Technology And Teacher Education For A Knowledge Era: Mentoring For Student Futures, Not Our Past

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Three initiatives are described that focus on cultivating inquiry based learning with technology for student teachers. The article describes an approach by a Faculty of Education to the design, development, implementation, and evaluation of media rich learning experiences and research projects. Descriptions are provided of the type of work that student teachers complete. Emphasis is on using technology as a medium for thinking, creation, and invention rather than productivity. The main goal is to foster closer connections between campus and field experiences by cultivating collaborative relationships between university faculty, classroom teachers, and student teachers.

Educators need to rethink how student teachers are prepared for the knowledge era. Today’s dominant information and communication media are highly interactive, and include international networks, digital video and audio, and hypermedia. Unlike broadcast media of the recent past, digital technologies and the Internet enable both adults and children to author, publish, and freely exchange their stories using multiple media with a global audience. Digital media and network technologies represent a major communications revolution and integration for teaching and learning demands and requires us to question conventional methods and approaches to schooling. Today’s digital media requires us to reconsider how to enable students and student teachers to take advantage of unregulated online resources, and contribute to and extend those resources as they share their knowledge and perspectives with the world. Educators must examine school and campus structures
and instructional approaches that privilege textual forms of literacy while largely ignoring hypermedia and online forms of discourse.

An important job for all educators is to enable learners to author using the media of their time. It is not enough to teach today’s children in ways we were taught because they live in a different age. Rushkoff (1996) calls them Screenagers: today’s children have been “born into a culture mediated by the television and the computer” (p. 3). Screenagers participate fluidly in online, interactive digital environments and virtual spaces—the rapid-fire, nonlinear, chaotic, multisensory world of digital media. Screenagers invent uses for computers and networks that adults often do not anticipate and frequently misunderstand. What educators first assumed children needed from us—careful instruction, step-by-step activities, and computer lessons developed with a close eye to scope-and-sequence—is often exactly what gets in their way (Clifford, Friesen, & Jacobsen, 1998). At home, much like the adult work experience, today’s children are multitasking and exchanging documents for social purposes using wireless networks, personal data assistants, digital video and audio devices, and distributed gaming environments. We must examine the implications of these daily interactions with technologies for schooling and for Faculties of Education. How are student teachers taught to leverage today’s digital technologies for their own, and for children’s, learning and collaboration needs?

Wouldn’t it be nice for teacher educators to have a crystal ball to guide planning and decisions on how to prepare teachers how to take advantage of technology in their professional roles? However, even with such a time-bending device, we would likely confirm what we already know—there are precious few certainties in today’s classrooms, and few set models about what teacher graduates will encounter in their first classroom populated by Screenagers. About the only “certainties” we can count on are that teachers’ professional lives will be characterized by unstructured problems and unpredictable hourly and daily events. Classroom teachers have reflexive roles in increasingly complex, multi-layered and distributed learning organizations that include colleagues, students, parents, and increasingly, the global community.

Therefore, the task for teacher educators is complex given that the classrooms our graduates take on rarely consist of neatly arranged rows of compliant students waiting eagerly and unquestioningly for a subject expert. Faculties of Education cannot graduate new teachers with a finite and set complement of technology skills and subject competencies. Instead, we must graduate teachers who can respond and be sensitive to the many complexities, diverse perspectives, and emerging technologies they will face as they invite increasingly technology savvy students to learn with them in expanding and distributed learning environments. A question that guides this article
is, how do teacher educators help to develop responsive cultural attitudes and dispositions, both in themselves and also in student teachers, that will guide complex ethical and moral choices about digital technologies and communications media that are driven by a vision of learning? Information and communication technology (ICT) poses a significant challenge to teacher educators in terms of how to best use digital media and global networks with student teachers to foster critical understandings and promote full participation in digitally rich learning environments. Three initiatives are described in this article that focus on cultivating inquiry-based learning with technology for student teachers. Today’s dominant communication media, international networks, digital video and audio, and hypermedia, required us to iteratively examine and reconsider how to educate teachers for their futures in the knowledge era.

PROVINCIAL CATALYSTS FOR CHANGE

Alberta’s Provincial Learning Ministry is dedicated to providing technology-enhanced learning experiences for kindergarten to grade 12 students. This commitment is reflected in three acts of legislation. First, Alberta Learning mandated the implementation of an Information and Communications Technology (ICT) Program of Studies in September of 2000 (Alberta Learning, 2000). This new program emphasizes:

the seamless relationship between technology and the subject disciplines, the process nature of technology itself, and the co-existence of KSAs (knowledge, skills, and attributes) for technology alongside those for the subject areas. In large measure, the program of studies also assumes a constructivist approach to teaching. (Jacobsen & Clark, 1999, p. 2)

Second, Alberta Learning’s Teacher Quality Standard, legislated in Ministerial Order #016/1997 Policy 4.2.1, required all Alberta teachers who hold Interim Professional Certification to demonstrate they understand functions of traditional and electronic teaching/learning technologies, know how to use technologies, and know how to engage students in using 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). Third, the School (Computer Instruction) Amendment Act, 1998: Section 25(1), clause (g) prescribed standardized objectives for the study of computer technology. The provincial mandates
have inspired expectations for an innovative technological learning climate for both teachers and students in the province, and have implications for the preparation of teachers in Faculties of Education. Universities must graduate teachers who have effective technology integration practices. However, provincial mandates alone do not achieve widespread changes, nor should legislation be the driving force behind technology integration efforts in teacher education. Instead, technology integration should be values driven and guided by a shared vision about learners and learning. The guiding vision needs to be woven throughout the various components of a teacher education program and must represent an ethical approach to teachers and teaching. Establishing a vision and seeking collaborative relationships with all educational stakeholders is required for changes to occur and to be sustained.

