
taken to professional development. The ironic backlash to such training schemes is that teachers
such as this can emerge feeling less confident about their abilities to use technology, rather than
more, despite the well intentioned efforts of everyone involved.

In the University of Calgary innovation, professional development addressed in many ways at
once. Teachers were working with professional development experts in full-staff sessions as part
of their regular professional development program. In teams and as individuals, teachers were
also mentored online by Galileo experts and in blended face-to-face and online environments
when these experts came out to the school to assist with
planning and instruction. Three of the teachers were enrolled in
a graduate course that explored the use of this online
environment in scholarly ways, and they designed inquiries into
which their student teachers could move in effective and
innovative ways. In addition, the staff valued the on-going
presence of Dr. Jacobsen in the school both because she helped
them address the inevitable difficulties that arise with student
teachers in timely and sensitive ways, and also because she
knew their context, knew their work, knew their children as well
as her own students.

A climate of inquiry, or of what Owsten calls self-study arose in
organic ways throughout the school in response to the real work of the teachers and of the
student teachers. While students and staff certainly reported the usual kinds of difficulties that
intense team work and the introduction of new ideas inevitably entails, many valued the chance to
work on these difficulties with collegial support. Moreover, the assignment of student teachers
was to the school as a whole. While all students were closely attached to at least one teacher, all
had the opportunity to work in other classrooms, as well. Thus, the difficulties that sometimes

Because sometimes I
feel a little guilty so I
don’t say much about
the access, the learning,
support. I think it was a
lot more than most
people [in my program]
got.... And the
innovation. To know that
you can be creative.
You can go anywhere for
help. There is this
network going on and
you have access to it.
And I know that it will be
some time before I will
be able to migrate to a
school like that but that’s
what I aspire to do.
Student teacher at
Meadowlands

Coming to Teaching in the 21st Century
ensue when one teacher does not use technology very extensively, or is deeply engaged in work that does not require technology when the student teacher is in the school, or is not yet really committed to new ways of teaching, are balanced with opportunities for the student teachers to work in several classrooms. While the cohort model pushes such thinking to a level that may not be possible in most schools, the principle is readily transferable: any school can make sure that a student teacher has meaningful access to a range of experiences with technology. All that this entails is moving away from the mindset that one experienced teacher is assigned “their” student teacher for the duration. Because the practicum is a powerful opportunity for students to learn both to integrate and to critique technology use in classrooms, such opportunities are essential. Mentorship becomes an increasingly collective responsibility—and sharing responsibility for the development of a student teacher becomes one vehicle for professional dialogue among experienced teachers.

One of the student teachers also observed that the sheer size of the cohort had a demonstrable effect on conversations taking place throughout the school, joking that while a school could easily ignore one student teacher with new ideas, it was pretty hard to get around fifteen of them! This offhand comment points, in fact, to the potential for intentional changes to practicum to assist in more widespread educational reforms. We also note the impact of the sheer number of Concordia students bringing a range of possible projects to teachers. While one student teacher can have an influence on his or her cooperating teacher, the leverage afforded when much larger numbers of students are able to work intentionally in the same environment is important to note.

Students reported great value in having Dr. Jacobsen walk the talk with technology. As they worked with students, she was there to lend a hand, problem solve or trouble shoot. When they debriefed as part of their weekly course responsibility, they could be assured that she understood the context of their questions and struggles, and they had many opportunities to make modifications to their plans in a prototyping environment: let’s try this, and see whether it works better. That is, they experienced what it was like to hold issues of technology integration within
the fundamental contexts of teaching and learning. They also worked with Dr. Friesen, as she helped them understand the professional development issues the staff was addressing and as she introduced her own experiences as a classroom teacher to help them reframe their questions and assumptions. As the term progressed, increasing numbers of the school's staff also made presentations or provided workshops for the students.

Three factors emerge as we consider this school's work with student teachers as part of a professional learning community. First, the ongoing support of all teachers as they worked with innovations helped to ensure that demonstrable results were forthcoming. At the early stage of a project that involved not only Semester Three student teachers, but also a first year student, one teacher posted to a discussion forum in IO:

> The question that I’m struggling with now is how we handle the kids’ desire to make their own standards [for fitness]. I know...[the first year student] can help us with this. He has some great ideas. Will there be some kids who are put off if they find they are at the bottom of the heap when they compare their results? Do we encourage just have ‘average’ and ‘above average’? Could we just encourage them to look at their own score & see if they can make their own improvements over a longer period of time?

The student teacher was viewed as an integral part of a team directed to compelling pedagogical questions. Student teachers who are let in on such principled uncertainty about the next best step have essential opportunities to understand how professionals collaborate around new ways of working. They get a chance to be part of the action as teachers have these kinds of experiences:

> On Tuesday we had a planning meeting involving other people and we seemed to lose our way. It was awful!!! I think speaking for myself that I liked all the ideas, but was worried about the time frame that we had with this particular group of kids....Nothing
seemed to click for me. I felt like we were directing the kids and I was losing focus on what we were trying to do with the heart rates.

Well…[my teaching partner] and I put our heads together and we started to roll again with ideas. We moved through the muck and got unstuck! We talked about what was important and that like real scientists our kids were collecting raw data (step tests) and then we would use this data & analyze it so the children could answer their own questions.

At the classroom level, both experienced and pre-service teachers got to see things happening. They experienced the stuck places, the messy uncertainties, and the ways in which teachers actually come to planning decisions that permit students to become deeply engaged—sometimes with surprising speed. While, again, we would emphasize that this happened on a naturally uneven front, with some teachers making more progress than others, throughout the school there was a feeling that good things were happening for students, and that people could actually see the impact of changed, or changing, practices. In one note that followed exchanges about advice a fitness club professional had given about how to track heart rate recovery times after exertion in a way that focused on continuous improvement for all, teachers experienced the exhilaration that comes from getting a project back on track:

On Friday we had…an Olympic speed skater in to talk about their heart rates and she did the step test with the children! You should have seen the excitement! We had them hooked again!

That is, the essential foundation for sustaining an innovation was intentionally developed throughout the project: teachers experienced "the personal and professional satisfaction…of being able to teach in what they found to be a more effective and meaningful manner, and from seeing the positive impact their work was having on students" (Owsten, 2004). And student teachers were part of this work. Describing his own involvement in the project, a Semester Three
student comments particularly on what he saw as innovative uses of technology he had the opportunity to explore:

The technologies that we used were that we set up a database on a website….The entire project was how to take care of ourselves. Students came up with checking their fitness and through that we decided to incorporate the use of heart rate monitors. So when people are thinking about technology they are always thinking about, 'Okay I have to use digital cameras or I have to make a website or something like that or PowerPoint. And they don’t think of the lower levels of technology and the one that we used is the heart rate monitors. We got 30 heart rate monitors from Galileo Network and using those heart rate monitors we recorded over a period of time the fitness level of the students. This was based on the Harvard Step Test. …it was very interesting to use these heart rate monitors….Students… were able to bring the heart rate monitors home with them and some of the students were doing different activities like skiing and dancing so that was really a neat avenue to take. And then we also used digital cameras, digital movies, to use those photos into a photo gallery that we posted on CommunityZero [a virtual classroom created for the project].

Second, the work of field supervision was taken up as a scholarly activity. While there are certainly simple economies of time achieved by having all practicum students in the same school, Dr. Jacobsen extended that opportunity far beyond those instrumental parameters. Her own expertise, both in a practical and in a scholarly sense, was an important ingredient in the success of the innovation. In this study, meta teaching, or the intentional exploration of the pedagogical implications of the technology work being done in innovative classes has emerged as a significant factor in other pre-service environments. In the same way, the role of the faculty advisor to take up the daily work of teaching as a subject for inquiry with student teachers demands the kind of scholarship for teaching that makes a difference to the experience of pre-service teachers.
Third, professional development that supports the meaningful and responsible integration of technology should be held within the larger context of educational reform for a changed and changing world. As Hargreaves (2003, p. 21) notes, professional development cannot be about helping teachers get better at doing more of the same kinds of things, nor can meaningful change be a simply additive process: more time for literacy, more programs for gifted students, more hours in the school day, more time spent in computer labs or online. It cannot be reduced to performance training, nor to a "slick, self-managed portfolio of certificates and achievements accumulated as individual credits, like frequent flyer points….Professional development, rather, is a personal path toward greater professional integrity and human growth." That personal path must include, but not be restricted to, the meaningful use of technology for teaching and learning.

