Coming To Teaching in the 21st Century: A Research Study Conducted by The Galileo Educational Network

Executive Summary

Purpose and Scope of the Report

Preparing teachers today requires critical examination of what it means to teach and learn in increasingly networked, technology-rich classrooms. Most young people entering teacher preparation courses in Alberta have not, themselves, experienced such classrooms.   The research literature concerning pre-service education that equips teachers to teach and learn with technology is clear: university faculty and the experienced teachers who accept students in practicum placements are only starting to come to grips with the changes to education required to engage students in technology-rich learning environments.

The vision of the Alberta Information and Communications Technology (ICT) Program of Studies extends far beyond the acquisition of computer skills and competencies. It emphasizes technology as a "way of doing things" – the processes, tools and techniques that alter human activity. It is a curriculum embedded within all core curricula, and it emphasizes learning *with* technology, as distinct from learning *about* technology. As such, it has the capacity to transform learning environments in ways that are difficult for most educators to imagine.

While the Alberta ICT Program of Studies rest on a multifaceted vision of the role of ICTs in society and in teaching and in learning, the translation of this vision into the reality of university and K-12 classrooms is a far more complex undertaking than the simple issue of how to train pre-service teachers and university faculty in the use of computer applications. At the moment, most faculty and most experienced teachers in Alberta (that is, the ones who would conventionally provide models of exemplary teaching for practicum students) are, themselves, only beginning to learn how to think and work in new ways with technology, and to consider pedagogical, social and ethical issues in their planning and teaching.

Finding ways to bring educators' attention to the implications of digital technologies for learning and to bring those technologies into classrooms in increasingly meaningful, effective, innovative and socially just ways is one of the tasks of teacher education programs. The purpose of this report is to analyze five innovative and effective courses in Alberta's teacher preparation programs in order to understand more about how we might better educate today's teachers for tomorrow.

Design of the Study

Two factors form the research context for this study —practicum opportunities to integrate ICT effectively, and pedagogical integration of ICT during pre-service education.   In particular, the study address a major gap identified in the research literature: what is being done differently in programs and in field placements that better prepares pre-service teachers to teach in the 21st century?

The Deans of faculties of education in each of the degree granting institutions in Alberta—the University of Lethbridge, University of Calgary, University of Alberta, King's University College and Concordia University College of Alberta—nominated sites and/or environments in which they

felt emerging practices in teacher preparation would yield insight into innovations that were particularly effective in preparing and supporting pre-service teachers to use technology for teaching and learning within the framework for ICT established by the Alberta Program of Studies. These sites and/or environments included university courses and experiences as well as field placements.

The objectives of the study were to:

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

This study was not designed to evaluate programs or participants, or to describe the full range of existing ICT courses on any campus, or to determine how well Alberta teachers are being prepared to teach and learn with technology. The point of interest in this research is to understand underlying issues that universities are grappling with in courses or approaches they, themselves, identify as innovative or as emerging practices.

Videotaping

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

Findings

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

The magnitude of the change in teacher thinking required for effective technology integration is enormous. The shift from industrial age practices of knowledge transmission to more constructivist understandings of the ways in which learners build understanding through active engagement with ideas, materials and one another is paradigmatic in scope, calling into question many of the most familiar routines and practices of teacher-centered classrooms. As well-documented as this research finding is in the literature, and as clearly as many of the innovators we interviewed saw the issue, there remained a huge disconnect between this kind of thinking and the teaching practices in many of the practicum classrooms in which pre-service teachers worked.

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

Students are arriving in faculties of education with increasing fluency and confidence with technology in their personal and professional lives. They are also arriving with many years experience of schooling and with little experience of how to think about the role of technology in

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the classrooms of today, and the classrooms one might envision for the future. These pre-service teachers are clear about how much they value the opportunities that courses such as the ones we studied afforded them to learn how to think like teachers. Even the most technologically fluent spoke about what they needed to learn in order to teach effectively with the technology they knew how to use. It is clear that the arrival of N-Generation teachers will not automatically translate into effective teaching. It will continue to be the job of teacher preparation programs to help students do this.

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

Because few beginning teachers have actually experienced the kinds of learning environments that they are increasingly being called upon to create for their students, on campus courses must provide a range of opportunities for students to learn in new ways and to understand the principles that lie behind such changes. In the absence of significant changes to the learning experience of student teachers, they are likely to teach in the ways that they have conventionally been taught—and this poses a problem for an entire generation of teachers facing challenges that are new to the profession. When we consider that computers have been a fact of life in schools for two decades, and that the meaningful integration of technology in core curricula is still a goal rather than a reality, we can gain some sense of the importance of interrupting this chain. Student teachers interviewed in this study gained a variety of insights into what it is like to learn in new ways with technology.