QUESTIONING TECHNOLOGY IN TEACHER EDUCATION

It is clear that training teachers how to navigate computer applications is insufficient for meaningful technology integration. One-size-fits-all workshops and stand-alone courses are limiting and tend to fragment professional development with little or no ongoing support. In addition, workshops tend to be noncontext specific (Meltzer & Sherman, 1997). One-shot training events fail to provide the necessary time or opportunity for teachers to reflect on teaching beliefs and practices and explore how technology can be woven into the learning environment (Sprague, Kopfman, & de Levante Dorsey, 1998). According to the U.S. Congress Office of Technology Assessment (1995), training teachers in basic technology skills does not sufficiently prepare them to constructively integrate technology into classrooms.

Integrating technology is much more than simply learning how to work the machines. 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). In their technology integration efforts, classroom teachers, student teachers, and education faculty members are confronted with fundamental questions about how to design learning opportunities and experiences that leverage the unique benefits and new possibilities provided by digital technologies. ICT supports powerful collaborative knowledge building experiences, “if we integrate well-designed technologies in the context of meaningful, mindful inquiry projects, nonrepresentational pedagogies, access to resources and tools, and adequate support for technological maintenance and pedagogical renewal” (Breuleux, 2001, p. 2). Renewal described “what happens to educators and to their practice when they gradually develop an understanding of the potential of ICT and start using it in their day-to-day professional activities” (Breuleux, p. 3).
The provincial expectation to integrate technology and literature calling for meaningful and authentic use of technology for inquiry-based learning is causing a shift in how teachers are prepared at the post-secondary level. Jacobsen, Clifford, and Friesen (2002) argued the challenge is to “develop fluency with teaching and learning with technology, not just with technology, itself” (p. 44). It is important to look beyond learning how to use computers, and consider best practices and strategies for “just-in-time” (Schrum, 1999) professional development focused on pedagogical rather than technological issues. Jacobsen et al. stated “when you begin to think differently about technology and learning, and you have different spaces in which to learn and teach, you can design different approaches to learning” (p. 27). Breuleux (2001) stated “technology is not a mere ingredient that ‘boosts’ teaching and learning. Rather, it is part of a collective project of educational communities, and the outcomes of that project depend on a multitude of decisions at the local as well as the global levels” (p. 1).

Changes that are called for when technology goes to school are hard work, especially in conservative educational environments that depend upon routine, set schedules and practiced methods. DeCastell, Bryson, and Jenson (2001) highlighted an emerging irony in how “educators have sought to render their and their students’ encounters with and uses of these transformative tools (a) familiar and (b) comfortable” (p. 117). The absurdity of a demand for comfort is captured here:

We have developed a powerful means for reshaping human knowledge, communications, educational structures and realities, epistemic concepts and practices, and have incalculably increased the amount and kind of information available to ordinary people worldwide, we have a master code capable of utilizing in one platform what have for the entire history of our species thus far been irreducibly different kinds of things—writing and speech, images and sound—every conceivable form of information can now be combined with every other kinds to create a different form of communication, and what we seek is comfort and familiarity. (pp. 117-118)

Rarely does a significant technological change mean that we can maintain comfortable practices or familiar routines. However, for the changes that technology brings to be reflected in classroom practices, both at schools and on campus, a range of emergent issues and barriers must be acknowledged and addressed. Many Faculties of Education have provided some opportunity for student teachers to use technology for their campus learning experiences. However, there is a great deal of work yet to be done. The CEO Forum on Education & Technology (2000) states that recent graduates
have shown little improvement since the U. S. Congress, Office of Technology Assessment (1995) study that found "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 experience" (p. 1).

There are a number of explanations for this unenviable state of affairs. Grabe and Grabe (2001) identified reasons why teachers are poorly prepared: (a) lack of equipment (hardware and software) on campus that limits opportunities to gain hands-on experience, (b) little exposure to technology integration on campus because many post-secondary educators are unable or unwilling to incorporate technology in their teaching, and (c) technology training offered in isolated courses that focus on learning about technology rather than learning with technology. Moursund & Bielefeldt's (1999) study echoed these deficiencies: (a) one-third of teacher education programs are limited by their lack of technology facilities, (b) most faculty and students have similar information technology skills, however, the majority of the faculty do not model these skills, (c) teacher education "programs do not have a written, funded, regularly-updated technology plan" (p. 28), and (d) student teachers have access to technology in field placements, but do not regularly use technology with children. Student teachers are often placed with teachers or supervisors who cannot effectively advise them in the use of the technology (Moursund & Bielefeldt).

