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Preparing Teachers for Technology Integration: Creating a Culture of Inquiry in the Context of Use

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Experience is something you undergo, it is not an accumulation of experiences.

In September 2000, teachers in the province of Alberta, Canada, began the three-year implementation process for an Information and Communications Technology (ICT) Program of Studies (Alberta Learning, 2000) with kindergarten to grade 12 students. This innovative curriculum, demanding the effective infusion of technology for communicating, inquiring, problem-solving and decision-making in core curricula, puts Alberta at the forefront in terms of what it means for students to think and learn with the full range of digital technologies that are so much a part of today's changed—and changing—world.

Visionary educational technology researchers (diSessa, 2000; Goldman-Segall, 1998; Papert, 2000, 1980) and the experience of the Galileo Educational Network (http://www.galileo.org) paint the same picture of what thinking and learning need to look like in a knowledge era. *Mindstorms*, Seymour Papert's book written in 1980, is a call to deconstruct the existing educational system by making a space for the love of learning that hands-on and minds-on engagement brings. *Mindstorms* continues to be a headlight for the present time as schools become increasingly disconnected from the societies of which they are a part, and the digital technologies needed to build new structures become increasingly available. He claimed that every child can program, and that learning to program can affect how children learn everything else (Papert, 2000, 1980). In his latest treatise on a

new direction for innovation in education, the focus is on power as a property of ideas. Papert (2000) advocated the re-empowering of disempowered ideas in his program of idea work for educators, and idea power for children. In *Changing Minds*, diSessa (2000) demonstrated how computers can be the basis for a new literacy, a computational literacy, which changes how people think and learn. In *Points of Viewing*, Goldman-Segall (1998) portrayed the cultural interactions and changes that can occur when meaningful partnerships are formed between learners and digital media. Building upon shifts in technology from broadcast to interactive digital media, Goldman-Segall (1998) promoted the idea of schooling as the learner actively constructing instead of just an expert instructing.

We no longer live in a world in which information is scarce, and the teacher's role is to hand deliver content to children. Overwhelmed by information from a wealth of sources, students desperately need the skills to create new knowledge, not just consume the old. Problems never come neatly packaged, defined-in-advance, and amenable to the rote application of familiar strategies—except in school. As our world learned on September 11, 2001 real problems erupt unexpectedly, demanding careful and creative attention in chaotic environments that had once seemed stable and unshakable. The old certainties of a world defined by four classroom walls and impermeable boundaries have disappeared forever, replaced by global interdependencies and complex systems that require flexibility, responsiveness, and imagination.

Our society can no longer afford to think of engaged learning, nimbleness, creativity, and commitment to action as educational "frills." Multiple and conflicting perspectives are no longer problems to be fixed, ignored, or eliminated. They are the way the world works. Our human survival depends on our ability to learn new things and use ideas to solve problems in deeply ambiguous and confusing situations; and it depends on our ability to teach our children how to do this. For Canada to compete and excel in a global community, our young people need to develop the understandings, skills, and attributes that will serve them well in a knowledge era. To increase options for further advancement and educational opportunities, our teachers need to be aware of idea power (Papert, 2000), the vital importance of computational literacy (diSessa, 2000), and the cultural perspectivities (Goldman-Segall, 1998) that will serve our children well across disciplines of study, and in future citizenship.

This is a time in which it is profoundly tempting to withdraw into old certainties, to return to familiar landscapes of teaching and learning whose routines and well-worn grooves give us comfort and a sense of control and order. But the world itself holds a different lesson for us: a lesson about the importance of teaching the young to live well when the very shape of that world emerges every day in ways that are unlike anything we have ever known before.

NEW WAYS OF LEARNING DEMAND NEW WAYS OF TEACHING

Today's classrooms do not look much different than they did 20 years ago when school districts began to invest heavily in technology. While recognizing that there are pockets of genuine innovation in classrooms, schools, and universities across the province of Alberta, we feel confident in making a few generalizations about the current state of affairs in education as a whole. First, while many school and university students are using technology in their personal lives in a wide variety of ways, they are not using computers very extensively in classrooms to learn effectively in a variety of subject areas. There are a number of explanations for this state of affairs. One, computers tend to be available to students mainly in labs. This means that for many students, computing remains an event, scheduled in advance according to the convenience of a timetable. Technology is not yet seamlessly integrated as a powerful way to think and learn. Too often, instead of making possible the new ways in which people can share and exchange information in a digital commons, school networks and workstations are secure, standardized, preconfigured, and completely locked down. Two, tasks involving technology tend to involve a fairly low level of thinking and research, focusing heavily on the presentation of final products rather than on thinking differently, rigorously and effectively at every stage of a project. Third, there is a growing "digital divide" between what students actually know how to do with technology and what they are permitted to do in school. There are growing numbers of students who routinely expect their school computers to be old, connectivity to be slow, networks to be unstable, and their teachers' knowledge and confidence to be significantly less than their own.

