Using Technology to Support Real Learning First in Alberta Schools

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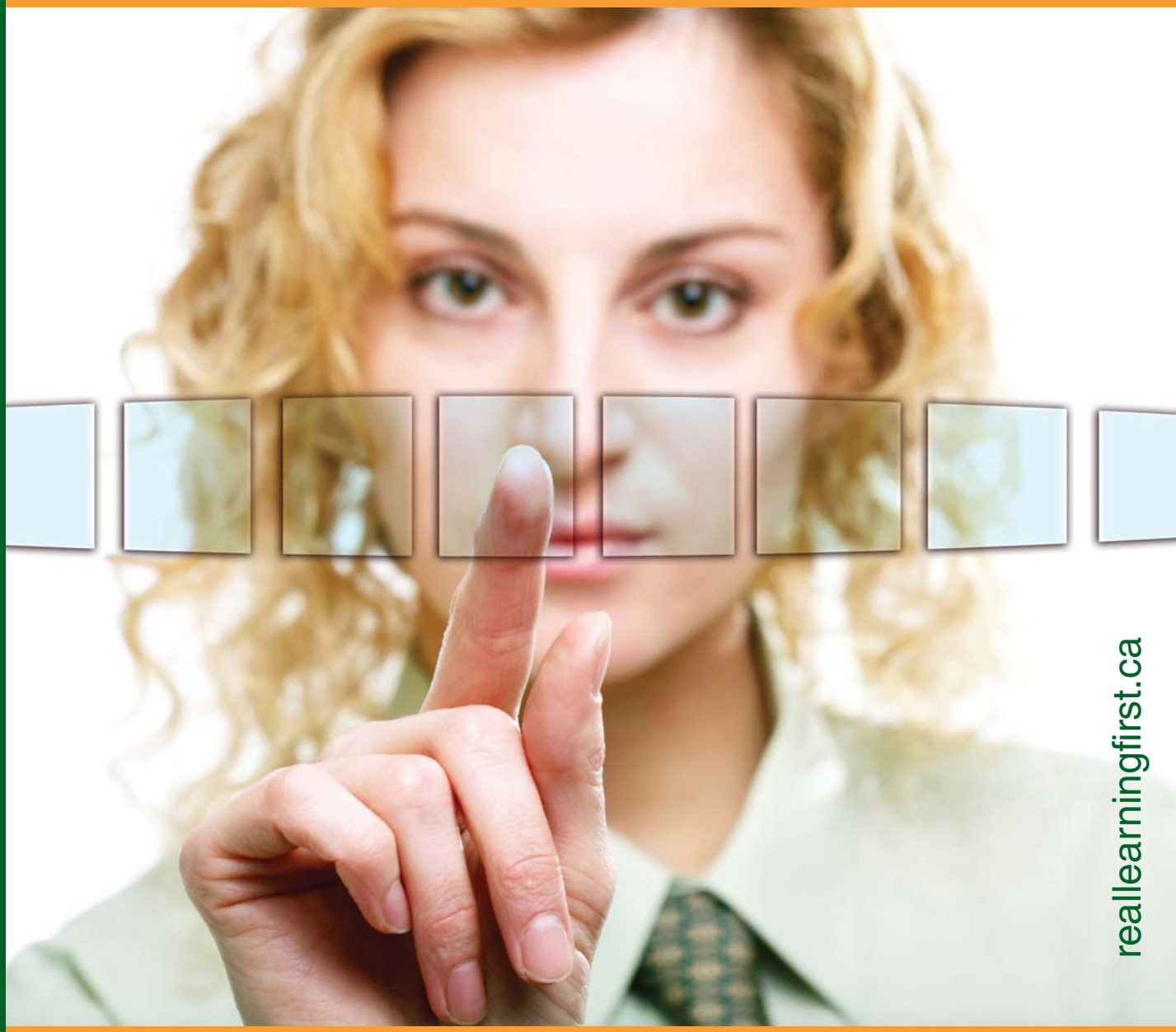

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Preface

The explosive growth in digital technologies during the last three decades has profoundly affected virtually every facet of modern life, from our interpersonal relationships to our work lives to the way in which we access goods and services. Nowhere has the application of technology raised more controversy than in the realm of K to 12 education. At one extreme, enthusiasts have promoted technology as a magic bullet that will transform the delivery of education and give students access to a range of information—whether in the form of text, video, images or audio—that would have been unimaginable even a few years earlier. At the opposite extreme are those who argue that no technology, however sophisticated, can ever play more than a minor role in the teaching–learning process. True learning, these critics maintain, has almost nothing to do with the acquisition of information and nearly everything to do with establishing connections between ideas and concepts. Such higher-order thinking skills, they argue, can be instilled only through the kind of ongoing teacher–student interaction that has always been the mainstay of the traditional classroom.

In this monograph, J-C Couture, an executive staff officer with the Alberta Teachers' Association, and Stephen Murgatroyd, a consultant with Innovation Expedition, contend that we need to step back from this debate for a moment and focus on a much more basic question, namely, how will pedagogical practices and the curriculum need to change in order to truly prepare students to participate meaningfully in the knowledge-based and globally interconnected world of the 21st century? Only when we have fully answered that question, the authors maintain, should we begin contemplating the role that technology might play in facilitating and optimizing student learning. To do anything else is to put the tools before the learning.

The monograph is timely for several reasons. First, it complements the Association's Real Learning First initiative by arguing that efforts to integrate technology into the classroom must begin by rethinking the nature of the teaching–learning process itself to ensure that it meets the needs of today's learners. Using technology simply to reinforce traditional teaching practices, the authors argue, is inefficient and unlikely to improve student learning. Second, the monograph addresses many of the issues concerning the future of learning that have been raised in the Alberta education minister's "Inspiring Education: A Dialogue with Albertans" initiative. Third, the monograph coincides with the release of Alberta Education's 2010–13 business plan, which identifies technology integration as one of the significant opportunities and challenges facing the ministry.

It is my hope that this monograph will serve to stimulate debate on the true nature of learning in the 21st century and on the role that technology can play in transforming the teaching and learning process so that it optimizes student learning.