Proposals for how to improve the use of technology in teacher preparation abound in the literature. Pierson and McNeil (2000) proposed the "purposeful creation of collaborative, authentic, and content-focused learning environments where future teachers are empowered to develop content, pedagogy, and technology strategies concurrently, as a critical factor in the design of preservice teacher education programs" (p. 9) as a solution for what ails teacher preparation. Moursund and Bielefeldt (1999) argued for increased levels of technology integration throughout entire programs instead of delivering isolated classes, and student teachers need greater opportunities to use technology in their field placements. Education faculties need to model effective technology use in teaching. To promote change, professional societies, educational agencies, and researchers need to study and disseminate information that provides examples of effective technology integration both at the K-12 and post-secondary levels (Moursund & Bielefeldt). Educators on campus and in schools need to share images of student scholarship and achievement in digital learning environments in order to dispel the enduring myth that there is "insufficient evidence" of the impact of technology on learning.
LESSONS TO GUIDE ONGOING DESIGN AND DEVELOPMENT

Education faculties have launched a variety of promising initiatives that address the challenges associated with technology in teacher preparation. Breuleux, Baker, and Pagliaroli (1998) described an innovative partnership between McGill University’s Faculty of Education and local schools in Montreal. A feature of this partnership is that faculty members offer site-based inservice technology courses to teachers. A challenge is the:

devlopment of teacher knowledge in the renewal of information and communications practices. The tools can be used to renew the relationships to information and the communications with others, and it is such renewal that we try to foster rather than simply the use of new tools to perpetuate traditional relationships and communication patterns. (Breuleux et al., p. 13)

Laferrière, Breuleux, Baker, and Fitzsimons (1999) examined professional development initiatives and models used across Canada that encourage and support in-service teachers in the integration of ICT, and conclude that what works for teachers can also be used in the design of teacher preparation programs:

- partnership and collaboration between schools and faculties of education;
- inclusion of teachers in the design of their own development, and of all students in the expectation for improvement;
- inquiry, long-term reflection and research on practice; and
- renewal and openness to inventing new ways of doing (Laferrière et al.).

Pierson and McNeil (2000) described how the University of Houston’s College of Education reorganized its preservice program through an “action research process to actively collaborate with Houston-area school districts to establish networked learning communities of university faculty, preservice teachers, and school-based educators to support the development of future teachers” (p. 1). Technology courses have been replaced by integrated content-methods based courses. Field-based students work with mentor teachers who infuse technology into their classrooms. Students are required to create and maintain electronic portfolios. Sharing of field-based and campus-based resources and exemplary teaching occurs using technology.

From this brief overview of successful examples, it is apparent that several challenges must be addressed for efficacious technology integration in
teacher education: (a) implement a vision and values driven technology integration plan, (b) encourage education faculty members to infuse and model effective technology use across the curriculum, (c) provide authentic learning opportunities for student teachers to integrate technology in campus and field experiences, (d) foster greater campus and K – 12 school partnerships that cultivate and nurture technology integration, (e) provide ubiquitous access to a more than adequate technology infrastructure, and (f) disseminate research on effective use of technology for learning. Student teachers require diverse opportunities and authentic learning experiences with ubiquitous technology to design meaningful projects to implement with the children they will teach. Further, public exhibits of scholarly work and research need to become more widely available.

TECHNOLOGY INTEGRATION IN AN INQUIRY-BASED TEACHER EDUCATION PROGRAM

The Faculty of Education at the University of Calgary launched its innovative Master of Teaching (MT) Program in 1996. This two-year, after degree teacher education program is learner-focused, inquiry-based, and field oriented, and does not use a course-based model to provide learning experiences. Instead, learning is encapsulated in professional, field and case study seminars, independent inquiries, and extensive field experiences in schools and other community organizations. Therefore, the challenge is to fully integrate technology across all strands of the MT Program rather than locating it in a single course. The MT Program is grounded in an inquiry-based learning philosophy designed to assist student teachers to develop practical wisdom, which refers to the “capacity to make wise decisions in relation to others in particular situations” (Division of Teacher Preparation, Faculty of Education, p. 4). The MT Program draws upon John Dewey’s belief that it is “critical to foster dispositions of inquiry, and not just focus on narrow skills” (Division of Teacher Preparation, Faculty of Education, 2001, p. 4). A key component of the program is for student teachers to experience and practice inquiry through a case study approach and extensive field experiences that help them to formulate an understanding of the complexities of teaching and learning.

Inquiry-based case studies present authentic learning and teaching scenarios and issues for analysis, debate, and perhaps resolution. The case inquiry process expands and deepens current understandings and skills, and invites students to explore the complexities in a variety of educational situations that require careful attention throughout their teaching careers (Division
of Teacher Preparation, Faculty of Education, 2000). A goal for each case is to provoke discussion, challenge assumptions, inform perspectives, complicating images, and problematise boundaries between subject areas. The complexity of each case requires student teachers to work cooperatively and collaboratively in wrestling with critical questions and to engage in critical dialogue about education. The emphasis for inquiry is not on finding the “single correct answer.” Rather,

the inquiry task is an iterative and disciplined cycle of research, reflection, writing, and revising one’s knowledge and understanding… the iterative cycle of inquiry is not “done” when the project, or product, or paper, is finally presented to the group… It is impossible to “know all” about a subject or topic. There is always more to know… (Jacobsen, 2001, p. 19)

Questions that are worth understanding must be enduring, be at the heart of the discipline, be potentially engaging, and require uncoverage versus coverage of the curriculum (Wiggins & McTighe, 1998). Within the inquiry-based cases, student teacher learning opportunities have been designed to foster critical thinking that assists in the development of enduring understandings and informs practical actions. To truly understand a phenomenon requires that an individual explain, interpret, apply, have perspective, empathize, and have self-knowledge (Wiggins & McTighe, 1998). An inquiry philosophy and case process are essential components that inform the creation of all new technology integration initiatives at the University of Calgary.