A second general trend observed is that many classroom teachers and faculty members in teacher preparation programs lack confidence in their

own ability to think broadly with technology. Few classroom teachers use computers extensively in their own lives outside of school. Traditional models of professional development, such as workshops and courses, have not been particularly successful in helping teachers and university faculty to find ways to integrate technology into their teaching. Faculty members and classroom teachers are not comfortable with this state of affairs. They often feel bad about not knowing how to use technology for teaching and learning. They use phrases like "technopeasant," "technophobe," "resident luddite," or "stupid about computers" to describe themselves.

Related to this second trend is the third observation that many education faculty and teachers who do feel more confident about their own ability to use computers for professional tasks are often uncertain about how to use technology in their teaching. Those in academic and school leadership positions often have less experience with technology than their teachers, and are therefore not always able to provide strong leadership, or strongly informed support for required changes to enable the effective infusion of technology in their buildings. Almost by default, visions for the use of technology for teaching and learning are often created by IT specialists who are not educators. Network design and student access are often determined according to what is standard, easy to maintain and monitor, rather than according to what is educationally sound. Alberta Learning's ICT Program of Studies (2000) tends to be poorly understood by teachers in schools, and education faculty in teacher preparation programs. Many believe the program of studies focuses on teaching about computers, rather than learning with technology. Dominant curriculum models, based on fragmentation and discrete units of study (even in e-learning), tend to emphasize course delivery and information-transfer rather than knowledge creation. While there are thousands of examples of digital media objects and teacher-created units and lessons that claim a meaningful technology component, there are far fewer authentic images of the effective and imaginative infusion of technology.

Teachers and leaders in the schools and school districts often look to new teachers to shore up the gap between technology presence and use. However, the fourth observation is that the current generation of preservice teachers simply do not routinely infuse technology in their own learning and student teaching, and thus, few bring the skills and experiences that are needed to transform today's classrooms. There are several possible explanations for this state of affairs. First, information and communication technology tends to be regarded as an optional area of specialization in preservice

courses rather than as a crucial way for everyone to learn. Second, when compulsory courses are available, they tend to emphasize software applications rather than technology-infused curriculum design. Third, not enough preservice teachers are being taught in ways that demonstrate effective infusion of technology in all subject areas. There is a great deal of talk about constructivism on North American campuses, but fewer examples of how to live and learn in these ways. Fourth, issues of perceived threats to professional freedom and standardized accountability mechanisms make it difficult to insist on the widespread and effective infusion of technology-enhanced teaching practices in preservice courses. Finally, there has been no mechanism to deliberately place preservice students in technology-enhanced classrooms where experienced teachers are finding new ways of teaching and learning with technology.

The final trend that concerns us is that many good teachers are leaving the profession. There is little or no sustained support for beginning teachers to learn or consolidate new ways of teaching. There is a lack of widespread support and professional development to help existing classroom teachers make the necessary changes to classroom practices, let alone support the enthusiastic efforts of beginning teachers. Classroom teachers with a high level of technology expertise, or commitment to learning to teach in new ways with technology, frequently end up frustrated by the barriers they face in using what they know in their daily work with children—and they leave.

TEACHER PREPARATION AND TECHNOLOGY INTEGRATION

A shift in thinking is required for teacher preparation that is similar to the one needed in professional development for inservice teachers (Clifford & Friesen, 2001; Jacobsen, 2001). It is simply not good enough to teach the next generation of teachers in ways we were taught because they will live and teach children in a different age. Preservice teachers must routinely encounter the effective infusion of technology in the normal course of their learning at the university and in their practicum placements in schools. Let us be clear about this—no one of us has learned in classrooms where these powerful new tools were freely available to use. The technology is simply too new. This means that educators in school and university classrooms must figure out what to do with these new digital media, and create meaningful learning opportunities for students that they themselves have never

experienced. Learning how to teach and learn in new ways with technology requires imagination, intellect, creativity, and no small courage.

The Faculty of Education at the University of Calgary is no stranger to innovation and revolution. Teacher education programs in general are organized around an applied science model within which individual courses are framed by philosophical and theoretical content, and these in turn are followed by short-term practice teaching in schools. Beginning in 1996, the University of Calgary embarked on a course of action to discontinue its teacher education programs formed in the conventional model, and to replace them with a program in which the elements of the professional degree program are integrated, the learners are treated as professionals-in-the-making, the richness of pedagogical knowledge is acknowledged, and cooperative problem-solving is valued. The Master of Teaching Program at the University of Calgary is a two-year teacher preparation program that fosters closer links between theory and practice and more effective one-to-one communication between teacher educators, classroom teachers, student teachers and learners. The Master of Teaching (MT) program replaced discrete courses with professional, case study, and field seminars, independent studies, and extensive field experience. Students spend approximately equal amounts of time on campus and in the field from the first day in the program, and the one experience is expected to reflexively inform the other.