Finally, I would like to thank Executive Staff Officer Philip McRae and Administrative Officer Harlan James for helping to prepare this document for publication.

Gordon R Thomas
Executive Secretary

Executive Summary

Changes in technology tend to bring about social, cultural and even political changes as people begin to take advantage of the opportunities afforded by the new technology and to mitigate against any negative impact that it might inadvertently produce. Like virtually all areas of human endeavour, education has been profoundly affected by the technologies that have emerged during the last 30 years. This paper documents both the successes and the failures that have accompanied Alberta Education's efforts, over the last three decades, to infuse technology into the K–12 classroom.

Since the early 1980s, the Government of Alberta, school districts and individual schools have invested more than $1.5 billion in information and communications technology (ICT). The preponderance of this funding has been used to acquire hardware and software and to keep it up to date. Spending on professional development and collaborative inquiry to help educators take advantage of these technologies has been paltry by comparison. Even less time and money have been spent on making the kind of deep cultural changes at the jurisdiction and school levels that are necessary to implement technology in a way that truly enhances student learning.

What is the legacy of these policy changes and how effective have they been in transforming the teaching and learning process? Do schools have the ICT required to equip today's students with the skills they will need to fulfill their career ambitions? What should happen next in terms of investing in ICT and developing a strategy for infusing ICT into Alberta schools?

During the last three decades, Alberta Education has employed at least four arguments to justify its ongoing investment in ICT in Alberta schools:

- ICT makes education more efficient.
- ICT helps students to build a sense of community and connect to the world.
- ICT is needed to engage the interest of the so-called digital generation.
- ICT is essential to equip students to function in the knowledge age of the 21st century.

All four arguments imply that the education system must change. However, each argument is based on a different set of values and, as a result, the kind of change that would result by pursuing any one approach to its logical conclusion is quite different. Each ideology is highly politicized and not necessarily consistent with the others. Alberta Education has tended to embrace a combination of these ideologies at the same time and, as a result, its ICT strategies lack coherence. The situation is compounded by the fact that the Alberta government has never developed a long-term, sustained approach to education funding, depending, instead, on the vagaries of oil and gas revenues and other primary resources. Alberta Education's efforts to undertake innovative technology projects at the school level are also often undermined by a concomitant tendency to want to impose system-level

"Technology itself is not a destiny but a scene of struggle."

—Feenberg 2002, 15

policy directives. Implementing ICT projects in schools and adapting the curriculum to take advantage of new technologies require a long-term investment of both time and money.

Society needs to look at the ethical, physiological and social costs associated with digital connectivity. These costs vary with the age, gender and socioeconomic status of the young people involved. An emerging body of research, for example, suggests that gazing at a computer screen for long periods of time may not be healthy for children. Indeed, the Canadian Paediatric Society has recently revised its screen-time guidelines to recommend that children under the age of two not be exposed to computer screens at all.

Inspiring Albertans, the minster of education's recent initiative to consult the public about the future of education, promises the opportunity to fundamentally rethink the design of curriculum in the province. By contrast, Alberta Education's attempt, in the last couple of years, to launch a distributed learning strategy has floundered because the government has taken into account neither the interrelationship among the various branches of the education ministry nor the diverse needs of Alberta's 1,950 schools. What is needed is an open and thoughtful discussion on the technology that schools need to optimize student learning.

Infusing digital technologies in a way that truly supports student learning requires all stakeholders to make a paradigm shift in the way they think about education. Before investing time and money in technology, teachers, parents and students must thoroughly examine the various ideologies that drive initiatives to infuse digital technologies into schools. A good place to begin is with a survey of the various changes that have resulted from the government's investment of approximately $1.5 billion in educational technology over the last 15 years. Understanding the past will help clarify what options to choose for the future.

Introduction

The terms *distributed learning*, *blended learning*, *e-learning* and *laptop learning* have entered the lexicon of K to 12 educational practice in the last few years. When education policy is ambiguous, people contemplating the potential impact that new technologies might have on teaching and learning tend to read in what they want to see and read out what they want to ignore. Simply inserting the word *digital* into the discussion, for example, allows promoters of technology to generate a whole new stream of compelling—if imaginary—policy goals such as *digital literacy* and *digital citizenship*.

Debates about the integration of technology into schools have tended to leave out the sociological back-story—that is, an account of how a particular technology gets taken up or appropriated by the culture. Just as educators today, for example, are anxious that the Internet, cell phones and other digital devices might harm students, so educators at the beginning of the 20th century worried that the telephone—the technological innovation of the day—might contribute to a breakdown in social cohesion (Klaver 2009).

Because technological innovations directly affect the lives of individuals and groups, they ultimately affect the culture of institutions that employ them. Implementing new technologies in schools, which are complex cultural institutions, can radically change the culture. More than a decade ago, Sumara and Davis (1997) pointed out that schools and school systems are complex social entities that maintain their coherence by undergoing "spontaneous self-organisation" in ways that are not always easy to predict.

Several factors prevent schools from taking full advantage of the benefits of new technologies: (1) the various educational partners may have conflicting perspectives about how technologies should be employed, (2) the *School Act* and the curriculum limit the room for change, (3) some stakeholders are unwilling to consider radical options and (4) some students are unwilling to serve as guinea pigs in what they perceive as a social experiment. Although some schools remain remarkably resistant to any change (Murgatroyd 2009), they may have good reason to be skeptical. In its recent efforts to infuse learning technologies into schools, Alberta Education has tended to position teachers as passive agents whose primary role is to take advantage of the costly technologies made available to them (Brooks 2009).[1] School communities have also been accused of resisting change for raising such basic questions as why they should have to pay the costs of printing electronically distributed materials that were previously published by the department.

As educators debate the appropriate role of technology in supporting student learning, children and youth are going about their daily lives. Many students

"Since the convenience and the irritations of the Internet have become an inseparable part of the banalities of everyday life, many have come to see these two worlds as less different than expected. [T]he binary opposition between cyberspace and 'the real world,' scholars have come to learn, is not nearly as sharp or clean as it's [been] made out to be."