If, as the experience of most students we interviewed suggests, practicum placements provide a somewhat hit-and-miss opportunity to engage with technology in such meaningful ways, schools, school districts and universities must be prepared to re-think the conventional placement structures that currently dominate. For the rigorous exploration of all the issues that pertain to teaching and learning in a digital age, we can no longer afford to maintain the fiction that any classroom placement is the equal to all others. Clearly, some schools make far more intentional choices about how to align their own professional development work with the mentorship of pre-service teachers. The CUCA example also suggests that universities seek a range of opportunities other than the practicum in which students can be closely connected with experienced teachers and classrooms.

With regards the practicum experience, itself, however, schools that accept student teachers could be accountable to at least these questions: (1) How will the school ensure that the student has a range of experiences with teachers who use technology in different ways? (2) How does the school demonstrate that the teacher(s) with whom the student will work are engaged in formal and informal professional development opportunities around technology integration? (3) How will the school ensure that student teachers have meaningful access to technology? A school that
cannot provide answers to at least these three questions is unlikely to be able to provide the kinds of experiences that would permit student teachers to deepen and broaden the insights into teaching and learning with technology that they develop on campus.

It will be argued, of course, that such questions may drive schools away from accepting student teachers, and we recognize that likelihood and acknowledge the problem universities often have in securing an adequate number of practicum placements. As a policy issue, however, it must be stated that a school in which children are not, themselves, experiencing a range of opportunities to learn through technology; a school in which teachers do not include technology in their on-going attention to professional development in a digital age; and a school in which teachers have restricted access to supported technology cannot be implementing the ICT Program of Studies in a meaningful way. And that is an issue which, while disclosed by issues of teacher preparation, actually transcends them.

Put another way suggested by Hargreaves, would we accept such haphazard professional internships for our personal physicians or dentists?

For schools willing and able to demonstrate the kinds of commitments suggested by this finding, it must be acknowledged that adequate professional development support comes at a financial cost to the school district, or to the school, itself. In the Recommendations section we will address this issue in more detail. Here, we will discuss one element of this larger picture that could be easily addressed by targeted funding. At present, universities provide small honoraria for teachers who accept student teachers. In setting the standard for accepting student teachers demonstrably higher, additional and meaningful incentives are needed to attract and support schools and school districts willing to develop more integrated approaches to professional development with the express purpose of improving opportunity for pre-service teachers to experience the meaningful integration of technology in their practicum experiences. We do not think of such funds as compensation for accepting student teachers. Rather, we think of them as grants that
would permit schools to involve student teachers in meaningful ways in schools’ intentional efforts to address technology integration.

It must also be acknowledged that when universities work in more collaborative ways with schools, new demands are created in terms of establishing and maintaining close working relationships. Placing students in the conventional manner is a complex managerial issue that demands concerted attention at the university, and we do not underestimate or under value the current effort that is required to make these placements. When faculty are intentionally involved more closely in the life of the school, certain new factors emerge as important. For example, if universities move toward cohort placement of students, it may become increasingly important for field supervisors to get to know the school as part of the placement decision. Our experience has been that if a faculty member is going to work on site for 2 days a week, it matters very much to the school who that faculty member is. Dr. McVea’s involvement with the schools accepting students for the TNT section of Education 503 was also very demanding of her time, and the work of establishing and maintaining powerful personal relationships with schools willing to work in new ways with pre-service teachers must be acknowledged. These are environments in which valuable work can only proceed through authentic relationships between faculty and field, and building and caring for those relationships takes time and effort.

Where districts receive student teachers in smaller numbers than either the University of Calgary of CUCA situations, it may be worthwhile considering how university faculty might establish working relationships with co-operating teachers through professional development at a district level. In other contexts, we have seen district professional development providers connect intentionally with student teachers in different schools as they do their regular work with teachers. The potential to link the work of those professional development providers more intentionally to the field supervisors and to professional development expertise at the universities might also be a valuable avenue for exploration. Again, this would mean establishing a level of working relationships that is not currently an intentional part of practicum placement issues. This study
suggests, however, that the efforts involved to create closer ties with between universities and the classroom yield substantial benefit.

**7. Technology, infrastructure and support still present considerable challenges**

*Introductory courses*

A conventional focus of course work in pre-service programs has been to insure that students are exposed to, and know how to use an array of technologies. Introductory courses have often filled such a need in the past. Such approaches were identified by the pre-service students in this study as generally unhelpful. While they appreciated the motivation to prepare them with background courses that emphasized technology applications, they told us that they often forgot what they had learned, and could not call it forward within specific contexts of use. This, they told us, was in sharp contrast with the courses they were taking with the faculty we interviewed. Here, they said, they learned in ways that they knew how, and really wanted to, apply in their own student teaching.

An important distinction must be drawn, however, between comments students made about general introductory courses that were unconnected to anything that came after, and those compulsory courses that introduced technology within a strong educational context and then were followed up with more in-depth explorations in a subsequent course. Students identified compulsory introductory courses as particularly useful when they: (1) introduced technology within a context in which students could immediately use what they were learning, (2) explored the teaching implications of the technologies and (3) supported the students in organizing and managing their own emerging professional lives by using a variety of technologies for planning and for communicating with faculty and one another. Students were either grateful for the

In those other classes they talk about it and it's really hard to talk about technology and they talk about it and then you go into the lab and just do it. And there is usually just one person who knows how to do it and everyone is relying on that one person

**Student teacher**
opportunity to follow such courses up systematically, or were hopeful that such opportunities might become available in subsequent years of their program.

**On campus technology infrastructure**

On campus, students generally reported that they were well able to do the work they wanted or needed to do for the courses under discussion. This stands in contrast to general findings in the research literature, where many report the access remains an issue. Given the generally favorable account students give of their ability to access the technology they need, and the availability of support if they have difficulties, students did encounter some challenges that universities should continue to address. (1) The availability of computers other than in designated labs was sometimes an issue, as were problems of interoperability in at least one university, where students were not able easily to exchange data with, or connect to, other computers when they moved out of the Education labs to different locations on campus. Well equipped campuses require a variety of digital environments for students: centralized locations that permit them to experience and experiment with the demands of teaching in computer labs; high end hardware and software that support the use of sophisticated environments for design and creation; ready access to a wide range of peripherals; wireless access that permits students to experience the possibilities inherent in increasingly mobile and ubiquitous computing. Investing effectively and responsibly in all the environments in which pre-service teachers must learn to work bears significant cost, as well as a clear commitment to the educational vision and values that underpin good technology choices.

(2) Students sometimes spoke of the challenges of negotiating across platforms. The commitment of one university to a Mac environment was identified as a challenge for student
teachers when they went into what were perceived as predominantly PC environments in schools. Students sometimes experienced this as a disconnect, particularly if they used PCs in their lives outside the university. At another university using only PCs, students commented that they frequently encountered Macs in the schools, and had questions about how prepared they were for those environments. However, students across this study also discussed the benefits of developing fluency in both of the platforms they were likely to encounter as teachers, and felt that they had actually learned quite a lot from opportunities to work across platforms, even when it was sometimes harder to do so.

If asked to predict the vector of technology change that is most likely to address this issue, we would say that the public will increasingly come to expect to connect their own computers and other mobile digital devices to networks wherever they find them: in coffee shops, in libraries, in meeting rooms and in schools. Rather than trying to achieve platform consistency as the gold standard of technology access, faculties of education might intentionally plan for more of what we catch glimpses of today: technological literacy means more than being able to navigate familiar structures and applications. Basic technological literacy includes having confidence that, having learned the protocols for accomplishing your purposes in one platform, you can find them out in another. Rather than being stymied by the differences between Mac and PC environments, students should have the opportunity to become more "bilingual", understanding both the fundamental similarities between the platforms, and also understanding what the particular strengths and weaknesses of each might be. Increasingly, as well, students both in the universities and in schools have their own personal devices, and welcome the opportunity to connect them to existing networks. It may soon be the case that faculties of education and schools will have to invest less in boxes and more in designing and securing learning networks that permit increasingly ubiquitous, mobile and personal access.

As with all aspects of technology integration, fundamental decisions about hardware, software and network design should be driven by a pedagogical, not a technological, vision. This is not
often the case. As examples sited earlier demonstrate, decisions about technology driven mainly by expedience, by what is easy to control, or by habitual practices of having children all doing the same thing at the same time, create dysfunctional learning environments: children huddle on the floor between rows of computer tables to see a guest speaker's projected slides; more than 16 children on the network at the same time cause it to crash; students have access to computers for two, half hour periods a week. Such examples provide windows into types of thinking that shape the learning environments pre-service teachers often encounter in their practicum placements.