4. Well-constructed digital environments provide engaging and meaningful interaction for students

One of the surprising and delightful findings of this report is that several of the universities have found different ways to engage students in digital and online environments that support, extend and sometimes even replace conventional approaches to teacher preparation. The three innovations described in the report approached the integration of digital environments for learning in very different ways—and each was successful in bringing very new elements into play for their students. This finding holds real promise in addressing many of the problems with teacher preparation and technology in solid, practical and achievable ways.

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

Here, it is apparent that universities and school districts must find better opportunities for student teachers to experience technology-enabled practicum placements. With the exception of the innovations which were deliberately designed to create new relationships with the field, student teachers reported a generally dismal picture of their attempts to integrate technology in their student teaching. This finding raises real concerns in terms of the quality of student teaching experiences afforded many pre-service teachers, and it confirms findings from the literature that effective technology integration remains problematic in many classrooms.

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

The problem identified in Finding 5 is in large measure, directly related to the need for better professional development experiences for teachers, and for the intentional harmonization of pre-service, in-service and even graduate studies. When teachers are well supported as learners, they can be more supportive of student teachers' efforts to integrate technology effectively. Moreover, the progress made by pre-service teachers in their course work can become part of the entire professional development picture in schools in which pre-service teachers are brought

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into a community of practice that includes technology integration in its efforts to improve teaching and learning.

7. Technology, infrastructure and support still present considerable challenges on campus and in schools.

It would appear that Alberta universities are generally better equipped than the literature suggests is the case in many places. Students had few problems accessing computers when they needed them to complete the course work identified in this study. Some universities have already begun to consider what we would call "the next generation" of thinking about access: increasing mobility that permits pervasive use of digital devices of all kinds on an as-needs basis. This movement presents itself as mainly a technical issue, but as the report makes clear, current thinking about distributed technologies and the move to increasingly pervasive ones is rooted in very important issues of teaching and learning.

Of more immediate concern were student teachers' comments about how difficult it was to access and use technology in schools. They found computers still to be old, to be confined to labs that made daily access impossible or to be locked down by district policies that permitted only a narrow range of possibilities for use. As this report indicates, the context of Alberta's investment in SuperNet makes it important to address the broad issue of how students get to use computers in classrooms very important.

8. Innovation is often a lonely road.

Finally, findings from this report confirm the research literature that innovation in teacher preparation is challenging, and is often accompanied by a sense of isolation from colleagues that makes the work difficult. This finding suggests the importance of creating structures that support Alberta's innovators so that their energy may fruitfully be devoted to exploring better ways to prepare teachers to use technology. Such fruitful exploration should encompass deepened relationships between technology and curriculum and opportunites to collaborate on cross-campus research initiatives

Recommendations

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

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

The Alberta ICT Program of Studies mandates the meaningful integration of technology in core curricula. Students we interviewed did not regularly encounter such integration in their university course work. Increasingly sophisticated technologies pervade every aspect of our society. Knowledge is created and communicated through technology in every discipline, and in every

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aspect of the way the world does its work. Thus, it is imperative that systematic attention be directed to the preparation of teachers who are not only competent users of technology, but who also know how to take a discerning stance toward technology, and who are able to compose and create in the media of their times.

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

Implications for universities

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

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

1(c)   In order to do this, universities may need to give priority to hiring or developing existing interests and abilities among current faculty in curriculum, foundations, leadership, policy and other areas to adopt leadership roles that bring a broader range of questions and issues regarding technology integration firmly to the fore in helpful ways.

1(d)   Attention to the professional development needs of faculty to teach with technology must move beyond support for the acquisition of technical literacies. As this study indicates, issues of technology integration are primarily pedagogical, not technical ones. Each campus should develop a core of faculty who take the lead in identifying professional development needs for faculty within this recommended context. While this work will certainly include technology specialists, it cannot be relegated to them, nor should it necessarily be led by them.

Implications for Government

1(e)   A potential new action identified in the Learning and Technology Policy Framework (2004) is to facilitate collaboration among teacher preparation programs to share models of best practice. We recommend that such collaboration also extend beyond sharing of current best practice. One way of doing this is to identify thought leaders in technology integration and to sponsor province-wide working groups of such thought

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leaders to explore ways in which technology integration can become the meaningful and intentional business of all teacher educators. These thought leaders should be drawn from such areas as curriculum theory, methods, educational philosophy, educational policy, leadership, literacy and professional development. They should also included teachers and thought leaders from other environments chosen for their demonstrated expertise and commitment to new ways of thinking and working.

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

2. Continued province-wide design research

Context

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

It is helpful here to distinguish design research from more conventional approaches to research. Design research is not defined by its methodology. Instead, it is defined by its central purpose: creating sustained innovation. Within this framework, several critical aspects emerge. First, the people designing the innovation (in this case, practitioners involved in each campus innovation) remain an integral part of the whole research process. Second, it is inherently interventionist. Such research is intended to make things happen. This is significantly different from research that demands researchers maintain a distance from the educational processes of interest. In design research, conventional boundaries between actor and observer blur significantly—and they blur in a principled way. Because it is designed to address a problem or a perceived shortcoming in existing situations:

> design research requires a community of practice in which people both believe in what they are doing and pay close attention to negative results. This is in contrast to many educational communities that vigorously reject any negative evidence or criticism of their favoured approach (Bereiter, 2002).