When one thinks about learners and learning with technology, it is easy to agree, at least in principle, that we all learn at different rates and in different ways. Almost all student teachers readily “talk this talk” in the first few weeks of the MT Program. However, there can be some bumps along the road when making the crossover from student teaching to thinking of oneself as a professional teacher. The transition to “walking the walk” can be uneasy and full of tension. Experiencing the diversity of actual children in the daily life of schools, and making professional decisions about how to respect and respond to different needs, is much harder to do well in practice than it is to say it is the right thing to do. In the classroom, faced with many decisions and requirements to act each day, a teacher’s values, beliefs, and attitudes are constantly challenged. Therefore, putting professional dialogue and an inquiry philosophy into practice is an important and challenging goal of Calgary’s teacher education program. To further complicate the issue, we must invite student teachers to consider the role of technology in all aspects of learning, and to grapple with the complex ethical and pragmatic issues that accompany the changes that digital technologies bring to classrooms, schools, and society. Three initiatives are presented in the remainder of this
article that describe how Calgary’s Faculty of Education provides learning opportunities for student teachers to inquire into the moral and ethical challenges associated with technology integration, and develop experience with integrating digital media for teaching and learning.

LAYING A FOUNDATION

The meaningful integration of technology has been considered a key factor in the MT Program since its inception. Early on, Jacobsen and Clark (1999) recommended that ICT integration efforts must focus on "sophisticated technical skills and on the integration, communication, decision making, and problem solving aspects of education technology" (p. 9). Over the past few years, the Faculty of Education has engineered several initiatives to provide intentional learning opportunities for student teachers and teacher educators to understand the integration of technology and to develop fluency using technology. For example, lectures based on the meaningful integration of technology were included in early versions of the weekly student lecture series. A diverse range of technology skill and integration workshops were made available to students and faculty members. A small group of teacher educators integrated authentic technology and telecollaboration projects with student teachers in professional and case seminars. EGallery (http://www.ucalgary.ca/~egallery), an electronic peer reviewed publication, was launched in 1999 to showcase exemplary work completed by MT students. A faculty technology integration committee was established to promote "ubiquitous integration of technology for learning" (Jacobsen & Clark, 2000, p. 5) as part of developing a faculty-wide shared vision and commitment to technology integration. The committee was eventually disbanded, however, it played a critical role in the inception of an MT3 initiative funded by the Imperial Oil Charitable Foundation in 2001 that is described in a subsequent section. Technology integration initiatives evolved in the early years of the MT Program, but failed to provide widespread opportunities for all students and faculty members to confront complex questions and develop practical wisdom to do with learning, teaching, and technology. An expanded view of technology integration was needed to cultivate pervasive involvement and enthusiasm for the changes that digital technology brings to learning and living in society.
CURRENT THINKING—THREE FACULTY WIDE INITIATIVES

The Faculty of Education’s investment in technology integration has been expanded in 2001/2002 with three initiatives targeted at student teachers, classroom teachers and teacher educators: (a) The Teaching and Learning for a Knowledge Era project, (b) Inquiry-based Technology Cases, and (c) Integrating Technology Across the Curriculum: A Special Topics Seminar. These initiatives give educators and students the opportunity to design, develop, implement, and evaluate technology for learning. Student teachers have increased opportunities to observe, experience, and develop inquiry-based projects and technology rich learning environments. Emphasis is on research and dissemination of knowledge about the impact of technologies on learning, teaching, and schooling. Such initiatives reflect the ever-growing Faculty of Education’s culture of promoting “educational technology as a way to fundamentally rethink teaching and learning, and as a way to question and explore new approaches to writing, communication, and research” (Jacobsen & Clark, 1999, p. 12).

Teaching and Learning for a Knowledge Era

The Faculty officially unveiled its “Teaching and Learning for a Knowledge Era” project in November 2001. This initiative was made possible by a $1 million donation from the Imperial Oil Charitable Foundation. The nickname “MT3” reflects the third generation of the Master of Teaching Program, and builds on the realization that “third generation” students, as defined by Norton and Wiberg (1998), are no longer the future. Third generation students, like Rushkoff’s (1996) Screenagers, are our present reality, in elementary, middle, and secondary schools, as well as in our teacher education program. Through the MT3 initiative, the faculty provides resources and learning environments, both in the teacher education program, and in school based, practice-teaching placements, where future teachers can witness, participate in, and help construct new ways of teaching and learning appropriate for a knowledge era.

MT3 grants. Currently, few educators at any level, kindergarten to graduate school, have actually experienced the kinds of learning and teaching with technology they are called upon to design for children and adults. Thus, MT3 Grants up to $5,000 are provided on a competitive basis to support faculty members, classroom teachers, and student teachers in designing and
developing innovative uses of technology in their teaching, and to support research on the effective use of technology for learning. Ten projects have been awarded MT3 Grants to date. The classroom-based research projects include elementary students using robotics for learning, and a first year teacher examining students as designers and authors using the media of our time. In the research on teacher preparation and technology category, teams are investigating the use of online case studies and the role of distributed learning in teacher education. In the collaborative teaching and research team category, researchers are studying the impact of global information systems (GIS) on grade six students’ understanding of the impact of location on identity, the role of the internet in global education and media literacy, the meaning of technology in schools, the role of technology in French immersion learning environments, the role of inquiry in inquiry about technology, and technology supported curriculum decision making. All MT3 projects are expected to be sustainable and to result in a scholarly legacy for the Faculty of Education.