The campus elements of the program include case, professional, and field seminars. Much of the “academic” content of the program is carried by a series of case studies with which students must wrestle, research, take positions, and defend their perspective in well thought-out writing. Each case encompasses far more knowledge than any one student can deal with in the time given—hence the incentive for collaborative learning endeavors. Team work and collaborative inquiry and problem solving is encouraged, valued, and rewarded. Field seminars provide a forum for the exchange of ideas and experiences gleaned from the variety of educational settings in which a group of students find themselves, not to mention dealing with many of the pragmatic issues that characterize the lives of teachers and students. Professional seminars offer students an opportunity to reflect critically on themselves as teachers-in-the-making, to pursue topics and skills of particular interest, and to engage in the many debates that surround the nature of education and teaching. In its fifth year, the MT program clearly demonstrated its capability to prepare teachers who are energetic, reflective, cooperative practitioners capable of solving problems, confronting

new challenges, and taking and defending positions on complex issues. The move away from specialist courses has not been without its challenges, however, and one of the first to rear its head was how to re-examine the integration of technology. The Master of Teaching program accepts 400 students per year, which translates into approximately 800 students in progress at any one time. The MT program must address technology in education *but* it must do so within the structure of the new program.

For the past two years, the three of us have co-taught preservice teachers about the integration of technology into learning and teaching. Our planning for this special topics seminar on integrating technology across the curriculum was guided by a vision of engaged learning and educational reform (Clifford & Friesen, 2001, 1998, 1993; Jacobsen, 2001), and a commitment to address the kinds of concerns outlined at the beginning of this article. We wanted preservice teachers to experience digitally rich, inquiry-based learning environments on campus and in their field placements. Thus, technology infusion was situated within the larger context of inquiry-based learning. Our seminar was not about technology; it was about teaching and thinking with technology. We moved well beyond skills acquisition or a focus on software applications, and instead created a context of use within which preservice teachers learned by designing learning opportunities for real students in real classrooms (Figure 1). Through focused tasks, we designed opportunities for them to learn in just the ways they will be called upon to teach children (Clifford, Friesen, & Jacobsen 1998).

Figure 1. Student teacher learning robotics with children in ways she will be called upon to teach children.

In the design of our seminar on technology across the curriculum, we drew on what we know about good professional development practice: (a) technology is best learned just-in-time, instead of just-in-case, (b) planning, designing, implementing, and evaluating are best done in collaboration with others, (c) learning must be situated in authentic, challenging, and multidisciplinary tasks, (d) a culture of inquiry around technology for learning supports risk-taking and knowledge creation, and (e) teachers need intentional and meaningful opportunities to reflect on professional development and growth.

Technology Is Best Learned Just-In-Time, Not Just-In-Case

Students were able to take advantage of newly renovated, technology-enabled learning spaces in our seminar. In the first year that we taught the seminar, students had to move from the traditional "lecture" space, in which we had rows of desks facing an overhead projection of a computer screen, to two separate computer labs to work on their projects. The constraints of a lab model that we had to grapple with were similar to the computer lab model that most teachers in schools encounter.

The design of our learning environment in the second year leveraged the ubiquitous access to technology in the seminar space (i.e., 16 networked workstations) and also the larger public learning spaces (i.e., 30+ additional workstations, multimedia development suites, scanners, digital and video cameras, LCD projectors, SmartBoards, CD burners, and so on). Our students had access to more than four dozen networked computers distributed throughout the seminar and public learning spaces. All seminar rooms are equipped with Ethernet ports and traditional white boards to provide an effective blend of visualization and communication technologies. Breakout rooms provide faculty and students with secluded workspaces for open discussion and group work—an excellent complement to the Faculty of Education's philosophy of inquiry-based and collaborative learning. The fluid and ready access to technology tools, Internet access, and to each other changed the learning culture—it was easier for students to gather around a workstation or deskspace to collaborate, and to move out into public spaces as needed, rather than as a special field trip to a computer lab.

The permeable environment permitted flexible arrangements and grouping, and also provided ready access to other experts (i.e., faculty support staff).

A primary goal of the reference and technology support staff is to provide the essential support to the students and faculty as they make complex and often difficult transitions to new ways of learning, teaching, and organizing instruction.

The first assignment was two-fold: students were required (a) to read the ICT Program of Studies (Alberta Learning, 2000), reflect upon their own readiness to teach it, and to set learning goals within that context, and (b) to publish their reflections in an individual, web-based portfolio that would eventually contain all of their coursework. Each student created a personal, and personalized, web site for the purpose. For students with no experience with scripting web pages, we provided a template to scaffold their early efforts.

"Oh, Easy for Leonardo"

The requirement that students engage with the program of studies, and publish a response on a web site they had to design themselves, sent many into a tailspin (not unlike that experienced by seasoned classroom teachers and faculty members). There were tears and complaints, and many were worried about a perceived mismatch between their present ability and our expectations. These concerns are typical. When a novice first enters the culture of technology use, everything seems overwhelming. There are several ways in which we might have responded to this level of distress. From a technocentric perspective, we might have reassured students, "There, there, dears, don't worry, IT is actually very easy," and grabbed the mouse and clicked madly away (like geeks on speed). We might have told students that learning the computer part is really quite easy—just take a couple of extra courses or attend a few workshops. We could have set up some kind of detailed course manual, reminiscent of the "Easy Hobbi-Games for Little Engineers, complete with instructions" over which Dylan Thomas (1954, 1959, p. 13) sighs in *A Child's Christmas in Wales*: "O easy for Leonardo." But we didn't.