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

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

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

Implications for the universities

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

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

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

Implications for government

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

2(e) Design research of the kind envisioned here should be supported by targeted grants that specifically require
- Practical, on-the-ground changes to teacher preparation and practicum experiences;
- Collaboration among university-based researchers;
- Collaboration with pre-service teachers, experienced teachers, and others;
- Prototyping structures, with clear feedback loops throughout the process of designing, implementing and modifying the innovations as they develop.

3. **The existing disconnect between campus and practicum experiences with technology integration must be addressed.**

Context

The existing practicum element of teacher preparation programs worked very effectively when it could be assumed that experienced teachers had mastered familiar classroom skills that student teachers could adopt through modeling. Technology integration places teachers in the role of learners, which significantly changes their role in working with student teachers. It is clear that an

inquiry stance to technology integration is required by everyone: pre-service teachers, experienced teachers, faculty and professional development providers.

This report suggests some key principles that could begin at once to address the disconnect between campus and practicum experiences with technology. See *Finding 6* for a fuller description of those possibilities. Design research should be directed to identifying what elements of increasingly intentional placement of student teachers in classrooms might entail. Recommendations specific to the professional development issues related to this finding may be found in *Recommendation #4: Teacher education must include commitment to the professional development of experienced teachers.*

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

Implications for government

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

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

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

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

Implications for universities

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

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

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

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

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

Implications for schools and school districts

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

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

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

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

Context

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

have access to computers, do not feel they have time to integrate technology, or do not support its use by their student teachers.

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

Implications for government

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

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

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

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

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

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Implications for universities

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

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

Implications for schools and school districts

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

4(g) Changes to standardized testing practices will require that schools and teachers be well prepared to meet new requirements.

5. Robust, innovative and effective digital environments should be developed and incorporated into a wide variety of campus and practicum experiences.

Context

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

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

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

Implications for government

5(a) Alberta Learning could take the lead in supporting province-wide design research that creates a range of online resources and examples that will assist schools and school districts in the development of intentionally designed learning environments. These could include: building on the approach of the social studies Virtual Field Trip; digital cases that permit the exploration of key areas of technology integration; new approaches to online

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courses that are increasingly interactive, and that build in meta teaching, coaching and critical analysis; using open source to design innovative, collaborative working spaces; online working environments that mentor teachers and students through all aspects of designing and implementing technology-enhanced inquiries; etc. That is, the range of approaches should be wide. Participants in this design research initiative should be supported to bring their own experience, expertise and interests to the table in collaborative efforts to develop a rich suite of resources for faculty, pre-service and experienced teachers across the province.

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

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

Implications for universities

5(d) The creation of rich resources for intentionally designed learning spaces will require close collaboration between educational technology experts and curriculum and instruction experts, with issues of curriculum and pedagogy driving the design of new spaces and resources.

5(e) People who are intimately involved in the creation of such resources feel a great sense of commitment to their use. It is equally important that all faculty come to see these resources as intriguing, useful and effective, and be involved in their design, development and evaluation. This is a significant professional development matter for each campus.

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

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

Implications for schools and school districts

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

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

5(i) District network, security and technology policies must be flexible and robust enough to permit students and teachers to work creatively and effectively in collaborative online spaces. School districts should be able to demonstrate the ways in which network design,

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security and other policy issues increase rather than stifle the efforts of educators to move to increasingly mobile and ubiquitous learning environments.

6. Revise Interim Certification Guidelines

Context

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

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

While the revision of existing KSAs requires an attention to specific detail that is beyond the scope of this study, it is recommended that the revisions address such areas as students' ability to
- Use digital technologies in a variety of ways for the management of their own learning and teaching responsibilities throughout their university program;
- Plan for instruction that includes the integration of technology in a variety of meaningful and creative ways at every stage of an inquiry or unit of study;
- Work in blended face-to-face and online environments;
- Interpret and critique the role of technology in the areas in which they are learning, and for which they preparing to teach;
- Assess learning in digital environments in appropriate ways.

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

Implications for Government

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

6(b) Monitoring demonstrations of preparedness to teach in new ways with technology can be regarded as both accountability and as professional development initiatives. As new images of what it means to teach in more sophisticated ways with technology emerge, the knowledge base of educators in the province can be broadened and deepened

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significantly. Meanwhile, the seriousness of government intent to deepen and broaden the experience of pre-service teachers can be established in its commitment to update its guidelines in significant ways

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

Implications for the Universities

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

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

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

Implications for Schools

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

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

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