**Infrastructure, training, and support.** The University of Calgary and the Faculty of Education committed $1.4 million to create a new Learning and Teaching Centre in the Education Building. The newly renovated Doucette Library of Teaching Resources integrates traditional forms of information with new generations of technology and has quickly become a hub of activity for faculty, staff, and students in the Faculty of Education. Staffed with reference and technology support personnel, the Information Desk is designed to respond to most instructor and student requests from a single location. The Faculty’s technology support personnel are able to consult on a number of different project types, software and hardware needs, and provide advice or solutions to virtually any technology requirement. The learning environment provides fluid workspaces that anticipate and meet the unique needs of education students and faculty members. Classrooms and breakout rooms are equipped with ethernet ports and traditional white boards to provide an effective blend of visualization and communication technologies. Breakout rooms provide a secluded workspace for open discussion and group work; an excellent complement to the Faculty of Education’s philosophy of inquiry-based and collaborative learning.

A priority during the first year of Imperial Oil Foundation support was building a more than adequate infrastructure—both of staff and equipment—that would support the goals of the Teaching and Learning for a Knowledge Era program. The full-time position of Technology Coordinator was created to manage expanded technological assistance operations, and to
develop and deliver technology-related workshops and professional development opportunities for Faculty of Education staff and students. The Technology Coordinator mentors several student teachers each year who then are able to provide extended support and training for peers and instructors.

An integral component of the Teaching and Learning for a Knowledge Era project has been the Faculty of Education’s relationship with the Galileo Educational Network (http://www.galileo.org), an innovative professional development and learning organization located at the University of Calgary. The Galileo Network’s contribution to the MT3 initiative involves (a) creating enabled environments for the infusion of technology in schools by providing on-site planning, coaching and mentoring in Calgary-area school districts; (b) conducting collaborative, classroom-based research with education faculty that explores questions to do with learning and technology; (c) facilitating the strategic placement of MT students in Galileo classrooms to carry out their fourth semester, practice-based inquiry projects, and (d) to work collaboratively with cohorts of MT students and their field advisors in technology-enabled field placements. Student teachers who are placed in Galileo schools can access professional development opportunities that are available to staff, as well as Galileo support and mentorship in planning inquiry projects for their practice teaching.

An extensive MT3 Website (http://mt3.ucalgary.ca) has been developed to communicate the vision and goals of the initiative, to promote project achievements and current events, and to disseminate findings about the impact of the MT3 grants on changed instructional practices on campus and in schools. Phase one includes information and resources related to the project goals, educational technology research, and the MT3 Grant process. Subsequent phases of the website will provide a forum for ongoing discourse and coconstruction of projects related to the MT3 initiative.

Inquiry-Based Technology Case Studies

Given the inquiry-based philosophy of the MT program and the ICT mandate from Alberta Learning, a case development initiative was launched in the Faculty of Education in 2001 using a research grant from Alberta Learning (LEE4). The main goal of this initiative is to provide opportunities for educators to develop pedagogical strategies and skills to effectively integrate technology in kindergarten to grade 12 learning environments. Three Alberta universities embarked on the shared goal of designing, developing, and testing course materials, which will be made available on a common
website. For this project, the University of Calgary elected to develop a series of inquiry-based technology integrated case studies for student teachers with an eye to also using these cases with practicing teachers.

The inquiry-based technology cases are presented in an online, digital format. Numerous critical issues are embedded within the inquiry cases; key topics such as technology integration, fluency, teaching and learning with technology, and implementation of the ICT Program of Studies, challenge student teachers as they work through the cases. Through the case experience, student teachers develop pedagogical understandings and strategies needed for technology integration. Student teachers are required to use a variety of technologies in meaningful ways to complete each case task. The design of each digital case focuses on the need to model and provide an environment that promotes innovative thinking about teaching and learning with technology. This type of professional development is “congruent with the philosophy of the MT Program, adequate for provincial requirements, and in line with professional development required by experienced teachers within schools to implement the new curriculum” (Jacobsen & Clark, 1999, p. 3).

The case study initiative was launched through a three-phase iterative design process in Spring 2001. The first phase, the conceptualization phase, began with a review of the literature. Key themes relating to technology integration sparked the creation of four inquiry-based cases. The first case, entitled “The Integration Of Pedagogy And Technology,” examines the relationship between pedagogy and technology for the purpose of creating learning environments that foster critical and creative thinking. The second case, “Information Literacy,” explores expanded notions of literacy in a digital age. The third case, “Telecollaboration,” investigates the role of teachers as designers and mentors of telecollaborative learning experiences. The fourth case, entitled “Constructivism or Confusion,” challenges student teachers to further develop their understanding and application of inquiry-based projects. Three cases have been prepared using the MT framework that includes an introduction, a narrative or scenario, positioning questions and tasks, scholarly readings, and supplementary resources. The fourth case is a classic example of problem-based learning given its focus on a video scenario.

In the development phase, educational technology graduate students applied their technological knowledge and experience to transforming case ideas into online, inquiry-based technology cases. This approach to case development has given graduate students greater insight and experience in designing inquiry-based cases, using an iterative design process, producing digital hypermedia, applying instructional design principles, and understanding the complexities of educating people in a new way of thinking with technology. As ideas and plans have been solidified for each case, the development
team had to ensure that what they proposed and built would meet the needs of the target audience (e.g., student teachers). Striking a balance between necessary detail, support for inquiry-based learning, and accommodating the flexibility of a nonsequential environment has been a challenge that has resulted in the ongoing redrafting of plans before the right balance is struck. Lewis and Rieman (1993) argued that, to create a good interface, designers must understand who will be using it and for what purpose. A designer's view of what should be included in the design may not meet the needs of users. Consequently, it is imperative that developers received feedback from their colleagues and faculty on their work throughout the iterative design process.