**Learner Focused Networks**

Schools are currently facing the dilemma of preparing students to live well in a post-industrial age while the very structures of our buildings and of our thinking about how to educate derive from much earlier images of the factory and the monastery. Schools are "still ruled by clocks and bells, periods and classes; children…[are] grouped by age and taught memorizable knowledge via a standardized curriculum that …[is] conventionally tested" (Hargreaves, 2003, p. 21). These are familiar structures, the ones into which most of the student teachers we interviewed experienced during their practicum placements. From a technology perspective, when professionals, technology specialists and bureaucrats "look inward to the custom and certainty of their own expertise and routines rather than outward to the concerns of students, families, …communities (Hargreaves, 2003, p. 11) as well as to the ways in which technology use is developing in society as a whole, schools are frequently stuck into highly controlled and controlling technology environments. The following diagram illustrates both the current situation in the kinds of schools students often described, as well as the vector of technology change educators need to be considering as they develop more learner focused networks:
At the moment, many schools have technology infrastructures that might be characterized as "distribution technology". In earlier decades, the authority centered structures of classrooms were dedicated primarily to information transfer that was controlled by lecture, textbooks, teacher worksheets, fixed assignments and standardized examinations. That is, even when the dominant technologies of schools were not digital, tightly managed learning environments were common—and continue to be so today as those responsible for network design and access to boxes and software mirror their own experiences and understandings of what responsible teaching looks like. This kind of thinking is responsible for the kinds of technology "horror stories" that several student teachers offered as they commented on how they had—and had not—been able to use technology in their practicum classrooms.
The Alberta ICT Program of Studies pushes teachers to think much more about the interactive capabilities of digital environments which are far more student-centered, and that enable the development of processes and skills for learning through engagement with a range of technologies. We observed students in their innovative classes designing experiences such as Web Quests and other inquiries accessed through PowerPoint and websites created for children to explore a wide range of topics. As we have explained in earlier sections of this report, the students found it both challenging and rewarding to learn to teach in this way, and we note that they experienced the classes in which they did this as quite different from other courses.

In acknowledging the power of what these students learned to do, and sometimes had the opportunity to practice in their practicum placements, we also note that schools and faculties of education have some way to go in addressing the remaining environments on this graph. The move to collaborative and pervasive environments represents another big shift in thinking about learning environments, this time characterized as more intentionally focused on teams or on communities of learners, both virtual and face to face. These are the kinds of environments we identified earlier as having the character of knowledge building spaces where the differences between school work and work of the world begins to collapse. We caught glimpses of these environments in the teamwork required to experience the social studies field trip, and in the online environments created for the University of Lethbridge students, and in IO used by University of Calgary students. There, the locus of learning expands to include others as essential team members, or as part of an intentional community devoted to addressing shared questions, issues and developing understandings.

One example of work carried out by a University of Calgary student in the final semester of his degree illustrates something of the potential of this shift to transform learning for all. Self-described as someone who really didn't think about technology until he did his extended practicum at Meadowlands, this student was going to complete his fourth semester overseas, an opportunity that the University of Calgary makes available to MT students. Initially, he told us, he...
thought he would do his fourth semester independent inquiry into differences between Chinese and Alberta schools. Inspired by his experiences as a student teacher, he changed directions significantly. Before he left, he set up a Virtual China inquiry with 4 classrooms in different towns and cities near Calgary. Working with Galileo, he was given access to an online environment to which he could post pictures and text, and engage in conversation with children in Alberta who set him off on quests to answer questions that they had about life in China. Knowing that one group of students was studying heroism in their class in Canada, he sent back the following picture and comment:

![Calligraphy](image)

**Calligraphy**

This is just an example of how beautiful Chinese calligraphy can be. But here is the best part. This was made by a man who does not have the use of his hands. He did it all by holding the paint brush in his feet. He made the trunk of the tree by putting a big blot of ink on the page, then blowing it into the shape of the tree. The flowers on the tree are actually his toe prints. The painting is a poem about struggle. Kind of suiting for a man without hands, don't you think?

The richness of the experience of all the children who followed his travels in China provides insight into what it could be like if student teachers had the opportunity both to create and to experience increasingly imaginative learning environments made possible by the power of technology. Moreover, this small example also lets us catch a glimpse of the ways in which children might be afforded opportunities to become more cosmopolitan members of a global community.

Coming to Teaching in the 21st Century
It is to be noted, too, that the capacity to engage in this kind of experience was afforded through resources provided by the Galileo Educational Network, which housed the virtual community on its own server. School districts frequently control student and teacher access to digital environments with policies that seem to derive from a belief that security can be achieved most effectively by locking teachers and students out of environments others do not see the need for them to access. Describing the educational implications of what he calls increasing paranoia, Hargreaves (2003, p. 48) could easily be describing the "lock down" mentality that restricts the freedom of teachers and students to create and explore vibrant digital learning environments. This paranoia, he says, "spreads like a plague. In education, it makes us exaggerate school safety...[creating] padded playgrounds, no-touch classrooms and a world where children wear helmets for everything."

"We Can't Afford It"

One story from the students we interviewed is instructive in understanding the obstacles district policies sometimes create for teachers and children. The student teacher had designed an opportunity for the class to explore an exceptionally rich science site that allowed children to access text, high quality photographs, and video and sound clips. The site provided a broad range of resources that would permit students to experience the complexity of questions about, among other things, why different looking animals were grouped as belonging to the same species. Her pedagogical reasons for choosing to have all students explore different aspects of the same site at once were sound. All went well until the sixteenth student in the class logged into the site. Immediately, all screens froze, and all the computers in the remained inaccessible for twenty minutes.

Asked about why this had happened, the cooperating teacher explained that the school could just not afford to have enough copies of Internet Explorer for more than fifteen students to use at once. We cannot comment on what district policy or practice was actually in place to make it impossible either for students to access the same site in any
number, or for teachers to restore the computers locally, but we can certainly say that the purchase price of *Internet Explorer* (which is available free) would not be among them. One of two things may be at play here. Either the teacher was given incorrect information that was more palatable to accept than district policies to lock students out (that is, teachers readily understand that schools cannot afford things), or the teacher misunderstood the explanations she had received, and had put her own interpretation on the situation. In either case, a fundamental literacy issue is at play here. No teacher should have the impression that there is a charge for internet browsers. Misunderstanding of this basic fact of life in North America makes it impossible for a teacher such as this either to challenge or to understand explanations given to her for restrictive policies.

In this classroom, children were also prevented from bringing work they had done at home on computer, to their classroom. Anything given for homework had to be completed by hand, and if it was required for work being done with computers at school, it would have to be re-done. Asked why that was, the teacher offered this explanation: we just can't afford to have computers crashing, and they will do that if students bring in work from home.

While we do not discount the serious security issues that schools face, we also know that there are many ways in which the transfer of data from one place to another can be reasonably and effectively secured. Creating technological barriers between the ways students learn at home and the ways they learn at school are, at best, pedagogically questionable.

As educators, we can and must do better to ensure that school infrastructures are designed in the most sophisticated rather than the most tightly controlled ways possible so that all learners can explore not only with safety, but also with a sense of joy, freedom, and genuine curiosity.
Children need to work with good computers, with a wide range of peripherals, with increasing mobility and ease of access to the world of learning outside their classroom walls. As the Statistics Canada 2004 report, *Computers in the classroom: Opportunity and challenge* makes clear, however, “availability of computer equipment does not necessarily mean that students and teachers make effective use of it, that it is easily accessible or that it is of good quality”. Student teachers’ experiences indicate that this remains an issue in Alberta.

The province of Alberta has invested heavily in providing a sophisticated high-speed network to all Alberta schools. As SuperNet nears completion, the promise of broadband technologies for videoconferencing, real time and streaming video becomes a reality for teachers and students. Figuring out how to integrate the different forms of media that these high-speed networks make possible will require that teachers seriously consider technical, critical and rhetorical literacies. It also points to the importance of the analysis of scholars such as Hakkarainen, Lakkala, Rahikainen, Seitamaa-Hakkarainen and Leinonen (2001) who insist that four infrastructures of change include, but are not exclusive to, technological infrastructures. Changes here must be made within the context of pedagogical, social and epistemological changes. Held together, such changes may help educators make genuine progress on the kinds of changes to the culture of schooling that remain such a challenge.

Held together, perhaps the next report on the education of pre service teachers will no longer contain stories about doing *Pioneer* reports on 3 PowerPoint slides or finding that your computer crashes because everyone else in the class is trying to do that, too.

**8. Innovation is often a lonely road**

The essential loneliness of people who set out to do things in new ways is a recurrent theme in this study, as well as in the research literature, which demonstrates ways in which technology
issues in faculties of education are frequently marginalized. Some of the innovators we
interviewed spoke about working largely alone in their faculties, and most longed for, or eagerly
welcomed, opportunities to establish or extend connections with colleagues to help shoulder the
load, to affirm the value of what they were doing, to provide much needed encouragement when
the going gets rough, or to extend scholarship in the field of teaching and learning with
technology. Even students spoke about sometimes feeling very alone and very frightened, when
they were trying to do new things.