—Kolko, Nakamura and Rodman 2000, 4 (cited in Friesen 2009, 190)

[1] In a comprehensive review of technology policy initiatives in Alberta, Brooks illustrates how well-intended ministry efforts were often driven by the unproven assumption that technology would inherently transform teaching and learning processes. One example is the unsuccessful attempt to use videoconferencing to deliver second-language programs (p 143). Another is the Grade Level of Achievement Reporting initiative, which focused on getting student grades into the provincial "data warehouse."

All human artifacts, including learning technologies, embody their own sort of politics.

see technology not as a way of enhancing learning but as a practical tool for helping them organize their day-to-day activities, such as going to school, contacting friends and so on. The fact that teachers and policymakers still think of ICT as "innovative" and their efforts to infuse technology into teaching as "innovative practice" would surprise many young people for whom ICT, especially mobile technologies (hand-held devices, Smartphones and iPods), gaming devices (Xbox, PlayStation and Wii) and social networking resources (MySpace, Facebook and YouTube) are indispensable elements of their everyday lives.

Many young people regard educators' cautious attempts to integrate technology as an indication that "they just don't get it!" Teachers themselves are often the first to admit that students have helped them see how to integrate technology into various learning activities and projects. As one teacher put it, "I have learned more from my Grade 7 students than I ever did through professional development." This situation illustrates a phenomenon confronting all professions: once technologies are released, they begin to affect all aspects of society in ways that their creators likely never contemplated and cannot control. Today's family physicians, for example, have to contend, on a daily basis, with patients who have diagnosed themselves by researching their symptoms on the Internet. What physician, a decade ago, could have predicted the profound impact that the Internet would have on the doctor–patient relationship?

Technology is also forcing many professions—education, law and medicine—to become more open and transparent. As a result of technology, people are no longer willing to accept authoritarianism; they want authoritativeness. The tasering of Polish immigrant Robert Dziekanski by RCMP on October 17, 2007, an event captured on video, triggered a public inquiry into the abuse of police authority. The reputation of the police force suffered significant harm as a result (Keller 2009). The RCMP's subsequent efforts to rationalize their behaviour have largely failed to restore public trust in the institution.

Incidents such as this are forcing all professions to accept more responsibility for their judgments and to become more transparent in dealing with the people—whether students, clients or patients—that they serve.

Philosopher Langdon Winner (1980) notes that all human artifacts embody their own sort of politics. He gives, as an example, New York City's first bridges and streets into wealthy beach areas. These roadways were designed in such a way that they could not be accessed by buses, only by private automobiles. As a result, black people, most of whom could not afford cars, were effectively excluded from entering these parts of the city.[2] Like other artifacts, learning technologies are not politically neutral. They impact the teaching–learning process in both intended and unintended ways.

Curriculum theorist Ted Aoki cautions educators to avoid thinking of learning technologies as nothing more than "applications," divorced from the people using them. He argues that people inevitably change as they become "folded into" the tools they use (Aoki 2005, 154). Let us now look more closely at the complex relationship between culture and technology as it exists in Alberta's education system.

[2] A full historical analysis is available at http://www.bruno-latour.fr/presse/presse_art/GB-06%20DOMUS%2006-04.html.

Learning Technologies in Alberta: A Cultural Historical Framework

After reviewing the educational polices in place in several countries, Somekh (2007) concluded that most attempts to integrate technology into the classroom take place according to one of four scenarios, each based on certain underlying assumptions about how educational reform occurs:

Scenario 1: Policymakers attempt to "shoehorn" technology into the existing regulatory framework governing curriculum and assessment, thereby augmenting the government's bureaucratic, centralized control over schools.

Scenario 2: Policymakers and educators acknowledge that infusing technology into schools is a complex and uncertain process. To encourage innovation and research at the school level, they relax controls and accountability mechanisms.

Scenario 3: Schools deploy technology as a way of reconceptualizing the curriculum. For example, teachers may use technology to help students understand how their community fits into the global context and what it means to be a responsible citizen.

Scenario 4: Policymakers undertake a series of initiatives to integrate technology into schools, all of which fail. In the end, the teaching–learning process largely reverts to what it was before.

The historical review that follows will argue that Alberta Education's efforts to infuse technology into the classroom have, for the most part, been consistent with Scenario 1. The historical review will be followed by a discussion of some promising practices that have emerged in jurisdictions whose efforts to integrate technology are typical of Scenarios 2 and 3.

In Scenario 1, policymakers attempt to fit the available technologies for enriching student learning into the government's current policy and accountability frameworks. In this scenario, the purpose of technology is to do little more than, as one teacher put it, "amplify a better version of yesterday." An example of this approach, apparent in many classrooms in Alberta today, is the use of PowerPoint presentations to supplement traditional pedagogical practices. Another example—this one having to do with student assessment rather than curriculum—is the move by some jurisdictions to digitize student report cards and make them available to parents online. Instead of resulting in a more meaningful assessment, online reporting tends to produce more data, thereby amplifying what were already less-than-optimal assessment practices. Meaningful assessments, by contrast, are those that take into account the informed professional judgments of teachers and that involve face-to-face discussions among the teacher, the student and the parent (Couture and Judah 2008).[3]

In Scenario 1, teachers often adapt technology in imaginative ways to support the teaching–learning process. For example, they may use educational software (such as serious gaming, simulations and applications designed to

"Technology is socially relative, and the outcome of technical choices is a world that supports the way of life of one or another influential social group."

—Feenberg 2010

[3] The Association, in collaboration with the Alberta Assessment Consortium and a number of school jurisdictions, is currently studying the implications for schools of adopting systems of reporting student progress online.

meet specific curriculum objectives), acquire tools to support students with special needs, and encourage students to use the Internet to access inquiry-based learning tools as well as books, journals, magazines and audio-video resources. Yet, as long as these teachers work in an accountability regime in which standardized tests and other simple reductionist measures are relied upon to assess student learning, the kind of transformational changes in teaching and learning envisaged by Andy Hargreaves and Dennis Shirley in their recent book *The Fourth Way* (2009) can never occur.

In today's computerized world, the closest many people come to solving a problem, in Crawford's view, is pressing the delete button on their laptop.