It is not enough to design and develop technology cases to be implemented in a teacher education program. Before they are fully implemented with all students, the cases need to be pilot tested with a selected audience. Pilot testing is the third phase of the iterative design process, and has been funded by an MT3 Grant for the 2002 – 2003 academic year. By piloting the cases with a number of case and professional seminar groups, additional data will be gathered to strengthen the design of each case. Technical and pedagogical issues associated with each case will be examined by collecting data from faculty and students as they interact with the cases (e.g., focus groups, observations, reflections). Research findings will be used to modify the cases, inform future case development, and provide direction for infrastructure decisions in support of faculty-wide implementation of the digital cases.

When fully implemented across the MT Program, it will be important to monitor the digital cases for relevancy and effectiveness. The following questions frame the evaluation process to analyze what impact the cases are having on faculty development and technology integration within the Faculty of Education and in K - 12 classrooms:

- What impact do the technology cases have on the way people think about teaching and learning with technology?
- Do the technology cases help to build educator's capacity to effectively integrate technology in learning environments?
- What impact will the technology cases have on future case development?
- With the building of faculty and student capacity, how will this impact the existing cases used in the MT Program?
- With each year, how will the technology cases need to be modified to better meet the needs of student and classroom teachers?

Program-wide implementation of the inquiry-based technology cases is not the end of the process. Rather, it is a catalyst to bring about widespread
changes to current practices within the MT Program. Teacher educators and student teachers will experience additional learning opportunities through their inquiry in the technology cases to develop the capacity to create meaningful teaching and learning environments using today’s digital technologies.

**Integrating Technology Across the Curriculum: A Special Topics Seminar**

Special topics seminars are designed to provide student teachers an opportunity to broaden and intensify their understanding about a particular aspect of education in their final semester. A major requirement in the fourth semester is to complete an inquiry project that is situated in teaching practice. Two major learning outcomes guide the inquiry task. First, the inquiry project is designed to contribute to improving teaching and learning in the field. Second, it is designed to have students consolidate understandings and skills acquired throughout the MT Program. A special topics seminar, entitled “Integrating Technology Across the Curriculum,” has been offered since Winter 2000. The goal is to provide student teachers with an opportunity to “experience digitally rich, inquiry-based learning environments on campus and in their field placements” (Jacobsen et al., 2002, p. 14). The emphasis is on thinking with technology, not learning about computers. It is designed to create “a context of use within which preservice teachers learn by designing learning opportunities for real students in real classrooms” (Jacobsen et al., p. 14). By developing an electronic portfolio, completing a focused task, designing an integrated unit of study, and carrying out an inquiry project, student teachers learn in the same ways that they will be called upon to teach children. Student teachers learn through first hand experience with technology and by designing and developing new inquiry projects.

The instructors who designed and taught the special topics seminar were guided by what they knew about good professional development practices from the literature, and from their experience with the Galileo Educational Network:

- technology is best learned just-in-time, instead of just-in-case;
- planning, designing, implementing and evaluating are best done in collaboration with others;
- learning must be situated in authentic, challenging and multidisciplinary tasks;
- a culture of inquiry around technology for learning supports risk-taking and knowledge creating; and
- teachers need intentional and meaningful opportunities to reflect on professional development and growth (Jacobsen et al., 2002).

Both within and beyond the seminar, student teachers have ready access to technology-enabled learning spaces in the Doucette Library of Teaching Resources. Students access fully networked workstations and a range of software programs, and gather in workspaces to collaborate and engage in robust learning experiences within a well-equipped and fully supported technological learning environment.

The first task students complete is to read and reflect upon the ICT Program of Studies (Alberta Learning, 2000) in terms of their current knowledge, skills, and attitudes associated with technology and learning. Based on this self-inventory, students prepare a professional development and growth plan that identifies learning goals for the seminar, and publish it on their individual, web-based portfolio. "The act of designing, creating and publishing their working websites became an integral part of their thinking about the reflexive relationships among teaching, learning and technology" (Jacobsen et al., 2002, p. 23). Growth plans are used by instructors to generatively design learning experiences and opportunities in the seminar; topics and questions come directly from the students themselves. As the semester evolves, the websites are "works in progress" subject to continuous modifications and enhancements based on new knowledge and skills acquired by students. Focused tasks and integrated units of study are published on websites for peer review. The electronic portfolio evolves into a rich showcase of scholarship that reflects complex thinking about teaching and learning with technology. For the past two years, the instructors have published the student teachers' work, at their request, on a CD-ROM that serves as an archive, and also a collective portfolio of work that can be used in future teaching roles.

Based on a belief that the best way to understand the range of issues that surround technology integration is to dig in and start working on a project, the student teachers are required to complete a curriculum-based focused task designed for children. Students individually select a task that interests them from several that are designed for grade 3, 6, 9, and 11 students. Focused tasks explore topics across the curriculum such as Media Literacy, Penrose Tilings and Tessellations, Storytelling with Video, Family Treasures, and forming a Travel Agency. Collaborative groups are then formed based on shared interests, and students develop a project that pushes their thinking about technology, curriculum, and the ICT Program of Studies. An entire, three-hour seminar is dedicated to peer assessment and evaluation of
the focused tasks. Peer assessment accomplishes several goals: (a) it serves as a celebration of the meaningful, authentic and challenging student work, (b) students learn from the work of others, (c) students gain additional ideas and perspectives about what effective technology integration looks like, (d) students benefit from feedback, both as a learner and as a peer, and (e) students build interpersonal networks of shared expertise. Many students commented on how the focused task became much more than a university assignment. Instead, the work was authentically engaging, the groups developed cohesion and synergy, and they were excited and proud of their accomplishments.