There appear to be a number of reasons for the faculty sense of isolation. Sometimes
educational technology remains largely the domain of Ed Tech specialists. As one participant
noted, there continues to exist a significant divide between technicians and pedagogues that
sometimes makes important educational conversations across disciplines difficult. It appears to
be challenging for “non techies” to assert with credibility the primacy of pedagogical issues in
educational technology. In this regard, the relationship between Dr. Gibson and Dr. Campbell to
create the social studies virtual field trip is particularly noteworthy. When Dr. Gibson began her
work on the creation of the virtual field trip, she worked closely with an instructional designer, Dr.
Katy Campbell, from the Academic Technologies for Learning Production Studio on campus.
Availing herself of the opportunity to create a technology-enhanced course, Dr. Gibson expected
to be plunged at once into conversations about technological possibilities. Instead, her
technologically sophisticated mentor established that the most important issues to be defined
from the outset were the educational goals and values Dr. Gibson brought to the table. Such
partnerships point the way to the kinds of opportunities for technology specialists and
pedagogues to collaborate in fruitful ways.

Scornful of technological environments with which they have had apparently little personal
experience such as the instructors cited in this study who were openly dismissive of technology,
pedagogues do not always invite considered deliberation about the role of technology in teaching
and learning. In other contexts we have had the experience that academics concerned about the

Coming to Teaching in the 21st Century
dangers of technology often maintain their distance from technology, sometimes without the kind of engagement with the parameters of the discipline that might mark understanding in other forms of academic research and debate.

Within this context we also recall Dr. Gibson's observation that she was one of very few faculty who availed themselves of the opportunity to design a new type of course. Offers from technology specialists to assist colleagues to integrate technology in their courses are sometimes charged with historical tensions and philosophical differences that lurk just under the surface of seemingly straightforward offers "to help". These tensions and differences have little or nothing to do with the individuals involved or the value of collegial support. They are also ideological, theoretical, philosophical and pedagogical. It may be the case that the least useful thing faculties of education could do in trying to address existing or perceived gaps between technology specialists and pedagogues is to frame the issue in terms of resistance, as often happens. Perhaps an openness on both sides to understand principled differences would help to foster strong dialogue to the benefit of all.

Second, the technology module(s) of current programs may exist in isolation from other course work. It is striking how few students had the experience of using technology in their "other" education courses, other than email, word processing, occasional opportunities to use presentation software, and perhaps accessing course outlines online. Many said that the course about which they were being interviewed was the only one in which the ICT Program of Studies was explicitly addressed, except perhaps for a general reminder to include ICT outcomes in unit or lesson plans. It seems to be the case that large numbers of faculty in all universities leave technology to people they perceive to have an identified interest in the topic, rather than seeing the ways in each course could, and should, embed the use, analysis and critique of technology in meaningful ways.

In our methods class as an art major, …[our instructor] is a real sort of techno-geek. All of our information is available online all the course content. Like there is no textbook for the class. All the readings are delivered online. Students are expected to visit …[the] website almost daily and that is how we interact. …[There is] has a real focus for integration at all levels of art training and its all curricular stuff. That's all [this instructor] teaches.

Student teacher

Coming to Teaching in the 21st Century
Third, innovative approaches are sometimes introduced by individual faculty out of personal interest and commitment, and thereby remain on the margins of the program as a whole. Students were sometimes able to identify a faculty member who enthusiastically used technology to teach subjects like math or art, but this enthusiasm was always attributed to the quirks of a particular instructor’s approach. Sometimes students identified themselves as lucky to be in the particular course under discussion, explaining how students in other parts of the program didn’t get the chance to do the same kinds of things that they did. Such students experienced their placements more as good fortune than as an intentional part of their program design.

Fourth, when non-technology specialists find themselves immersed in issues of ICT integration for pedagogical reasons, they often become branded as a “techie” or “one of them”, and in service of getting things done for students, they take on responsibilities for technology for which they have little expertise or genuine interest. That is, people who introduce innovations using ICTs are sometimes transformed into technology specialists in the eyes of colleagues. While they expressed real longings to have conversations with colleagues about the deep curricular and pedagogical purposes of introducing ICT in the ways they did, they often found it difficult to do so. Picking up a job they felt needed to be done, they were aware that others were now content to let them do it by themselves.

There are many reasons for the apparent lack of sustained, insightful and rigorous dialogue about the role of technology in teaching and learning, some of which we may have uncovered here. About its impact, however, there can be little doubt. A recent book by Hargreaves (2003), *Teaching in the Knowledge Society: Education in the Age of Insecurity*, is a particularly important and insightful analysis of the urgency of asking new questions across the entire spectrum of education. Citing Oakes’ research into the failure of the Carnegie Corporation’s “bold efforts to reform the middle years of schooling” (Hargreaves, 2003, p. 58), he could as easily be describing issues essential to consider in making wise decisions about technology integration:

Coming to Teaching in the 21st Century
The reason for the failure...is that those who implemented the changes, like the leading change theorists whose advice they followed, treated change as a technical, neutral process of pressure and support that was emptied of all controversy and values. It was the failure to address such values and controversies head-on in the process of change; to tackle issues of race, color, and injustice; to challenge deep-seated beliefs about the incapacity of children in poor and minority families; and to resist political cowardice and tendencies to compromise in the face of elite parents' pressure that ultimately undermined the reforms. What Oakes and her colleagues' work shows is that values, social justice, and caring have to be central to professional development among teachers, to community development among parents, and to the agenda of large-scale policy making if change is to make schools better for all students and foster the public good (Hargreaves, 2003, p. 59)

Calling for a "courageous counterpoint" to simple, instrumental approaches to technology use in schools, Hargreaves suggests that students must be taught "to think and act above and beyond the seductions and demands of the knowledge economy" (2003, p. 60) if they are to become more than mere consumers of market-driven applications, environments and values. They must be taught to think and act above and beyond the vision of the teacher as one who simply and effectively delivers curriculum to a vision of someone who is 'socially and politically critical and responsible, professionally competent and in touch with contemporary developments'. It is of a teacher as a true intellectual who engages with the world as well as instructs in the classroom, and who grasps the connection between the two (Hargreaves, 2003, p. 56).

It is beyond the scope of this paper to follow the complexity of Hargreave's argument, or to do more than commend the book as the context from which we note the disturbing lack of engagement with such issues as they pertain to technology throughout and across the pre-service experience of too many teachers.

Coming to Teaching in the 21st Century
Conclusion

Alignment between research literature and findings

Coming to Teaching in the 21st Century reports on insights into issues currently facing teacher preparation provided by five innovative pre-service programs in Alberta universities. Findings from this study confirm several major themes that emerge from the research literature. First is the importance of understanding the characteristics of today’s children and youth, who have known no other world than a digital one. Sometimes called the Net-Generation, or Digital Natives, students in schools today spend their time in a variety of computer-based activities, some of which include traditional educational projects such as writing, researching school projects and getting help with homework, but some of which demonstrate a range of literacies and competencies that schools have barely begun to recognize, much less understand. This report substantiates concerns raised in the literature that current practices with ICT in schools tend to replicate industrial age models of education rather than engaging seriously with questions about the ways in which pervasive, increasingly mobile technologies afford both new opportunities and new challenges for teaching and learning.

The literature review identifies both issues and progress that Canada has made concerning current levels of connectivity and computer use in Canadian schools, and describes some of the technological challenges that impact the meaningful integration of technology in various subject areas. It also summarizes findings about the pedagogical practices that are most likely to lead to effective integration of ICTs and the sustainability of innovations that support this integration. This information forms the context for examining how post-secondary institutions are preparing pre-service teachers to integrate technology effectively. How are these institutions helping pre-service teachers to learn innovative pedagogical practices that effectively and appropriately integrate technology in support of meaningful learning? Various proposals on how to improve the use of technology and the integration of technology in teacher preparation programs are described in the literature, as well as identifying the challenge not only to develop a vision and

Coming to Teaching in the 21st Century
mission for change, but also to implement it in ways that lead to successful teaching and learning with ICT.

From a program perspective, for ICT integration to be a major focus and/or interwoven component in the teacher preparation program, a number of factors need to be addressed. First, a more holistic approach that fosters the integration of technology within the program requires educational stakeholders to think differently about ICT. There has to be a shift away from thinking about it as a subject taught in isolation. Rather, it needs to be approached within a more ecological framework that supports and enhances the learning environment. Findings from this study confirm these themes and recommendations from the research literature.