Our response was to tell students this truth. Learning and teaching with technology is hard, it can be overwhelming, and the field is always changing. The way in which preservice teachers reacted to the ICT Program of Studies and building web pages is much like the reaction of many class-

room teachers and faculty members when they grapple with how to integrate technology and the curriculum. It is also the way that experienced technology users venture into an area that is unfamiliar to them. Because the field is changing so quickly, everyone is in some sense a beginner. And everyone has exactly the same starting place—where they are, at the moment. While where you are will change with experience and the acquisition of skills and knowledge, there will always be new skills, new knowledge, and new starting places for us all.

It was also important for our students to understand that teaching and learning with technology is much more than dividing up the supposed chore of integrating technology by "teaming" with the computer teacher. We resisted the image of classes of children taking field trips to the computer lab to learn software applications that they would subsequently apply in core subject areas under the supervision of their classroom teacher. Nor, we told our students, is technology integration a matter of content teachers providing fodder for computer classes: "Here, my students will write their Hamlet essays in class, and come to your Info Pro to word process them."

What we supported instead was a robust experience of learning to think with technology within the context of a meaningful and challenging task. What the students thought about, and how they used digital tools to do that thinking became inextricably bound up together. They began at once to do authentic work with us—work that led to deepening understandings of the relationships between tools and content, design and publication as the work developed. While our students began publishing almost at once, they did not create electronic fridge magnets that pinned down thinking they had done elsewhere in handwritten journals. Nor did they word process their reflections and observations to be handed in to the teacher. Instead, publishing their coursework and reflections on a web server became a public commitment to a professional community. Thus, the act of designing, creating and publishing their working website became an integral part of their thinking about the reflexive relationships among teaching, learning and technology.

Some students had created web pages before, and set to designing their web site at once. Others worked with us to learn how use the template and how to upload their finished sites to the university server. Each time a new site went up, there were whoops and squeals and broad grins of pure delight. Students felt the special rush of seeing their own work on the Web. They

were like parents with a newborn—even though some of the initial sites were a little plain and a bit wrinkled, they were beautiful to their creators. Our students were proud of themselves, and we were delighted, too. But something quite unexpected happened with those pages throughout the course of the seminar. We were content to have those early, functional sites to house each student's work, but they, themselves, were not content to stop there. As they gained new knowledge and skills, they kept going back and redesigning their websites, and adding new pages. And each time, their sites became new and exciting all over again.

One student dissolved after our first class, certain that her complete lack of technology experience would make it impossible for her to achieve any kind of success. She ended the year not only proficient in a wide range of technology skills unimaginable to her at the start, but also confident in her own ability to design engaging inquiries for students. She joined three other students who requested placements together in a school where teachers were working on new approaches to teaching with technology. We came to call this group "The Roadies," because they wanted this particular school because it required a full hour's drive each way from the city, and they knew they would use the time to plan and talk as professionals together. One of the first things this group did was, in fact, to critique one of the focused tasks to which we had linked them online. While the presentation of this task was smooth and very entertaining, The Roadies felt that the content was shallow and the game-like structure of the simulation too easy to navigate without actually learning anything. Borrowing ideas from the task they liked, they set about to design something they felt was more worthwhile, and then they planned to roll this new version of the task into the integrated unit of study they later developed together. Knowing that they had then two solid months to create a coherent study, the set to work with a will to develop the kinds of technological fluencies that would help them enact what they imagined to be possible.

Several of our students talked about being inspired into a culture of use which is different in kind than the application focus of many preservice courses in IT. We concentrated on just-in-time, not just-in-case, instruction with technology applications.

We discovered through our own direct experience a fundamental truth we had only known in our minds: 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. If your basic assumption is that everyone needs to learn the same technology skills at the same time before they can do anything meaningful with them, then a computer lab scenario makes sense. You can have workshops, lessons, and skill-building sessions on how to manipulate a word processor, use a spreadsheet, or build a web page. However, when the teaching space itself is more fluid, new possibilities emerge. We were able to introduce meaningful, challenging, and multidisciplinary tasks that posed complex and meaningful learning problems, and enabled a host of possible solutions. In the context of these tasks, the three of us coached and guided individuals and groups of students to design creative solutions, and to acquire the skills and competencies they needed to solve their problem in the way they wanted to approach the task. The tasks were large enough that no one student could complete them by themselves. The tasks required preservice teachers to draw upon their multiple and diverse perspectives, and to share emerging expertise with the technology.