A third requirement of the seminar is to design an inquiry-based, integrated unit of study that requires effective integration of technology into one or more core curricular areas (e.g., English language arts, social studies, mathematics, science, fine arts, and physical education). Groups need to collaborate in order to construct an engaging student task that operates at the highest level of the ICT program of studies. Students identify essential questions that the unit is designed to address, and construct learning tasks and evaluation rubrics. The students complete the actual tasks they designed for students, and include these examples in their electronic portfolio. The seminar groups spend an entire three-hour seminar peer-reviewing each other’s integrated units of study. Some of the Winter 2002 semester units of study were:

- Exploring Leonardo Da Vinci: The Renaissance Man
- Why Do Students Read What They Read?
- Harmonies In Physics And Music
- Special Communities: Nunavut
- Integrating Robot Design In Applied Mathematics And ICT

All 15 of the Winter 2002 semester integrated units of study were published, along with samples of student work and evaluation rubrics, on the CD-ROM that students took with them as a legacy of their work in the special topics seminar.

The inquiry project is more than a research paper—the inquiry project is rooted in classroom practice, and serves as a rich professional development opportunity. Inquiry projects are curriculum and practice oriented, and serve to bridge theory and practice. The product is a professional development legacy for the experienced classroom teacher and the student teacher, as well as a fecund learning opportunity for all learners. In the past three years, a number of students were offered enriched field opportunities as a result of the relationship between the Faculty of Education and the Galileo
Network. In the context of their inquiry projects, one-half of the student teachers were placed in schools where classroom teachers are actively questioning and exploring the role of technology in learning in conjunction with the Galileo Network. The goal is to foster closer connections between campus and classroom, and to collaborate on research into essential questions to do with technology and learning. Student teachers worked closely with innovative classroom teachers and their students to design projects, implement units of study, and to inquire into essential questions to do with teaching, learning, and technology. Student teachers shared knowledge, consulted the literature, and bridged what is known with what they were actively exploring and creating in the classroom. Questions that students in 2002 inquired into included:

- Do mindtools, such as semantic maps and hypermedia, enhance a student’s communication of understanding?
- Filters and firewalls: Safeguards or epistemological blockades?
- What can robotics teach students about technology and product design?
- Does self-directed computer-based learning enhance the understanding of elementary math?

Students presented the results of their inquiry projects in a public forum, which provided an opportunity to celebrate and share the work beyond an instructor-only audience.

The success of the special topics seminar in increasing student experience with technology, and dispositions towards its ethical use, is assessed using four key metrics. First, instructors have consistently observed a high caliber of students’ scholarship, engagement, and achievement in each of the seminar tasks (Jacobsen et al., 2002). Second, awareness of student diversity and how to collectively benefit from diverse knowledge, skills, and attitudes became a critical resource for all to draw upon. Third, the seminar focuses on pedagogical issues to support the development of fluency with teaching and learning with technology, rather than focusing exclusively on technological issues and competencies. Fourth, the use of collaborative environments that included various stakeholders (e.g., instructors, students, student teachers, and classroom teachers) demonstrated the benefits, and created new possibilities, that can be realized within technology-enabled learning environments.

Along with our enthusiasm about student success in this learning experience, a number of questions remain. For example, when student teachers take on their first classroom as a professional educator, what kinds of support do they need to integrate what they have learned in the seminar into
their teaching practices? An MT3 funded project is investigating the experience of one MT graduate as she designs learning experiences for grade five students. An area for ongoing research is to examine ways in which our graduates are infusing technology into everyday learning experiences for children, and to better understand the challenges they encounter. We want to understand what graduates have done to grow and develop beyond what they learned on campus. Do our student teachers become leaders in schools and school jurisdictions with regard to changed thinking about technology, teaching, and learning? A deeper understanding of these questions will inform ongoing and iterative development of learning opportunities provided across the MT Program.

MENTORING THE NEXT GENERATION OF TEACHERS

The three initiatives described here are different from past practices used within the MT program and differ from previous experiences people may have had with “technology as computing.” Even with thoughtful and intentional planning and ongoing evaluation of the initiatives, the Faculty of Education has not been immune to the growing pains often associated with technology integration. Based on experience implementing these initiatives, several priorities have emerged that inform ongoing efforts to develop responsive cultural attitudes and dispositions among teacher educators and student teachers about digital technologies and communications media for learning in the knowledge era: (a) challenging the perception that technology is an add-on, (b) moving initiatives beyond educational technology specialists, (c) supplying a more than adequate human and technological infrastructure to support and encourage technology integration, (d) implementing strategies that enable initiatives to become systematic and sustainable, and (e) fostering closer connections between campus and field-based technology-enhanced, inquiry-based learning environments.

The vision for and value placed on effective technology integration practices within the faculty needs to govern infrastructure decisions. Immediate and reliable access to digital media and networks is necessary for effective integration of technology into teaching and learning. However, capital acquisitions are only one part of the journey into technology integration; building a supportive and responsive human resource network has been vital for successful integration. Teacher educators and student teachers need ready access to skilled support staff who have the technical, communication, and pedagogical skills necessary to help them with their inquiry projects.
While the ongoing investment of resources in the technological infrastructure is necessary, especially as scarce resources become used more often as more people adopt technology, it is the long-term investment in supporting the human infrastructure that has had the greatest impact in the Faculty of Education over time.