Specifically, the literature suggests that technology integration into teaching practice not only requires technology training but must also be grounded in pedagogy. As La Grange and Foulke (2004) report, “Implications for use of ICTs must be examined within the context of broader approaches to teaching and learning (e.g., inquiry-based and problem-based pedagogies and constructivist epistemology)” (p. 10). This is a claim that participants in this study also confirm.

The problem of the current disconnect between on campus experiences in technology-enhanced courses and the opportunity to use what is learned in schools was also confirmed in this study. Several areas of concern emerge: (1) the old model of student teachers learning from the modeling of practice by experienced cooperating teachers becomes problematic when experienced teachers, themselves, need to learn how to teach in new ways with technology. (2) Practicum placements in technology-enabled classrooms are almost exclusively left to chance, not to deliberate program design. (3) Current practices in many schools demonstrate low levels of technology use and understanding of how ICTs can be integrated in meaningful ways into core subjects. (4) Student teachers cannot depend on ease of access to computers when they do their student teaching. They continue to find that computers in schools are old, or that laboratory schedules make daily and meaningful use of computers very difficult.
The research literature also addresses current gaps between the efforts of teacher education programs to improve pre service teachers’ experiences on campus, and the difficulty of securing practicum placements which permit students to see technology being used in innovative ways, or to implement ideas that they, themselves, had planned in their course work. Difficulties with field placements and the need for new partnerships to bridge the gap between campus and practicum experiences is a major concern identified in the literature.

Finally, the literature and the response of participants in this study are in accord about the challenges of being an innovator in areas such as this. Both identify the marginalization of Educational Technology as a specialty that causes a “two solitudes” sense of isolation, and even suspicion, between those interested in working with technology and those who see themselves as curriculum experts.

**Gaps in the research literature**

**What can be done differently?**

One of the first gaps in the research literature emerges as a question: what is being done differently in programs and in field placements that better prepares pre-service teachers to teach in the 21st century? This entire study could be framed as a response to that question. While the literature identifies problems in both field placements and teacher preparation programs, it is less clear what solutions might address them. In this area, innovations well underway in Alberta have an important contribution to make to this literature. It is particularly intriguing to note that each innovation described in this study developed within the context of different institutions, sometimes as the “baby” of one or two individuals alone. These innovations are very different in their structures and in the approaches individuals and institutions have taken to address problems in the two major areas of field placements and campus programs. That said, there is a remarkable degree of consistency in the underlying principles that have led to their success. This finding
suggests that Alberta need not look for a one-size-fits-all model to reform teacher education, but can continue to support vibrant local practice. There is also, within this diversity, a strong basis for continued collaboration across institutions.

Evaluating Innovations

A second, related gap in the literature raises the question of how innovations can be evaluated to determine the degree of success and impact they have on preparing people to teaching in a knowledge era. One of the recommendations of this report addresses this question directly. Calling for design research approached on a province-wide basis, this report suggests that research that is intentionally interventionist in its approach will help to create a new generation of research, one that is far more closely tied to creating, interpreting and improving innovations in a way that more closely approaches images of prototyping than conventional research paradigms. Innovative thinking is already a strong part of Alberta’s teacher preparation programs. A design research agenda could leverage the power of these local initiatives to help everyone understand more fully the degree of their success and promising modifications.

N-Generation Teachers

A third gap in the literature concerns the arrival of increasing numbers of the N-Generation into faculties of education. These young people have increasing levels of technological proficiency and routinely use technology in their personal lives. As they enter teacher preparation programs, how will the program leverage this new knowledge and skill set in fostering innovative, technology-based pedagogical practices within teacher education? How will pre-service teachers learn how to appropriately use the technology to foster meaningful, deep learning?

Findings from this report suggest that any confidence that the arrival of these N-Generation teachers will automatically solve the problem of technology use in schools is misplaced. It is very clear that even the most technologically fluent students we interviewed knew that they did not yet...
understand what it means to teach with technology. They were enormously appreciative of the efforts of their instructors to help them bridge the gap between their own levels of fluency and their ability to think like teachers.

We identified pedagogical concerns that cluster around this finding, specifically changes to teacher practice that are less transmissionist and more constructivist or inquiry based. What became more clear in the interviews and site visits than the literature establishes, however, is that the complexity of technology integration does not stop with changed classroom practices. There are clearly defined issues in the development of what Selber identifies as critical and rhetorical literacies. We did not see such literacies strongly addressed in the programs of pre-service teachers. One of the major reasons for this current state of affairs seems to be the absence of engagement with technology-related issues in “other” curriculum and methods courses, or in foundations classes. As the report makes clear, students we interviewed received, and valued, opportunities to create projects they saw as actually or potentially useful. That is a strong first step that required hard work on the part of both students and their instructors.

Deeper issues concerning the development of critical and rhetorical literacies require that others explore what it means to create in the disciplines in which they work. Held within the larger context that fewer than 10% of K-12 students in Canada have the opportunity to use software in school that lets them create rather than simply consume in technological environments, the urgency of addressing the myriad issues that emerge from the convergence of rhetorical and critical literacy become clear. Issues of how and when pre-service teachers explore the social impact of technology in our times belong to all teacher educators, not just to technology specialists.
Partnerships

Research suggests that fostering stronger partnerships between the field and campus has a critical role to play in addressing a number of identified shortcomings in teacher preparation. It suggests that further investigation is needed into the formation of partnerships, the ongoing professional development and sharing of resources and the nurturing of effective mentoring practices. The following question emerges strongly from the literature: what types of supports and resources need to be in place for expert and novice teachers to work and to learn together in this new space, where they are designing a learning environment that effectively integrates technology?

Findings from this report suggest that these partnerships need to operate on several levels. First, the placement of student teachers into schools willing to make the effort to allow them to deepen and extend their campus experiences with technology demands a move away from instrumental approaches to placing student teachers so that the numbers work out. Faculty interviewed for this study who had opportunities to be directly involved with schools established close working relationships with the schools, and became a presence in the professional development of experienced teachers. Innovative ways of drawing upon the growing confidence of pre-service teachers to help their cooperating teachers work in new ways with technology emerged in this study.

Moreover, it was clearly identified that teachers, themselves, require a different kind of professional development in order to be able to use technology effectively in their classrooms, and to mentor student teachers effectively. Such ongoing, job embedded professional development that intentionally includes pre-service teachers in a community of practice that takes an inquiry stance to ICT integration yields significantly stronger results than conventional
approaches to professional development. And they yield significantly better opportunities for student teachers’ growth than conventional assumptions that opportunities to model expert practice is the major function of the practicum.

A related question concerns faculty professional development. A clear movement is occurring that replaces a “tools and tips” kind of in-service to help faculty become familiar with technology applications to ones that are more immersive in character, and that start from pedagogical and subject-based concerns rather than from a technology focus. While there may not yet be strong relationships in all faculties between those who use technology for teaching in a variety of ways and those who do not use it very much at all, such connections are beginning to emerge. Two of the participants in this study identified initiatives that would be implemented in their faculties in the upcoming year to bring technology questions to colleagues in new ways. Emerging from this movement are questions of what kinds of mentoring would be most helpful to faculty, and who should be taking the lead in defining needs and interests around technology integration.

**Digital Environments**

A most promising finding from this study concerns the effectiveness of well designed digital and online environments to help engage pre-service teachers in the range of issues that surround teaching and learning with technology. Whether these environments provided the primary structure for courses, as in the case of the social studies Virtual Field Trip, or provided a planning, collaborative and mentored environment, the findings were remarkably consistent: well constructed digital environments can enhance good face to face teaching and learning. It is clear that continued attention to the design of such environments and increased use of them to create media rich, interactive environments for learning holds great promise to address many of the problems identified in the literature and in this study.
Policy Questions

Finally, this study addresses a gap in the literature concerning policy development in the area of ICT integration in schools if technology initiatives are to be sustained over time. These policy issues include, but are not restricted to the need to:

- support a clearly enunciated vision of Alberta as a learning society. While issues identified in this report fall clearly within the domain of teacher preparation programs, they must be held within the broader context of what kind of province Alberta is to become;
- develop coherent provincial assessment policies. Many teachers feel pressured by the structure of current provincial examinations to “cover the curriculum” in conventional ways. Moves to increasingly constructivist or inquiry-based ways of teaching, or efforts to persevere with the inevitable difficulties that surround teaching with new technologies are frequently undermined by the perceived impossibility of reconciling provincial examination and curriculum coverage pressures with technology integration. In these cases, the prevailing understanding is that what gets tested gets priority. Government must find ways to increase the presence of technology in examinations so that teachers are convinced of the value of adopting new practices. In the absence of such perceived value, technology may remain an “extra” in the minds of many;
- revise current Interim Certification Guidelines to more adequately reflect the complexity of teaching in digital environments;
- ensure that local decisions made concerning SuperNet implementation do not unnecessarily mimic current practices of centrally controlled distribution of information and learning opportunities.