Our approach challenges notions that constructionist classrooms are loose and unstructured. The just-in-time approach was a thread that ran through everything we did. It was flexible, generative and responsive—everything we did as instructors, and everything we talked about was in response to student queries and needs. The complex and multifaceted relationships we built between and among our students and ourselves also challenges current images of good teaching as a move from "sage on the stage to guide on the side." This image, while generous in its impulse to suggest that teachers adopt a more facilitative stance, understates the actual complexity of teaching. There are times when the teacher actually does provide information and content; there are times when the teacher probes and questions student thinking. There are times for critique, for coaching, for finding outside experts when the teacher's own expertise has reached its limits. In preparing future teachers to work effectively with technology, it becomes essential to cultivate a multiplicity of competencies, scholarship, and dispositions simultaneously.

Collaborative Planning, Design, Implementation, and Evaluation

All of our approaches to using and learning technology in the seminar were in service of a task, not in service of learning technology for its own sake.

Our focused task requirement put the preservice teachers in the position of the students they were going to teach. They had to actually complete one of 11 focused tasks designed for Kindergarten to Grade-11 students. The tasks required little prior experience with technology to get started. However, because of the nature of the tasks, there was no upper limit on the sophistication of technology use that was possible. Thus, there were steep learning curves for all students no matter what their starting point. Everybody got to sweat the same, and all students experienced the value and necessity of working in teams to build on the strengths and diversity in the group.

Tasks were drawn from the draft Alberta Learning ICT Assessment Toolkit, from the World Wide Web (WWW or Web) and from teacher sources. Individuals signed up based on interest in a particular task, and then formed groups based on their shared objectives. All of the tasks were designed to be interesting and meaningful, and best, or only, doable through technology. Groups were required to create something that really stretched their thinking both about curriculum and technology. Each task immersed students in experiencing what technology is good for, and engaged them deeply with what classroom teachers often face when considering how they will integrate the ICT program of studies across the curriculum.

The best way to understand the range of issues that surround technology integration is to dig in and start working with the kinds of tasks one might actually ask a student to do. The focused task requirement provided a range of opportunities for preservice teachers to learn how to design and evaluate challenging and authentic tasks. Groups did not have to design a pretend task, or create something for pretend students from scratch. Instead, they learned about Alberta Learning curricular expectations for thinking at the communicating, inquiring, decision-making, and problem-solving level of the ICT Program of Studies (2000) by actually doing something that has been structured for real students. Our students gained first hand experience with the type of learning we were asking them to create for students. This understanding contributed to their thinking and development of an integrated unit of study.

Situating Learning in Authentic, Challenging, and Multidisciplinary Tasks

Planning for engaged student learning (North Central Regional Educational Laboratory [NCREL], 1995, 2000) and technology integration requires an

applied understanding of project, instructional, and task design. To move beyond the "add on" approach of using spreadsheets or word processing as ends in themselves, teachers need to think and plan carefully about how to infuse technology in teaching and learning. Working in small groups, students collaborated on the design and development of an integrated unit of study for authentic and meaningful integration of technology into one or more core curricular area.

Inquiry Project

A major requirement of the fourth semester in the MT Program is that students engage in an inquiry project that can be a field-oriented research project at a school or community work place site that integrates theory and practice. The stewardship of the inquiry project is located in the special topics seminar. In the course of their Inquiry Project, students engage in critical inquiry in a systematic and intentional manner, contribute to ongoing efforts to improve teaching and learning at the field site, and demonstrate the understandings and skills acquired throughout the first three semesters of the Master of Teaching program. There is an expectation that the students' work will leave a legacy in the field.

Inquiry projects were designed to immerse preservice teachers in challenging and multidisciplinary work that made a difference in the present. They were meant to be real work—not just another way of preparing them to do something in the future. Responding to a focus on robotics at one elementary school, one undergraduate student, Rachel, learned how to construct and program *Lego*® robots alongside Grade 1and 2 students and their teachers. She had never had any experience with robotics prior to her tenure at the school. Starting with the youngest children in the school—the Grade 1, Rachel gained confidence with her new found competencies and growing understanding of how to guide children in inquiries and how to form the connections with mandated core curriculum. She bought her own *Mindstorms*® kit to make robots at home to better understand the complexity of children's' tasks. The momentum in the school grew as children in other grades wanted to design, build, and program robots. Rachel seized the opportunity to work with other teachers and children as the study of robotics extended, rhizome-like into each grade. Weaving together student questions, mandated core curricula and technology, she lived what it meant

to create an engaging inquiry learning environment for students. She became part of the coaching team and worked with teachers and students right up to Grade 5. Her pedagogical leadership developed and experienced teachers depended upon Rachel's contribution, her insights, and her creative solutions. She focused her inquiry project, the major research assignment for the special topic seminar, on documenting and interpreting her experiences with young children and robotics (Figure 2).

Figure 2. Seminar instructor working with a student teacher and elementary student on robotics investigations

We cultivated genuine partnerships between students and teachers at all levels to harness our collective energy on behalf of children. For example, in the first seminar, one of our students made a difference in his school through his inquiry project. He chose to investigate networking options that would leverage the older technology in an inner city school. Frustrated by the fact that these students did not have the kind of network access that would be routinely available to middle class students in middle class neighborhoods, he ended up moving workstations around and stringing cable himself. He created a network infrastructure that increased opportunities for student learning with technology that would otherwise not have been available. His inquiry project focused on exploring issues of network design, and it also became a treatise on social justice.