Developing technological fluency requires both a pedagogical and technological shift. Often such innovative initiatives are met with some initial resistance because of the inevitable increase in workload. "The growth process by which a teacher passes from novice technology user to expert technology integrator is a transformational one" (Dias & Atkinson, 2001, p. 3). It takes additional time to conceptualize the integration of technology and to begin to work within a context of inquiry with technology. Some of our colleagues have experienced feelings of insecurity and unease as they venture into innovative technology case practices because they have had to spend extra time on instructional planning and implementation, and also because they lack fluency with technology. The Technology Coordinator and educational technology faculty make themselves available to advocate and support colleague's early efforts at technology integration. The human support systems have enabled colleagues to leverage the technological infrastructure and make pedagogical transformations. Providing "just-in-time" support so that people can develop confidence in working innovatively with technology within their teaching and learning environments has helped move all three initiatives beyond early adopter faculty members.

Sustainable technology integration over the long-term requires cross-disciplinary modeling of effective technology integration across all subject areas within a teacher education program. Good progress is being made in our move away from the "silo" effect where only educational technology specialists work with the technology. For example, after a successful day-long, hands-on digital filmmaking seminar, several cross-disciplinary faculty members chose to implement video storytelling projects with student teachers. Immediate and ongoing support enabled faculty members to feel confident implementing digital filmmaking with their student teachers. Further, MT3 Grants provide research and teaching opportunities and support for cross-disciplinary faculty to develop and implement inquiry-based technology projects with students on campus and in schools. Most MT3 Grant recipients have been noneducational technology faculty who have cultivated innovative and diverse technology projects and research programs that impact all areas of the teacher preparation program. The Faculty of Education has begun to see the widespread effects of cross-disciplinary MT3 Grant projects in increased learning opportunities and benefits for full-time faculty members, graduate students, classroom teachers, and student teachers.
Technology initiatives will only have short-term impact unless they are implemented, supported, and sustained over time. Currently, with an equal mixture of full-time, tenured faculty and sessional instructors, sustainability is an issue for the technology initiatives in the MT Program. Part-time sessional instructors often want to pursue technology initiatives. However, they may not have the necessary resources, knowledge, and skills for technology integration. A question that guides our current planning is; how might the Faculty provide ongoing professional development that builds the capacity of all teacher educators to cultivate inquiry-based, technology-enhanced learning environments for student teachers? The sustainability of technology integration efforts will rest, in part, on finding a solution to providing ongoing and responsive professional development opportunities for the majority of instructors.

A final issue that needs ongoing attention is that of finding technology enhanced field placements for all student teachers. There is well-documented mismatch between what occurs on campus and the level of technology integration that student teachers experience in the field (Grabe & Grabe, 2001; Moursund & Bielefeldt, 1999). As student teachers work in schools alongside experienced teachers, and want to implement inquiry-based, technology enhanced pedagogical practices with children, they often encounter similar barriers and resistance that hamper experienced teachers’ innovation efforts. Further, the dispositions held by some educators can foster a demotivating atmosphere about inquiry-based learning and technology integration, which may result in student teachers feeling torn between what they are learning on campus and what they observe and experience in “real” classrooms. At the local level, administrators, classroom teachers, faculty advisors, and technical personnel need to support student teachers’ efforts to integrate technology across the curriculum. The support that has been cultivated in the teacher education program needs to be extended into the student teacher’s field experiences. Some progress has been made in finding and developing enriched field placements for University of Calgary student teachers, and in providing professional development opportunities for classroom teachers in graduate programs. The Faculty of Education is committed to working closely with classroom teachers, school administrators, and school boards to continue to cultivate inquiry-based, technology enhanced learning environments for student teachers and children in order to sustain and extend its campus initiatives. MT3 Grants, targeted field placements in special topics seminar, and professional development for inservice teachers through the technology cases and graduate seminars are all steps towards the goal of fostering closer connections between campus and field. We are attempting to replicate the support network that exists at the campus level in participating schools to
provide ongoing professional development for teachers who strive to implement innovative technology integration within their classrooms.

CONCLUDING REMARKS

The initiatives described here provide a range of opportunities for teachers, student teachers, and teacher educators to experience and to create inquiry-based, technology-enhanced learning environments. Earnest attempts are being made to create authentic learning opportunities that give student teachers greater control and direction over their understanding of what matters in learning with technology. The launch of these initiatives is part of an iterative assessment and development process that requires constant monitoring and evaluation. Breuleux (2001) suggested that ICT needs be seen as an approach to:

engineering more powerful ways of achieving the learning and teaching goals. 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. (p. 5)

The goal is to improve ways in which education faculty, classroom teachers, and student teachers solve problems, make decisions, communicate, and inquire with today’s digital media and communications technology.

Change rarely happens quickly. Motivation and momentum have to be maintained over time for the changes to “take.” The faculty has only begun to realize the full benefit of these initiatives, and is committed to ongoing investment in research, sharing, and disseminating our findings to better understand and respond to the many barriers that tend to hamper this work. Rogers (1995) identified two broad activities that occur in an innovation process: initiation and implementation. In the implementation phases of the process the innovation is modified, relationships between the organization and innovation are clarified, and the routinizing of the innovation become a reality. To attain routinizing means that members of the organization no longer think of the innovation as a new idea. Rather, the innovation becomes an integral component woven into the vary fabric of teaching and learning. The Faculty of Education will continue to build on the initiatives described in this article and will continue to focus on strategies for change so that technology integration becomes a natural part of what we do rather than an innovation that needs our constant attention.
References