Technology Infrastructure

The research literature does not adequately address the changes to school district policies that will be required as computing becomes an increasingly mobile, pervasive aspect of our society.
In some ways, these are technical issues that conventionally involve mainly technology specialists in debates and decision making. As the report indicates, however, these technological issues work themselves out in ways that deeply affect what is pedagogically possible in classrooms. At the moment, it appears that there is a huge divide between those who talk bits and bytes and those who talk curriculum. This report suggests some of the parameters that might frame a more strongly educational dialogue between the two.

The ubiquitous presence of technology in the lives of people today places strong demands on all those concerned with how to develop habits of mind, skills and values that enhance rather than diminish the quality of our lives in the 21st century; with how to ensure that Alberta becomes and remains a learning society. In 1997, Singapore adopted the phrase Thinking Schools, Learning Nation to describe its commitment to educational reform. Here is one passage from a speech by Prime Minister Goh Chok Tong at the opening of the 7th international conference on thinking:

A nation's culture and its social environment will shape what learning means, and determine its impact. Everyone counts. What grandparents, parents, students and teachers, employees and managers, and leaders in society take to be true about learning will have a profound impact on whether we respond quickly and effectively as a society to change. Our collective tolerance for change, and willingness to invest in learning as a continuous activity will determine how we cope with an uncertain future. We must make learning a national culture.

The question with which we end is this: what do we, as Albertans, take to be true about learning through technology, and how will we invest in the education of the next generation of teachers so that learning in uncertain times become an integral part of the culture of our province?
Recommendations

*Increased numbers of faculty must address meaningful technology integration across the entire range of courses offered in pre-service programs.*

**Context:**

The experiences of students in all five universities in Alberta indicate that:

- they have experienced success in addressing the issues of technology integration in the courses we have studied;
- the larger universities provide additional opportunities for them to pursue specialized interests in technology as elective courses;
- universities have infrastructures (both human and technical) that support faculty and students to use technology, but
- few students reported opportunities to use technology in courses other than those designated as technology-focused.

The Alberta ICT Program of Studies mandates the meaningful integration of technology in core curricula. Students we interviewed did not regularly encounter such integration in their university course work. Increasingly sophisticated technologies pervade every aspect of our society. Knowledge is created and communicated through technology in every discipline, and in every aspect of the way the world does its work. Thus it is imperative that systematic attention be directed to the preparation of teachers who are not only competent users of technology, but who also know how to take a discerning stance toward technology, and who are able to compose and create in the media of their times.

This study makes clear that even students who have extremely high levels of technology fluency are not generally well equipped to think about the pedagogical uses of technology by virtue of that fluency. They must *learn* to teach with technology, and helping them to do that in deep, powerful...
and socially responsible ways must become the business of every teacher educator, not just those who by specialty, or by default, have conventionally been given this responsibility.

**Implications for universities**

1(a) This recommendation does not replace the on-going need for universities to develop and maintain educational technology specialties and courses that “push the edge” of current thinking about technology. While non-technology users are sometimes overwhelmed by changes introduced by digital technologies, specialists in educational technology are well aware that in many areas, major technologies are either in a stage of relative infancy, or our society has not yet figured out fully what these new learning environments are good for. There are current advances on many technology fronts that have implications for education including: increasing possibilities for interactivity and collaboration; developing systems thinking in complex digital environments such as simulations; changes to our understanding of the character of literacy in interactive, hyperlinked and multimedia environments; mobile, ubiquitous digital environments, etc. There will be advances on many more. We need to be able to count on our faculties of education to maintain leading-edge involvement in these fields so that students and all faculty have a better chance of actually understanding their educational implications as children and youth engage with the emerging media of their times.

1(b) Technology integration must increasingly be approached in terms of curriculum and pedagogy, particularly core curricula. Those charged with responsibility for curriculum and instruction must assume a leadership role in ensuring that all pre-service courses experience intentionally designed learning environments that incorporate learning through technology in authentic and creative ways that challenge, deepen and extend current assumptions about teaching and learning, and about the role of technology in the lives of global citizens.

1(c) In order to do this, universities may need to give priority to hiring or developing existing interests and abilities among current faculty in curriculum, foundations, leadership,
1(d) Attention to the professional development needs of faculty to teach with technology must move beyond support for the acquisition of technical literacies. As this study indicates, issues of technology integration are primarily pedagogical, not technical ones. Each campus should develop a core of faculty who take the lead in identifying professional development needs for faculty within this recommended context. While this work will certainly include technology specialists, it cannot be relegated to them, nor should it necessarily be led by them.

**Implications for Government**

1(e) A potential new action identified in the Learning and Technology Policy Framework (2004) is to facilitate collaboration among teacher preparation programs to share models of best practice. We recommend that such collaboration also extend beyond sharing of current best practice. One way of doing this is to identify thought leaders in technology integration and to sponsor province-wide working groups of such thought leaders to explore ways in which technology integration can become the meaningful and intentional business of all teacher educators. These thought leaders should be drawn from such areas as curriculum theory, methods, educational philosophy, educational policy, leadership, literacy and professional development. They should also included teachers and thought leaders from other environments chosen for their demonstrated expertise and commitment to new ways of thinking and working.

1(g) Increased funding is required to begin and support this work so that it does not erode the existing commitments of universities to pursue leading-edge investigations of educational implications of digital technologies and to maintain solid infrastructures for learning with technology.
**Continued province-wide design research**

**Context**

Efforts to develop province-wide initiatives are complex, and have been historically challenging. This study identifies the need for design research that is deliberately interventionist in nature to create, or continue to develop, innovative approaches to teacher preparation with technology across the province. The diversity of the approaches taken by these universities, yet the commonality of themes that underlie their effectiveness gives us great confidence in the outcomes of focused research attention on designing, implementing, improving and extending the kind of work identified here. It is clear that no one model of teacher preparation should be sought or imposed. Rather, the findings of this report point to principles that can be implemented in local contexts in myriad ways, but that can also be researched and discussed in sustained efforts to make timely improvements across the province.

It is helpful here to distinguish design research from more conventional approaches to research. Design research is not defined by its methodology. Instead, it is defined by its central purpose: creating sustained innovation. Within this framework, several critical aspects emerge. First, the people designing the innovation (in this case, practitioners involved in each campus innovation) remain an integral part of the whole research process. Second, it is inherently interventionist. Such research is intended to make things happen. This is significantly different from research that demands researchers maintain a distance from the educational processes of interest. In design research, conventional boundaries between actor and observer blur significantly—and they blur in a principled way. Because it is designed to address a problem or a perceived shortcoming in existing situations, design research requires a community of practice in which people both believe in what they are doing and pay close attention to negative results. This is in Coming to Teaching in the 21st Century
contrast to many educational communities that vigorously reject any negative evidence or criticism of their favoured approach (Bereiter, 2002).

Finally, design research is characterized by its emergent goals that “arise and evolve in the course of cycles of design and research” (Bereiter, 2004). It requires a community of practice driven by a vision of potential.

In this sense, it might be said that design research shares the fundamental principles of research and development in which intentionally designed prototyping and feedback loops are an integral part of the entire process of creating and sustaining innovation.

This recommendation points specifically for the need for a particular kind of collaboration, and for sustained support for faculties both to create and to systematically critique what is working and what is not as innovations proceed, without fear that efforts to identify both weakness and strengths will be perceived as failures.

Implications for the universities

2(a) The faculty isolation identified in this report can be addressed in part by the commitment from individual institutions, school districts and the province as a whole to create the intentional, province-wide network of innovators described in Recommendation #1. Again, it is to be emphasized that this network will be formed by those who have a passionate commitment to re-thinking teacher preparation in light of current realities of the role of technology in our society, and best guesses about the needs of today’s teachers as well as those of the future. This group should include new voices as well as ones we would most often expect to see represented in technology decision-making in the province.

2(b) Designing and conducting interventionist research by creating new approaches to teacher preparation with technology must be regarded as scholarly activity, acknowledged and rewarded through the tenure process, merit increments and assigned work loads. Effective
technology integration is not a matter of implementing known processes and approaches. It requires scholarship at every stage, and the demands of such scholarship should be acknowledged.

2(c) Design research studies must include pre-service teachers and experienced teachers in the schools in collegial ways. These stakeholders cannot be regarded as the subjects of research. Their agency in creating powerful, new learning environments must be acknowledged and supported as a crucial feature of design research.

Implications for government

2(d) Messages to universities about the need for collaboration to design, create and research increasingly effective and intentional changes to teacher preparation must be unambiguous. Faculty cannot be expected both to cooperate for the good of the province, and also to compete against one another for scarce resources.