Creating a Culture of Inquiry Around Technology for Learning

One of the most powerful aspects of our special topics seminar was the intentional placement of students in enriched field settings for their action research projects. About a third of the class had the opportunity to work in schools in which the Galileo Educational Network was providing onsite support to teachers to design new learning experiences for students through the effective technology infusion. In most teacher preparation programs, field placements are more generic: students are matched to schools and partner teachers mainly according to grade and subject specialty. This "shotgun" approach to field placements builds on two notions. One is that the main goal of field placements is to make sure the numbers work out, given certain broad category matches. It assumes that, essentially, schools and classrooms are convenient catchments in which preservice teachers can "practice." Second, many teacher associations fight targeted placements on the grounds that all teachers are equally excellent in exactly the same ways. From such a viewpoint, targeted placements may smack of elitism. That, of course, is not at all our experience. We did not target "good" or "better" schools and teachers. Instead, we asked ourselves this: "What energies can we leverage if we place preservice teachers committed to developing their ability to infuse technology into teaching and learning with experienced teachers who are also intentionally pursuing their own professional growth in this area?" With only three and one half months with the students we knew that we could maximize the impact of their oncampus work by deliberately seeking out field placements where the infusion of technology was also a priority.

Reflection on Professional Development and Growth

It is an Alberta Learning requirement that all certified Alberta teachers complete an annual professional growth plan. The teacher's plan must include goals, strategies, and evaluation. It is reviewed twice a year by either the principal or a designated review body made up of the teacher's colleagues and peers. Teachers are expected to consider the Teacher Quality Standard (Alberta Learning, 1996), their school division's goals and plans, and their own school's improvement plan when developing their professional growth plans. While plans of such detail were not appropriate in a special topics seminar, we did reinforce the experience of our students

throughout the whole MT program: the importance of cultivating reflective habits of mind about professional practice. To that end, our students prepared a professional growth plan throughout the seminar that included three self-assessments. They published these as part of their web-based, electronic portfolio.

WHY DID THIS SEMINAR WORK?

First, how do we know it worked? The most significant indicator is the high caliber of the students' scholarship. The quality of their work, their thinking, and their reflection was exemplary. Each student was able to meet seminar requirements for curriculum design, planning and carrying out substantive inquiry, reflection on professional growth, and the acquisition of technology skills. Students asked us to burn a CD ROM of all the units of study they created, and the focused tasks on which they had worked. As we did this, we were struck once again by how much they had learned. From our perspectives both in staff development and in teaching in the graduate program at the University of Calgary, we have no hesitation in saying that each of our students left the class better prepared to infuse technology in their own classrooms than many experienced teachers. Many tackled inquiry projects at a level of complexity that approached performance expectations for graduate work.

Building on Diversity

We believe the exceptional degree of student success and engagement was an outcome of deliberate design and instructional decisions that were influenced by our knowledge of the current state of affairs in schools and on campus. First, the space in the seminar was open enough for all students to define a place for themselves. We designed the course so that it required a wide range and diversity of projects. From the first day, our students learned that it did not matter what grade or subject they were preparing to teach. We were not concerned about whether or not they had extensive experience with technology. It was all right to prefer different platforms, different software, and alternative approaches to tasks than the ones we suggested. That is, we structured the situation we wanted them to create for

their own students. They came to see that their diversity was not a problem to be overcome, but an essential resource on which we all could draw.

Pedagogical Focus

Second, all aspects of the seminar were centered on pedagogical issues rather than technology issues. There are two apparently contradictory consequences of a strong initial focus on technology skills acquisition in the common kinds of workshops and courses designed for experienced and preservice teachers new to technology. The first is that participants often seize on one or two of the applications they first learn to use, assuming that now the job of integrating technology is taken care of. This enthusiasm is apparent in how often teachers introduced to planning a technology enriched experience for students start with statements like this, "I was thinking of letting kids do *PowerPoint*™ reports on their animal…" Jamie McKenzie (2000) uses the felicitous phrase "Power Pointlessness" to describe the careless adoption of an otherwise effective presentation tool as if it were the be-all and end-all of technology use in the classroom.

The second consequence of an initial focus on skills acquisition is that such a focus feeds the growing sense of panic that sets in when many of us squarely face a harsh, but often unspoken reality about technology: no mere mortal can keep up with the innovations. No one in a classroom is going to win the race against new hardware, new applications, and new capabilities. There is always a new version, a new digital device or a new idea coming down the pike. Another unspoken, but harsh reality of teaching is the deep and pervasive assumption that somehow, as a teacher, I always have to know more than my students. I have to be at least one chapter ahead in the textbook, and I have to know how to use a software application myself before I teach it to students. Considering the range of applications now available to students and teachers, and the rate at which new versions are introduced, it is easy to feel overwhelmed even by finding a starting place.