Alberta's largely Scenario 1 approach to implementing technology has failed, for the most part, to recognize that technology has the power to transform all aspects of learning, from the simplest to the most complex (including problem solving). As Michael Crawford explains in his book *Shop Class as Soulcraft* (2009), technology, if used intelligently, can bring alive human experience rather than reduce it to the passivity of video gaming and interacting with a screen. Crawford, who is both the owner of a motorcycle shop and a professor of cultural studies, points out the irony at the heart of much education policy, which, on the one hand, broods about the importance of producing "knowledge workers" and, on the other, ignores the fact that most learning takes place by connecting to the world through direct physical experience, such as using one's hands. Digitization, in such a world, becomes a cruel joke. In simpler times, people spent their time solving the basic challenges presented by day-to-day life. In today's computerized world, the closest many people come to solving a problem, in Crawford's view, is pressing the delete button on their laptop. Crawford draws a parallel between officer workers, who may feel disconnected from the material world as they toil away in their office cubicles, and today's high school students, many of whom wander aimlessly from class to class feeling an inexpressible sense of loss. He suggests that both the office worker and the student would be hard pressed to answer the simple question, "What did you do today?"

In most schools in Alberta to date, technology has, for the most part, been used to help schools achieve an often dizzying array of learning outcomes (the Grade 7 program of studies, for example, identifies about 1,300 such outcomes). In other words, technology has been used to *supplement* traditional teaching and learning rather than to *transform* the pedagogical process.

In most other fields of endeavour—publishing, banking, travel, insurance, music, film, animation and, to some extent, private postsecondary education—digital technology has transformed the relationship between the service provider and the end user. What has driven the adoption of technology in these sectors has been the need for greater productivity and efficiency. Aside from a few government-funded showcase projects, these same factors, by contrast, have not driven efforts to implement technology in K to 12 education in Alberta. One exception has been the Alberta Initiative for School Improvement, which has focused on developing a more holistic approach to assessing student progress and has welcomed input from the local school community.[4]

[4] In 2008, Alberta Education commissioned an external research team to review the Alberta Initiative for School Improvement (AISI). The team concluded that AISI was effective in countering Alberta's "third way" accountability framework. The team's final report was published as *The Learning Mosaic: A Multiple Perspectives Review of the Alberta Initiative for School Improvement (AISI)* by Andy Hargreaves, Robert Crocker, Brent Davis, Lori McEwen, Pasi Sahlberg, Dennis Shirley and Dennis Sumara with Maureen Hughes. Alberta Education, September 2009.

Drawing on recent research, this paper will explore the potential of technology to promote real learning first in Alberta's classrooms and to improve student performance. In so doing, it will examine how Alberta's education policy and its leadership and teaching practices will need to change in order to fully capitalize on the more than $1.5 billion that the province has invested in technology since the 1980s.

The Key Investments

Although Alberta has invested a great deal of money in technology since the mid-1980s, the technology has, for the most part, been used to support Scenario 1 processes and policies. Based on data provided by the Government of Alberta, school boards, technology consultants and coordinators, and the ATA's Educational Technology Council, we believe that Alberta has spent more than $1.5 billion during the past 15 years developing a technology infrastructure for education. The government has spent $600 million just on building the Alberta SuperNet, a broadband network connecting public institutions across the province. The remainder has been used to equip schools, develop learning objects, provide teachers with professional development and support Alberta Education's technology branch. These calculations do not take into account the many other costs associated with owning technology, such as the salaries of technical staff and the time spent trouble-shooting system failures.[5]

Alberta has spent more than $1.5 billion during the past 15 years developing a technology infrastructure for education.

Initially, the government spent most of its budget for technology on such basics as purchasing computers, building the SuperNet, developing repositories of learning objects, acquiring videoconferencing capability and purchasing software. More recently, its spending has focused on acquiring software to collect and manipulate student results, access jurisdictional data, and harmonize business applications and accountability processes. Indeed, in the past few years, the government has enhanced its capacity to track everything from student test scores to the business operations of school jurisdictions. Recently ministry officials have extolled the virtues of the government's ever-expanding "data warehouse" and of its ability to analyze student achievement data from afar. According to the government, using technology in this way enables it to "enhance system performance."

David King, a minister of education in the Lougheed government, argues that this fixation with system-level reform and the accumulation of data is just a symptom of a much deeper problem: namely, the current government's profound distrust of local governance (characterized by democratic participation and community-building) and a concomitant desire to replace local governance with a system of state-controlled accountability. In King's view, many of the government's initiatives during the last three decades to infuse technology into education have masked its real motive, which is to

[5] In 2008, the ATA's Educational Technology Council surveyed a sample of district IT coordinators, school IT lead teachers and administrators. Not surprisingly, the survey revealed that up to 10 per cent of a school's budget is now dedicated to sustaining the school's IT capacity (a figure that is low by current industry standards). Increasingly, jurisdictions are having to bear these costs in the absence of adequate provincial funding.

inculcate a culture characterized by governmentality[6] and a willingness to accept statism:

> I would argue that for education, indeed for all social tasks, it is vitally important to maintain an environment in which human relationships, not systemic or statistical ones, are valued and nurtured. I would argue that the well-being of provincial or national democracy depends, first of all, upon the well-being of local democracy. And I believe that it takes a whole village—but no one ever said it takes a whole system—to raise a child.
>
> If we lose sight of community, if we lose all understanding of what it means to be "the public," if we accept "statism" and seek only to make the state's tests the best they can be, I am afraid that we will lose forever the chance to put real learning first. (Alberta Teachers' Association 2009d, 17)

"Ultimately, K to 12 education should be about building human relationships in vibrant democratic communities."

—Ken Chapman, Cambridge Strategies

Since about 2005, the government's investments in technology have focused on using technology both to enhance learning outcomes and to sustain the business operations of schools and jurisdictions. The first hint that Alberta Education intended to use the same technology for both pedagogical and business purposes appeared in its 2004 *Learning and Technology Policy Framework*. The concept resurfaced in Alberta Education's draft *Education Technology in Education Policy*, released on November 14, 2009.