2(e) Design research of the kind envisioned here should be supported by targeted grants that specifically require:

- Practical, on-the-ground changes to teacher preparation and practicum experiences,
- Collaboration among university-based researchers,
- Collaboration with pre-service teachers, experienced teachers and others, and
- Prototyping structures, with clear feedback loops throughout the process of designing, implementing and modifying the innovations as they develop.
The existing disconnect between campus and practicum experiences with technology integration must be addressed.

Context

The existing practicum element of teacher preparation programs worked very effectively when it could be assumed that experienced teachers had mastered familiar classroom skills that student teachers could adopt through modeling. Technology integration places teachers in the role of learners, which significantly changes their role in working with student teachers. It is clear that an inquiry stance to technology integration is required by everyone: pre-service teachers, experienced teachers, faculty and professional development providers.

This report suggests some key principles that could begin at once to address the disconnect between campus and practicum experiences with technology. See Finding 6 for a fuller description of those possibilities. Design research should be directed to identifying what elements of increasingly intentional placement of student teachers in classrooms might entail.

Recommendations specific to the professional development issues related to this finding may be found in Recommendation #4: Teacher education must include commitment to the professional development of experienced teachers.

Meanwhile, it remains a challenge for universities to find enough practicum placement positions that ensure meaningful opportunities to work with technology. New ways of finding and/or supporting willing teachers must be investigated.

Implications for government

3(a) In the short run, making wide-spread changes to conventional practicum structures is difficult, although design research may create pilot projects across the province that...
deliberately investigate a range of possibilities for changes to practicum placements. Supporting such design research is an important role of government, and will provide a medium to long range vision for innovation.

3(b) From a policy perspective, however, Alberta cannot afford to continue to graduate students who have only random access to practicum placements in which teachers are using technology effectively. At best, such a situation wastes some or all of the efforts of faculty on campus to move pre-service teachers’ thinking and practice forward. At worst, it reinforces a view of low, or no levels of technology use as “the reality” of the classroom.

3(c) The difficulty of many students interviewed in this study to use technology in meaningful ways in their practicum placements points to a potential concern about the extent to which teachers are, in fact, implementing the ICT program of studies in the robust and meaningful ways intended.

3(d) In order to accomplish the dual goals of developing the capacity of experienced teachers to work with technology in inquiry-based ways and to provide more enabled environments for student teachers, substantial incentives should be provided to schools and school districts willing to more effectively align professional development and pre-service commitments. We recommend that these incentives be tied to the ability of schools to develop clear plans tied to performance-based outcomes. Funds through these grants could address such issues as: using SuperNet to extend what we know about teaching and learning with technology; developing the capacity of teachers to implement inquiry-based learning environments; using blended environments for sustainable professional development; providing increased opportunities for job-embedded professional development for technology integration; developing better blends of effective lab and mobile environments for learning; learning to teach in online environments. Key to each grant, however, would be specific plans to increase the capacity of schools to welcome student teachers into technology-enabled environments for learning and teaching.
Implications for universities

3(f) Partnerships with schools and school districts willing to be part of developing new approaches to practicum must be established and properly supported. Conventional or habitual approaches to practicum placements should be replaced by plans to insure that increasing numbers of student teachers are placed in technology-enabled environments.

3(g) The design research project could be established so that teachers are eligible to receive graduate credit for their part in the work.

3(h) Faculty (rather than sessionals or university associates) would need to be involved in field supervision as part of the design research process in order to establish scholarly credibility.

3(i) Practicum supervisors and course instructors must, themselves, be able to support students as they design and implement studies using technology. At a minimum, they must be able to ask meaningful questions about how students are planning for technology, make suggestions about ways of approaching an inquiry or unit that would incorporate technology effectively, and direct students to technical support on campus or in the schools that they, themselves, cannot provide. It is not enough that they give a general instruction to include technology in unit or lesson plans. Supervisors and instructors must be able to give helpful critique of students’ decisions.

3(j) Beyond this minimum, all pre-service experience should involve immersion in intentionally designed learning environments that require learners to engage with robust tasks in which they do meaningful design work. Such work calls upon the creative, meaningful, insightful and powerful use of technology at every stage of inquiry. Teacher candidates must have increased opportunities to learn in the ways they will be called upon to teach.

Implications for schools and school districts

3(k) Schools and teachers who accept student teachers should be able to demonstrate that they are using technology as part of their approaches to core curricula, and/or are supportive of
its use by student teachers. Conventional or habitual approaches to practicum placements should be replaced by plans to insure that increasing numbers of student teachers are placed in technology-enabled environments.

3(l) Schools must address access issues that make it difficult or impossible for teachers to work with technology in meaningful ways. These issues include: inadequate or outdated hardware; difficulties in gaining routine access to computers on a daily basis; restrictive district policies; limited availability of peripherals.

3(m) On site support in schools for teachers to use technology effectively needs to be provided. This includes the kinds of support many think of when they hear the phrase “tech support”: keeping computers up and running; helping to trouble shoot and solve problems; helping teachers become more adept with the use of applications. In addition, this support should also include more broadly pedagogical issues: how to design studies, units or inquiries that use technology in creative and effective ways; how to change teaching practices for new learning environments; how to assess learning when students are using technology effectively. This support has more of the character of coaching and mentorship.

**Teacher preparation must include commitment to the professional development of experienced teachers.**

**Context**

Even while design research explores new ways to ensure a more intentional connection between campus and field experiences with technology integration, efforts can begin immediately to support more wide-spread use of technology among experienced teachers. As SuperNet becomes available to schools across Alberta, the importance of continuing to direct professional development attention to new ways of thinking with technology will be crucial. Even while intentional design research points to new ways of thinking about practicum, Alberta can make headway to reduce the number of teachers who say they do not believe in technology, do not
have access to computers, do not feel they have time to integrate technology, or do not support its use by their student teachers.

Existing practices of placing practicum students assume that all teachers are equally able to act as effective cooperating teachers in terms of technology integration. Result of this study indicate that this is clearly not the case at the present time. It is most fruitful to understand the current situation in terms of a professional development challenge for all organizations involved in professional development in the province: the Alberta Teachers’ Association, regional consortia, district level professional development and others with an interest in increasing the capacity of experienced teachers to integrate technology effectively.

**Implications for government**

4(a) Our experience in other contexts leads us to believe that many teachers feel pressured by the structure of current provincial examinations to "cover the curriculum" in conventional ways. Moves to increasingly constructivist or inquiry-based ways of teaching, or efforts to persevere with learning new technologies are frequently undermined by the perceived impossibility of reconciling standardized examination and curriculum coverage pressures with technology integration. In these cases, the prevailing understanding is that what gets tested gets priority. Government must find ways to increase the presence of technology in standardized examinations so that teachers are convinced of the urgency and value of adopting new practices. In the absence of such urgency or perceived value, technology may remain an "extra" in the minds of many. It is important to be clear that this statement does not mean (1) the specific testing of technology or (2) delivering conventional multiple choice examinations online. Rather, we suggest modifications to existing standardized test structures to permit technology to be used in meaningful ways to demonstrate competencies in core subjects. In particular, provincial test design could begin to address
meaningful ways to test students’ abilities to access, work with and critique data, and their ability to design and create in digital media.

4(b) Embed technology integration (including assessment) in all curriculum re-writes

4(c) Increasing the sense of urgency to use technology in new ways must be tied to on-going support for effective, job-embedded professional development. See the recommendation for substantial incentives to tie professional development to the willingness to accept student teachers in Recommendation #3. Here, it is to be emphasized that we do not recommend a replication of failed attempts to provide “bums in seats” workshops to credentialize teachers, or any version of coercive attempts at certifying some teachers as worthy and others, as not. Rather, we recommend an approach more congruent with Hargreaves’ (2003) insistence that professional development is a matter of personal growth, and of deep satisfaction with finding new ways to teach and learn.

This approach emphasizes that both formal and informal structures of professional development could help to establish communities of practice around the question of how best to improve practicum experiences for students. An inquiry stance to the role of technology in learning does not mean that teachers must be experts in technology use before they can work effectively with it. Rather, an inquiry stance supported by good professional development means that even the most basic, beginning questions can become fruitful starting places for all.

While we recognize that professional development is not the direct responsibility of the provincial government, we recommend that Alberta Learning broker efforts of professional development providers across the province to collaborate in addressing issues that arise from the need to support experienced teachers in ways that create better practicum opportunities for pre-service teachers to integrate technology.
**Implications for universities**

4(d) Professional development around these issues can be tied to increasing opportunities for graduate studies and credit. We envision here that there be recognition of both the importance and the opportunity to create a scholarship of teaching specifically directed to efforts to improve the capacity of experienced and pre-service teachers to integrate technology effectively.