When preservice students can be convinced to give up the idea that they need to know this application, and this application, and this application, and accept that they will never know everything about every piece of software, they undergo a transformation. Many feel suddenly liberated. They feel a burden lifted when we say to them,

> Look, there is no way that you will ever be faster, more fluent, more knowledgeable about what's out there as technology tools than all of your students. And you know what—that's okay. It actually gives you a whole lot of room to get things happening. There are some things that the kids will always do better than you. Let them. And there are important things that they need to be taught. Your job as a teacher is to design and support the learning experiences. They don't know how to do that. You have to figure out what these applications are good for. The kids will figure out how to drive them.

Sometimes technology intimidates experienced and preservice teachers and university faculty. It makes us feel stupid, inept, and somehow at the mercy of forces we do not understand and cannot control. Teachers sometimes ask us, "If I start letting the kids use all this technology, what's happened to my role as a teacher?" Of course, what they are really asking is what will happen to me? Do I still have anything of value to offer? Ironically, in our special topics seminar, identified as focusing on technology integration, we were able both to raise and to address this very real and important concern. Confident technology users ourselves, we know that deep understandings of the character of inquiry-based learning and knowledge construction have never been more important than they are in digitally rich environments (Clifford & Friesen, 2001; Jacobsen & Goldman, 2001). It is entirely possible to do foolish things with powerful tools just because they are there. Our challenge was to help our preservice teachers develop fluency with teaching and learning with technology, not just with technology, itself. In one of those lovely little moments that open up whole worlds to them, one of our students wrote to us about her experience of reading the Foundations level of the ICT program of studies, and of hearing us talk about teaching and learning as the primary focus of the course. "I thought," she told us, "that only people who were against technology ever raised questions about ethics and values and what is worth doing. I was amazed to find it in the curriculum, and to hear the three of you say critical things, too."

As our students become aware of the possibilities of both using and not using technology in their teaching, they developed a sense of their own agency, their own ability to make their ideas happen. In exactly the sense in which John Dewey once imagined a curriculum in which students built things, they set about creating pieces to which they were committed, not because they were technology tasks, but because they offered real possibilities for children and youth to learn important things about the subjects our

students were learning to teach. Encouraged to imagine possibilities, they developed a level of comfort with saying, “I don’t know how it can be done, but I know it can be done, and I am going to find out how.” They sought out help from the three of us, from the faculty of education support staff, from experts made available to them through the Galileo Educational Network. Husbands, wives, and roommates were drawn into their circle of mentors.

It was hard work. For most, there was a huge learning curve, coupled with a determination to dig in and learn what was needed in service of important ideas. That is, the culture of inquiry we talked about creating in classrooms became a living part of the seminar, itself.

Team Teaching

We, ourselves, worked collaboratively with one another and with the support staff who were available to assist our students. The course was enacted through the genuine collaboration that was required to get complex things done. We depended on our own collaborative efforts, and we valued and encouraged opportunities for students to access one another’s expertise. This collaboration extended to the field placements, and the students contributed to, and benefited from, the diversity among teaching staff as well. In a world in which we know we must prepare students to work effectively in teams both to define and to solve problems in ambiguous situations, teacher isolation is a terrible problem.

The culture of schooling makes it very difficult for teachers to form strong work teams. As part of helping preservice teachers both experience and understand the power of collegial support, we forced our students to become interdependent; “force” being both an extremely strong and a particularly accurate word. There was no way that any student could meet the demands of the course alone. They sought out one another, and they had to negotiate all the ordinary troubles of working together as part of their learning. We also made conversations about “grouping” part of the discourse of the class. Many were surprised, for example, that we required them to choose a focused task based on interest. We suggested that groups larger than four sometimes became unmanageable, but did not require them to have any specific number in the group. We didn’t force all groups to be

equal in size. We didn't try to sort them out by ability, nor did we say anything about working or not working with friends. When it turned out that no one signed up to do one of the tasks we had designed, we did not break up other groups to cover it. Nor did we get upset when 10 groups wanted to do the Travel Agent task. As they experienced intentional pedagogy around grouping to accomplish a task, they had new questions to ask about how this would work out with children.

What Are We Thinking About Doing Differently Next Time?

Ironically, given all that we have said about the intentional focus on pedagogy rather than the technology itself, one of the first worrisome things we discussed about the tasks and units that students created was how few of them build spreadsheets and data bases into their work. It is not that we wanted to be able to "check off" these applications from some sort of preformed list of to-do's and content to cover. Rather, we realized how little experience most of us have with the kinds of thinking that these tools make possible.

Spreadsheets are a standard feature of any integrated software package, and have been for decades, but they are shockingly underused in classrooms. They are good for exploring relationships between variables and properties, forecasting, reckoning probabilities, and sharing data online (Clifford & Friesen, 2001). There is a world of powerful information readily available to students in both the physical and social sciences. A pedagogical use of spreadsheets would allow students to concentrate on analysis and interpretation—that is, on real thinking—rather than on performing repetitive calculations, setting up tables or making charts. Thinking with data rather than simply practicing the use of the software application lets students try out strategies, revise hypotheses and ask and receive instant feedback to the powerful question, "What if?"