Since the early 1990s, the government has undertaken a number of initiatives consistent with a Scenario 1 approach. What is apparent in each case is that technology has been used to amplify rather than rethink existing policies, programs and accountability frameworks. Here are a few examples of how technology has been layered on to an existing approach:

- Introducing videoconferencing to give students, especially those in remote areas, better access to programs and teachers (2005)
- Developing an ICT curriculum (2000 onward)
- Encouraging blended learning, whereby digital learning objects are used in conjunction with face-to-face instruction (1997 onward)
- Using the SuperNet to facilitate collaborative learning among schools in Alberta (2006 onward)
- Using the Internet and communications technologies to deliver facets of the curriculum (1996 onward)
- Researching the feasibility of developing e-textbooks[7] (2002–04)
- Using SmartBoards to facilitate learning (2004 onward)
- Undertaking research on the effectiveness of the Emerge One-to-One Laptop Learning Initiative (2007 onward)
- Using ICT to facilitate authentic learning tasks (1998 onward)

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[6] Michel Foucault coined the term *governmentality* to describe the mechanisms that modern neo-liberal governments use to produce citizens who actively participate in their own oppression, domination or external control. His work has been widely embraced by a generation of education policy scholars. See Foucault 1978.

[7] The arrival of new devices on the market, such as Amazon's Kindle reader, have overtaken the government's efforts to regulate these applications.

Most—but not all—of these initiatives have focused on exploring how the particular technology can be used to support established methods of teaching and learning rather than create new ones. The implied rationale seems to be as follows: "This technology can do so-and-so. What can we do with it given the way our schools currently operate?" The assumption, in other words, is that technology is to be used to supplement and support the existing learning culture rather than to transform it. Seldom does the conversation begin by asking the teacher and the student the truly transformative curriculum-related question, "Where are you in this story?"[8]

Scenario 1 thinking is, in many ways, understandable. After all, the new technology is by definition emergent, and therefore untested in terms of how it affects student learning. Historically, teachers have tended to use *proven* processes. Students and parents, likewise, have predetermined expectations of the process by which learning takes place. Deviating from these practices and expectations will introduce change, which is not always easy to initiate and sustain. Although teachers may wish to adopt newer pedagogies, a variety of practical barriers often prevents them from doing so.

When policymakers lack a clear understanding of the transformative power of technology, the result is often a patchwork of technologies that, lacking coherence, tend to have little effect on student learning. A close examination of even some projects that appear to be transformative often reveals that the strategic intention behind them is to improve student performance on standardized tests, to ensure that teachers are complying with the curriculum or to make certain that teachers are being held accountable.

Although teachers may wish to adopt newer pedagogies, a variety of practical barriers often prevents them from doing so.

[8] This question was posed over three decades ago by the reconceptaulist movement, initiated by Bill Pinar and Madeline Grumet. It spawned a generation of curriculum inquiry in Alberta schools. For more information about the reconceptaulist movement see *The Worldliness of a Cosmopolitan Education: Passionate Lives in Public Service* (Pinar 2009).

Early Adopters and Early Majority

Rogers (1964) has observed that organizations tend to vary considerably in their approach to innovation. While some organizations embrace change, others take much longer to adapt. Based on his research, Rogers proposed the following adoption/innovation curve to illustrate the range of organizational responses to change:

Our research suggests that between 40 and 50 per cent of teachers in Alberta are comfortable using technology and integrating it into the curriculum and their teaching.

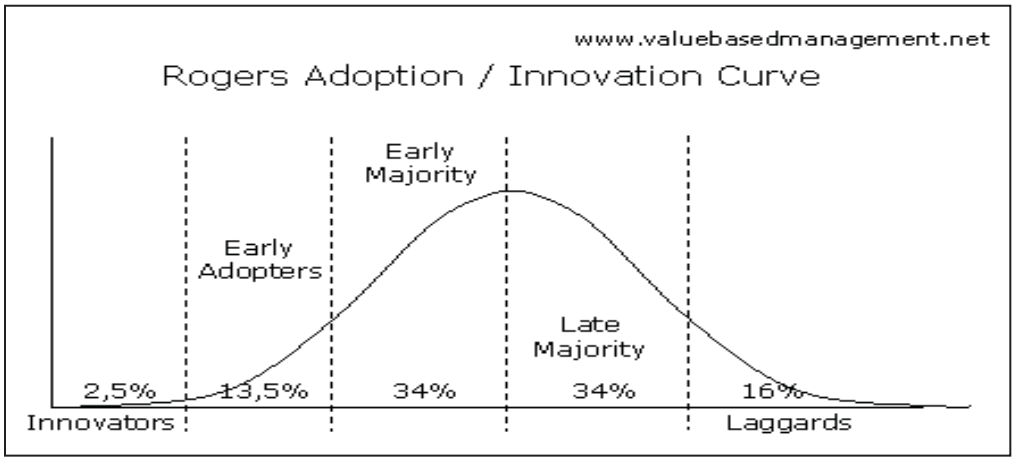

Figure 1: Rogers Innovation Diffusion/Adoption Curve

Although each school is different, this model provides a useful starting point for understanding the range of responses that Alberta schools have exhibited over the last three decades in the face of new technologies. The experience of each teacher in adapting to technology is also unique.[9]

When digital technologies first began appearing, innovators in the K to 12 education system in Alberta had the luxury of developing a business case for acquiring them, experimenting with them and developing some guidelines for determining when a particular technology warranted continuing financial investment. Most jurisdictions in Alberta have now reached the point at which an early majority supports innovative projects, provided, of course, that the jurisdiction is willing to provide all teachers not only with access but appropriate professional development. Although each school is unique, our research suggests that between 40 and 50 per cent of teachers in Alberta are comfortable using technology and integrating it into the curriculum and their teaching.

One factor that affects the willingness of teachers to embrace new technologies is the subject that they teach. An evaluation of Alberta Education's Emerge One-to-One Laptop Learning Initiative (a pilot project in 20 jurisdictions to explore the efficacy of one-to-one wireless learning), for example, revealed that teachers of social studies, science and language arts

[9] Without the teacher, according to the reconceptaulist movement, the curriculum is nothing more than an encounter between the subject and the student.

were more likely to use technology than those teaching the arts, mathematics and reading (Meteri Group and the University of Calgary, 2009).