4(e) Opportunities exist for intentional engagement with practicum placements to help support or provide professional development for teachers seeking to move to more inquiry-based approaches to teaching with technology. While student teachers cannot be charged with the responsibility for the professional development of their cooperating teachers, universities and school districts can find ways to leverage the work they are doing on campus when they bring new ideas and methods to K-12 classrooms.

**Implications for schools and school districts**

4(f) Professional development support for teachers to work in inquiry-based, constructivist and problem-based ways with technology must continue. This support is both recognizably technology-based, and also includes larger pedagogical issues about changes to the culture of schooling both enabled and required by technology.

4(g) Changes to standardized testing practices will require that schools and teachers be well prepared to meet new requirements.
Robust, innovative and effective digital environments should be developed and incorporated into a wide variety of campus and practicum experiences.

Context

Pre-service teachers experienced a variety of online experiences as engaging and effective in helping them to learn how to teach through technology rather than to teach about it. Such environments show promise in addressing questions of how Alberta universities might move more quickly to create intentional, technologically enhanced learning environments in curriculum and methods courses, and in other areas of educational study and practice.

By this, we do not mean that common practices of delivering courses online can be counted on to meet the standards set by innovators in this study, nor to move in the direction of a more ubiquitous technology presence in schools. Rather, this study points to the importance of new ways of thinking about online and blended environments for learning that permit learners to work in a design mode with technology.

In addition, increasing numbers of teachers will find themselves teaching in online and blended environments in the future. It is important that they learn how to do that effectively and creatively.

Implications for government

5(a) Alberta Learning could take the lead in supporting province-wide design research that creates a range of online resources and examples that will assist schools and school districts in the development of intentionally designed learning environments. These could include: building on the approach of the social studies Virtual Field Trip; digital cases that permit the exploration of key areas of technology integration; new approaches to online
courses that are increasingly interactive, and that build in meta teaching, coaching and critical analysis; using open source to design innovative, collaborative working spaces; online working environments that mentor teachers and students through all aspects of designing and implementing technology-enhanced inquiries; etc. That is, the range of approaches should be wide. Participants in this design research initiative should be supported to bring their own experience, expertise and interests to the table in collaborative efforts to develop a rich suite of resources for faculty, pre-service and experienced teachers across the province.

5(b) The creation of rich and effective digital environments will help address the dilemma of defining and supporting province-wide standards for technology integration in ways that leverage rather than eliminate vibrant local practice. That is, such virtual resources can provide common experiences through which faculty and students can read their unique approaches and contexts. They can also maximize the effort that inevitably accompanies the creation of such resources by making them (and the thinking that lies behind them) available to others for use, adaptation and continuous improvement.

5(c) Alberta Learning should lead the way in defining educationally sound parameters for working in networked environments that are increasingly robust and flexible. This becomes particularly important in terms of the investment that has been made in bringing SuperNet to schools across the province. Districts must be able to demonstrate that local policies implemented around SuperNet substantially increase the opportunities for teachers and students to work in interactive, networked and innovative digital environments.

Implications for universities

5(d) The creation of rich resources for intentionally designed learning spaces will require close collaboration between educational technology experts and curriculum and instruction experts, with issues of curriculum and pedagogy driving the design of new spaces and resources.
5(e) People who are intimately involved in the creation of such resources feel a great sense of commitment to their use. It is equally important that all faculty come to see these resources as intriguing, useful and effective, and be involved in their design, development and evaluation. This is a significant professional development matter for each campus.

5(f) Universities can take the lead in developing new approaches to online teaching and learning that move beyond conventional or teacher-centered approaches to course delivery. Pre-service teachers across the province should have opportunities to learn in online and blended environments.

5(g) Pre-service teachers must have opportunities to teach in online and blended environments. Currently, opportunities for students to complete an online practicum placement do not exist. The Council of Alberta Teaching Standards and the universities have a shared opportunity to investigate how such a thing might become possible.

Implications for schools and school districts

5(g) Teachers should be design research partners in the creation of innovative online teaching and learning resources and environments.

5(h) Teachers should be encouraged and supported to introduce a wider range of virtual and blended environments for their students, and to use such environments for their own learning. Doing so would mean that the creation of such intentionally designed environments for learning becomes available at every stage of teaching and learning, including the K-12 classrooms in which pre-service teachers complete their practicum experiences.

5(i) District network, security and technology policies must be flexible and robust enough to permit students and teachers to work creatively and effectively in collaborative online spaces. School districts should be able to demonstrate the ways in which network design, security and other policy issues increase rather than stifle the efforts of educators to move to increasingly mobile and ubiquitous learning environments.
Revise Interim Certification Guidelines

Context

At present, guidelines for interim certification require that graduating teachers possess the knowledge, skills and attributes (KSAs) that demonstrate consistently that they understand "the functions of traditional and electronic teaching/learning technologies. They know how to use and how to engage students in using these technologies to present and deliver content, communicate effectively with others, find and secure information, research, word process, manage information, and keep records."

These guidelines require revision to more adequately represent the range of issues identified in this report:

- That learning to teach with technology is a complex pedagogical issue that goes far beyond the conventional understanding of distribution technology contained in the phrase "using these technologies to present and deliver content";
- That combining traditional and electronic teaching/learning technologies in one KSA may encourage low levels of understanding and practice with the particular strengths and characteristics of digital technologies;
- That teaching and learning with technologies requires more than technical literacy. It also includes what we have been calling critical and rhetorical literacies throughout this report: literacies that permit a deeper engagement with the role of technology in our society, and the ability to design, create and critique in the media of our times.

While the revision of existing KSAs requires an attention to specific detail that is beyond the scope of this study, it is recommended that the revisions address such areas as students' ability to:

- Use digital technologies in a variety of ways for the management of their own learning and teaching responsibilities throughout their university program;
• Plan for instruction that includes the integration of technology in a variety of meaningful and creative ways at every stage of an inquiry or unit of study;

• Work in blended face-to-face and online environments;

• Interpret and critique the role of technology in the areas in which they are learning, and for which they preparing to teach;

• Assess learning in digital environments in appropriate ways.

Moreover, it is recommended that the standards for assessing students’ preparedness to teach with technology be performance based. Thus, for example, we suggest that revisions to the Interim Certification Guidelines include the completion of a digital portfolio demonstrating preparedness to teach with technology as an exit requirement for graduation.

Implications for Government

6(a) Revised interim certification guidelines must be developed within the context of the larger issue of the kind of society Alberta is, and seeks to become. These revisions can be regarded as a powerful instrument of public policy.

6(b) Monitoring demonstrations of preparedness to teach in new ways with technology can be regarded as both accountability and as professional development initiatives. As new images of what it means to teach in more sophisticated ways with technology emerge, the knowledge base of educators in the province can be broadened and deepened significantly. Meanwhile, the seriousness of government intent to deepen and broaden the experience of pre-service teachers can be established in its commitment to update its guidelines in significant ways.

6(c) The revision of these guidelines could be approached as a design research initiative so that new ideas can be developed, systematically piloted and interrogated for their effectiveness.
Implications for the Universities

6(d) All students must have a range of opportunities to engage in learning experiences that use technology in a variety of ways in curriculum or other core courses.

6(e) All students must have the opportunity to experience learning in pedagogically sound digital and online environments. It is to be noted here that if these environments include online courses, such courses must be designed to go beyond transmissionist pedagogies and distribution technologies.

6(f) Assessment policies within faculties must be examined with a view to broadening the opportunities for students to use digital technologies and to receive insightful feedback on the quality of their thought and design.

Implications for Schools

6(g) Cooperating teachers must understand that student teachers’ access to opportunities to learn to teach through technology is not an option. The integration of technology in core subjects is mandated in Alberta. Revising interim certification guidelines increases the importance of the practicum in providing innovative and effective opportunities for student teachers to integrate technology effectively.

6(h) Schools must be properly equipped to ensure not only that teachers and their pupils have good access to a range of technology enabled environments for learning, but also that student teachers come to see “the reality of teaching” as one that encompasses rich possibilities for learning with technology.
References


Eifler, K.E., Green, T.G., & Carroll, J.B. (2001). Walking the talk is tough: From a single technology course to infusion. The Educational Forum, 64 (4), 366 – 375.


Coming to Teaching in the 21st Century


Coming to Teaching in the 21st Century


Coming to Teaching in the 21st Century


Papert, S. Technology in schools: To support the system or render it obsolete. *Milken Family Foundation* Retrieved June 4 2004 [http://www.mff.org/edtech/article.taf?_function=detail&Content_uid1=106](http://www.mff.org/edtech/article.taf?_function=detail&Content_uid1=106)


Coming to Teaching in the 21st Century