Databases are good for helping students to organize and search for all sorts of information: text, pictures, sounds, videos, and references to other sources that contain more information (Clifford & Friesen, in press). Databases allow students to create knowledge by working with information, not just memorizing it. Using databases, they can look for commonalities and differences among groups or classes of things, analyze relationships,

identify and interpret trends and patterns, test and refine hypotheses, and organize and share information. For databases to be really powerful intellectual tools, students need to be involved in every aspect of their construction. They need to debate and determine the categories, or fields, decide what data will count, and collect information effectively to populate the categories. All of this involves coming to terms with fundamental structures and ideas in the topic or discipline they are studying.

We think it is important for preservice teachers to know about and experience first hand, the power of spreadsheets and databases. Thus, we need to think some more about how to introduce preservice teachers to the use of spreadsheets and databases as thinking tools, and not just "how to's" about setting them up. Can we design a meaningful requirement so our students *need* to use these tools, perhaps in the way that we established the requirement that they design, construct, and upload an e-portfolio to get all the work of the course done?

We decry workshops as a starting point for teachers and faculty members when they begin to think about infusing technology throughout their curriculum. That is not to say, however, that we think workshops per se are unhelpful. We offered structured instruction on "how to" use specific tools throughout the course. Once students knew that they needed specific tools, they had a real need to learn how to get started with them, or how to locate and use advanced features. Our students found these sessions helpful, and wanted more. Scheduling appropriate and timely workshops amidst all the other activity of the seminar is a real challenge, one that we want to meet even more effectively in the future. We know that the solution to this problem will lie in becoming a more effective team with faculty support services.

Another priority will be to secure technologically-enabled field placements for all preservice teachers in the special topics seminar, and ultimately, for all 800 students in the teacher preparation program. Experienced teachers are looking towards new graduates for competency and leadership in the area of technology integration. However, there is a disturbing disconnect between the inquiry-based approach that preservice teachers are beginning to learn with on campus, and what they often encounter in schools. In their preservice program, new teachers have to be learning in enabled environments on campus and in the schools. They need to be placed with classroom teachers who are themselves being supported in making the often difficult

changes to conventional practice that technology demands and requires. Deliberate and considered attention to how preservice and classroom teachers are matched will require that universities, schools, and professional developers work more closely than they have in the past.

Finally, we will search for additional ways to showcase the range and quality of student work. In our first run at the seminar, we made student projects available online through their portfolios, but we did not encourage or require everyone in the class to engage with their peers' work. The second time, we built peer assessment into each task, so there was a significant amount of class time available to see and respond to each other's work, and to talk about strengths and weaknesses. Encouraged by the class, we produced a CD ROM for students to purchase at the end of the course. Each student gave us permission to include parts or all of their work. Anyone who then wished a permanent record of what they had accomplished could carry away ideas and examples of good work. We have shared this class portfolio with others interested in issues of teacher preparation, and the results are always the same: people are astounded at how much can be accomplished in a very short time. We think others outside the immediate circle of interest in technology also need to see what teaching and learning with technology can look like. We will encourage more of our students to frame their inquiry projects with a view to possible publication, and we will consider how we can use some of the technology tools available to us to share their work more widely.

CONCLUSIONS

A deep commitment to the principles that pervade the entire Masters of Teaching program at the University of Calgary guided the creation of our special topics learning environment. We opened spaces in which preservice teachers used ICT fluently for personal productivity in the creation and maintenance of professional documents. Preservice teachers developed an understanding of Alberta Learning's (2000) ICT Program of Studies, and discussed the implications for learning and teaching in their discipline/grade level and for their own professional growth plans. Students were articulate in describing the ways that technology had influenced their own learning and in describing the ways they had seen technology play a role in others' teaching and learning. In groups, and as individuals, students wrote, communicated, made decisions, and conducted inquiry smoothly and effectively using technological aids if and when these technologies contrib-

uted to those processes. Students intelligently questioned uses of ICT and were appropriately skeptical about naive enthusiasms and overly simple "solutions." In the context of focused tasks and integrated units of study that they created, students discussed the strengths and weaknesses of ICT in a wide range of applications. They moved beyond being mere proponents of ICT usage, or already-hardened skeptics, and became thoughtful professionals who choose tools appropriate for the tasks they needed to accomplish. Students developed an informed personal position on ICT use in education and articulated and defended that position with each other.

In the school placements, preservice teachers encouraged their students both to actively question the place of ICT in their learning and to make responsible use of ICT in their own work. They developed an understanding of technology and its uses in learning and teaching that supports the pedagogic responsibility to foster students' development of understanding and meaningful learning. In the context of their own creative work, preservice students understood and developed ethical dispositions and practices in relation to the uses of technology in the classroom, and to encourage the uses of technology in ethical and pedagogically sound ways. They developed a capacity for critical inquiry and became ongoing learners in the applications of technology in learning and teaching, essential dispositions given the rapid pace at which information technologies are transforming our world.

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