Another factor that affects the willingness of teachers to accept technology is the extent to which they have been provided with appropriate professional development. Professional development not only ensures that teachers are familiar with the technology, but also gives them the confidence to be innovative in their teaching practice. Jurisdictions that provide teachers with adequate professional development often begin to exhibit the characteristics of Scenarios 2 and 3. That is, they begin to use technology to radically transform both the culture of their school and the way in which they think about the curriculum. Many of the innovative projects undertaken under the Alberta Initiative for School Improvement and Alberta Education's Emerge One-to-One Laptop Learning Initiative have been, to a greater or lesser degree, transformational. As well, some of the most transformative projects in Alberta have been initiated by organizations operating outside the public education system. One such organization is the Galileo Educational Network, a Calgary-based organization that was established in 1998. Affiliated with Axia NetMedia in its early stages, Galileo has focused on showing teachers (approximately 3,000 to date) how to use technology in innovative ways. Galileo, for example, believes that problem solving is an effective learning strategy and, as a result, many of its suggested learning activities are project-based. Technology helps teachers collaborate with their colleagues, access information and monitor student progress.[10]

Although Galileo and other organizations (including Alberta Education and the ATA) have undertaken many worthwhile projects, teachers in Alberta are still only moderately confident in their ability to infuse technology into the classroom. In evaluating the Emerge One-to-One Laptop Learning Initiative, Meteri Group and the University of Calgary (2009) found that only slightly more than 50 per cent of the teachers involved in the project felt adequately prepared (pp 20–21). Much more remains to be done, from improving initial teacher-preparation programs to developing communities of practice to instilling in teachers an ease with technology that matches that of their students.

A third factor affecting the willingness of teacher to embrace technology is cost. Building a network infrastructure, purchasing equipment, acquiring software and training teachers to use technology requires not only a substantial initial investment but sustained funding. Although today's computers are much more powerful than those purchased for approximately the same price as in the past, the overall costs associated with technology are rising, not falling.

A final factor affecting the acceptance of technology is fear of taking a risk. Teachers who use technology in a way that fundamentally alters their teaching practice are taking a risk. What they are risking is not only the

"[AISI is] a shining star in the sky of global large-scale school improvement. … It is difficult to find anywhere a comparable change effort that would be of the scale, size and overall magnitude of AISI."

—Pasi Sahlberg

[10] Galileo, in partnership with Axia, has developed a technology-based professional development tool to help teachers network and plan lessons. Known as Intelligence Online (IO), the system is powerful, effective and easy to use. IO has become a leading community of practice (see www.galileo.org).

prospect of failure but also the condemnation of their professional peers who will greet any unsuccessful effort with a chorus of "I told you so." Risk avoidance is a major factor in deterring teachers from embracing innovative practices, especially in jurisdictions that attach a great deal of importance to high-stakes testing. Fear of taking risks can also inhibit schools from building a culture of collaborative inquiry and from undertaking action research (Somekh 2007; Leithwood 2006).

Taken together, these factors—the fact that technology is more readily embraced in some areas of the curriculum than others, insufficient professional development, high implementation costs and fear of failure—have prevented many schools from taking advantage of the opportunities afforded by technology. Depending on their particular culture, some schools have embraced technology and used it to transform the teaching–learning process, whereas many others have maintained a more traditional approach, using technology only to support existing pedagogical practices. Too often, Alberta's efforts to integrate technology into the classroom have been fragmentary, sporadic and backward-looking rather than comprehensive, strategic and transformative.

Alberta's efforts to integrate technology into the classroom have been fragmentary, sporadic and backward-looking rather than comprehensive, strategic and transformative.

Returns on Investment in ICT in K to 12 Education

Among the arguments that have been advanced for implementing technology in the classroom are that it improves educational outcomes, gets students more engaged and boosts their sense of satisfaction. Kirkpatrick and Cuban (1998) and Leuven et al (2004) have argued that these claims are overstated and that the research findings are mixed. Others, such as the British Office for Standards in Education, believe that technology can have a positive impact on learning (OFSTED 2001). A major study by the Centre for the Economics of Education concluded that technology can benefit learning but that the benefits are more evident in some areas of the curriculum than in others (Machin, McNally and Silva 2006). Harrison (2002) takes much the same view. In a decade-long, statewide trial of the impact of technology on learning, Mann et al (1999) go much further, concluding that technology is more cost effective than other popular interventions, including reducing class size, in improving student performance.[11]

Peck, Cuban and Kirkpatrick (2002) argue that returns on investment are affected by a host of factors that have nothing to do with the technology itself. One such factor is that schools tend to be compartmentalized according to the subject being taught. Another is that teachers may be uncomfortable working in teams, may be unfamiliar with project-centred teaching or may have a limited understanding of the capabilities of the technology they are using.

[11] Sinko and Lehtinen (1999) found that focused ICT investments produced (depending on the intervention) learning gains of between 0.28 and 0.5 in objective measures of key skills. Parr (2000) puts the effect at 0.4.

The Changing Nature of Learners: A Contested Landscape

A number of factors may compel Alberta to adopt a Scenario 2 or Scenario 3 approach to the infusion of technology in the classroom. One such factor is the changing nature of students themselves. Students who began school in September 2009 will retire from the workforce sometime between 2069 and 2075. Unlike their great grandfathers, most will hold between 15 and 20 different jobs throughout their career and stay no more than five to seven years with a single employer. For many members of the iGen (also known as the Text Generation or Generation Z), achieving a work–life balance will be a bigger issue than acquiring generous pensions. Members of this generation will expect their employers to adhere to practices that foster their personal and professional development. Although work may be one source of satisfaction for them, it will not be the focus of their lives. These young people will bring to their work remarkable technical skills, a strong entrepreneurial outlook, a deep-seated social consciousness (especially with respect to the environment) and, like every new generation, a healthy dose of scepticism and a desire for change.

Although generalizations about the iGen cohort are still a matter of debate, many scholars believe that this generation will have a profound understanding of the power of social networks and of cloud-based computing. As a result, they will readily adopt technologies that facilitate work and social transactions, be willing to accept innovative work practices and be comfortable engaging in global conversations (Palfrey 2008; Tapscott 2009). Interestingly, the iGen will likely possess these skills *despite* the school system, which, at this point, seems largely incapable of adopting new technologies in ways that facilitate learning. Indeed, many school systems are outlawing social-networking technologies, which they regard—sometimes with good reason—as distractions. The iGen will also likely be quick to exploit the potential of artificial intelligence and of domestic and social robotics, innovations that will have a profound impact on human capital.

Some people believe that a particular strength of iGen members will be their ability to multitask, network globally and assimilate complex information and ideas from a variety of sources. As the world becomes increasingly globalized (Stiglitz 2006), this generation will have to grapple with the integration of machine and human intelligence, a fusion known variously as the *neurosphere* (Dulchinos 2005) or as *singularity* (Kurzweil 2005). Their schooling, however, unless it changes quickly, will not have prepared them well for this eventuality. As Robinson (2006) observes, schools are in the process of preparing young people for jobs that do not yet exist, that require skills not yet fully understood and that will use technologies still in development. Yet, these same schools behave as if the nature of human capital has not changed since the turn of the 20th century.

The iGen will also likely be familiar with the basic concepts of design. Many of them will own their own web space, will be familiar with social networks

"Generational differences are weak as a researchable variable in a manner similar to learning styles. … Educational technology researchers should treat this variable as failing to meet the rigor of definition and measurement required for robust individual differences variables. The gross generalizations based on weak survey research and the speculations of profit-oriented consultants should be treated with extreme caution in a research and development context."

—Reeves and Oh 2008, 302

The digital divide that separates people who have ready access to and a facility with technology from those who have limited or no access to technology and few skills is real and apparent in today's classrooms.

and will have created a weblog (blog), which they will either have customized from a template or designed themselves. They will also understand that design involves making a series of conscious decisions with respect to such matters as the environment, technology, living spaces and clothing. They will have personalized their hand-held digital devices by acquiring a unique combination of applications, designing their own covers or purchasing add-on features. As one teacher put it, "This is not simply a different generation; it's a different species." Indeed, Veen and Vrakking (2006) refer to the iGen as "homo-zappiens," a term that captures not only their different learning styles but also their distinctive psychobiology. Some commentators have even argued that these "homo-zappiens" will be the source of human capital in the communities and economies of tomorrow.

The digital divide that separates people who have ready access to and a facility with technology from those who have limited or no access to technology and few skills is real and apparent in today's classrooms. Which side of the digital divide a person inhabits tends to be determined by the following factors (Looker and Thiessen 2003; Selwyn 2004; Sciadas 2000):

1. *Available infrastructure*: With the exception of the school or public library, some communities do not have access to broadband services. Furthermore, some people have no secure place (other than an education centre or library) in which they can access technology for learning.
2. *Geography*: Rural students, especially those living on reserves or in remote communities, have less access to technology than their urban counterparts.
3. *Gender*: Females appear to be less interested in or have less access to the Internet and other technologies than males (Organisation for Economic Co-operation and Development 2008).
4. *Socioeconomic status*: Internet access and use as well as access to other technologies is a function of income, social class and employment status.
5. *Race*: Aboriginal students, especially those on reserve, are less likely to have access to technology than their non-Aboriginal counterparts.

Schools have to cope with students who range from highly competent to nearly computer illiterate. To be used in a transformative way, technology must take into account these differences, recognizing that a student's ability to access and use technology is often related to his or her socioeconomic status.

While technology is a convenience for most students, for those with disabilities and special needs it can transform the learning experience. Assistive technologies, which are constantly improving, range from audio books and worksheets to optical character readers to speech-recognition programs to self-programming intelligent devices to advanced writing tablets (operable by a single finger or toe and—soon—by brain waves) to robotic assistants. A protocol governing the development and design of these assistive technologies has emerged. Known as Universal Design for Learning (UDL), the protocol stipulates that as new curricular materials and learning technologies are developed, they should be designed *from the beginning* to be flexible enough to accommodate the unique learning styles of a wide range of people, including students with disabilities (more information is available at

www.nectac.org/topics/atech/udl.asp). UDL ensures, for example, that webpages are accessible to people with disabilities, that textbooks and other curricular materials are published both electronically and in paper, that videos are captioned or narrated, that word processors are capable of predicting the word that someone is trying to enter, that spell checkers and dialogue boxes can "speak," that programs have voice-recognition capabilities, and that menus include pictures. UDL does not eliminate the need for assistive technology; students with disabilities will continue to need communication aids, visual aids, wheelchairs and adapted toys in order to interact more fully with their environment. However, building accessibility into new technologies and curricular materials *as they are developed* helps to ensure that children with disabilities will be able to take advantage of most of the learning opportunities that are available to the general student population.

How will pedagogical practices and the curriculum need to change to accommodate the digital generation? Is engaging them and meeting their immediate needs *all* that matters, or are educators also responsible for meeting their long-term needs? What about the needs of the wider community? Which aspects of so-called traditional education should be preserved and which should be abandoned? On what basis should these decisions be made?

Surprisingly little research has been carried out on the physiological impact on children and youth of spending more and more time online. Interacting with a computer affects children not only psychologically but also physically. Some researchers, for example, have suggested that excessive online activity may be related to an increase in the rates of childhood obesity, seizures and hand injuries. Others (Anderson 2007) have called for studies exploring the impact that digital technologies and new media might have on children's brain development.

"The emerging revolution in learning technologies is evident in the acceleration of interface development. From punch cards three decades ago, we are moving to a world of natural user interface: multi-touch, gesture and speech recognition will bring us innovations such as eye tracking, bionic contact lenses and neuroprosthetics."

—Richard Yonck

What Continues to Drive Scenario 1 in Alberta?

Technology in Alberta schools has generally been used to supplement traditional teaching practices, not to transform them.

Alberta's efforts to develop a technology strategy for K to 12 schools have, for the most part, focused on how technology can be used to engage students and enrich their learning experiences. Teachers have been imaginative in adapting technology to support teaching and learning. What has received much less attention is the power of technology to change both the learning process and the relationship between the learner and the sources of knowledge. In other words, technology in Alberta schools has generally been used to supplement traditional teaching practices, not to transform them. The following factors help to explain why educators in Alberta have had difficulty implementing technology in a way that transforms learning:

1. *Most schools are not organized in a way that supports transformative changes.* As a result, any changes that are made tend to be gradual, incremental and hesitant. All the partners—parents, teachers, administrators, students and the community—may resist transformative change, often for good reasons. One reason is that education policymakers are constantly proposing radical reforms to the school system. If schools were to act on each proposed reform, the ministry of education would likely regard them as perennially failing institutions (Murgatroyd 2009). Although the inherent conservatism of educational systems helps protect schools from pointless change, it also renders them quite resistant to beneficial innovations. For schools to embrace sustainable change, they need compelling evidence, the necessary resources and a substantial investment in professional development.

2. *Teachers do not always have the skills necessary to use technology as a tool for transforming learning.* Although a growing number of teachers have become quite adept at using technology, the majority still find technology a challenge and, as a result, tend to rely on more conventional teaching tools. Even when jurisdictions invest in technologies such as SmartBoards, teachers are relatively slow to adopt the newer methods. A major reason for the slow acceptance is the paucity of professional development opportunities for teachers. Since 1999, schools have committed only between 2 and 3 per cent of their operating budgets to professional development, far below the 5 to 10 per cent that other sectors spend on staff training (Alberta Teachers' Association 2009b).

3. *The ability of students to access and use technology varies considerably.* Although more of today's students have technical skills than was the case in the preceding generation, the digital divide still poses a major barrier to the widespread adoption of technology as a way of transforming the learning process. Aboriginal students living on reserves are particularly disadvantaged in this regard.

4. *The government and school boards generally focus their technology spending on basic infrastructure rather than on transformative initiatives.* In other words, they tend to focus on the technology itself (whether videoconferencing,

"Ten percent of children in Grades 3 to 6 have their own cell phone. By Grade 10, that number has risen to 22 per cent. Sixty-two per cent of the children surveyed said their family has a cell phone."

—Canadian Teachers' Federation 2004

SmartBoards or one-to-one wireless learning) rather than on how the technology can transform the learning process. Examples of transformative strategies include teaching less and encouraging students to learn by undertaking projects, doing away with textbooks, and replacing the entire curriculum (math, science, social studies and language arts) for a particular grade with a set of technology-based activities designed to ensure the same learning outcomes. Rather than having a technology branch, Alberta Education should create an *innovation* branch, the purpose of which would be to develop the curriculum in a way that increases student engagement and improves learning outcomes.

5. *Teachers are only moderately confident in their ability to incorporate technology into the teaching–learning* process. Even though the Internet has been around since 1994, school districts and many teachers are still clearly feeling their way with respect to using technology to engage students and enhance learning. Indeed, some school districts now deny students access to such social networking media as Facebook and MySpace during class time. Others do not permit students to use mobile devices during class, even though many of these devices are now so sophisticated that they could serve as mobile learning centres, replete with access to the Internet, special applications, and audio and video materials.

6. *The provincial curriculum specifies so many learning outcomes that teachers tend to rely on time-tested processes rather than risk using new technology-based*

While acknowledging the potential benefits of technology, many teachers do not feel that they have the time or the resources to make the transition from traditional methods of teaching to those that involve a greater reliance on technology.

approaches that might lower student scores on provincial achievement tests. Currently, the approved program of studies for Grade 7 students in Alberta specifies about 1,300 distinct learner outcomes. While acknowledging the potential benefits of technology, many teachers do not feel that they have the time or the resources to make the transition from traditional methods of teaching to those that involve a greater reliance on technology.

7. *Teachers who risk using technology to transform their teaching practice receive little recognition*. In Alberta, being innovative in the classroom is seldom rewarded either by professional advancement or by peer recognition. Hargreaves and Shirley (2009) point out that many jurisdictions are addicted to undertaking initiatives that, while producing short-term improvements, fail to address the systemic issues that hinder teachers from embracing truly innovative practices. In such jurisdictions—and Alberta is a prime example—teachers are made to focus all their energy on complying with externally imposed mandates—with making what might be called "data-informed improvements"—rather than on exploring ways of transforming the teaching–learning process. "When schools follow policy mandates and pursue the relentless quest for short-term gains, they evolve into … addictive organizations" (Hargreaves and Shirley 2009, 23–29).

8. *Many schools in Alberta exhibit a culture of compliance that inhibits innovation.* School administrators in Alberta face a myriad of challenges: complying with accountability requirements imposed by the province and the jurisdiction, dealing with an increasingly complex curriculum, supporting teachers whose technology skills may be limited and appeasing parents who may be resistant to change. As a result, their attempts to improve student learning are seldom more than moderately successful. Some projects carried out by the Alberta Initiative for School Improvement (AISI) and the Galileo Educational Network, though modest in scale, demonstrate what is possible. A review of AISI projects undertaken between 2003 and 2006 revealed that the projects that had the biggest impact (albeit a modest one) on student achievement and on teacher, student and parent satisfaction were those involving technology (McRae and Parsons 2007, 8). As Hargreaves and Fink (2006) observe, "change in education is easy to propose, hard to implement, and extraordinarily difficult to sustain."

Although striving to improve schools on a continuous basis is not necessarily a bad thing, such an approach is not the hallmark of progressive organizations. A much more productive approach is to initiate a cycle of transformation, consolidate the gains achieved and then start a new cycle of transformation. Although change is disruptive, such a cyclical approach leads to higher productivity, improved outcomes and higher levels of employee and "customer" satisfaction over time (Collins 2001; Broughton 2008).

[12] This estimate is based on a review conducted by Stephen Murgatroyd in December 2009.

Moving to Scenarios 2 and 3

An important reason for undertaking transformative change is the recognition that the skills that employers, organizations and communities require in the 21st century are significantly different from those required in the 20th century (Partnership for 21st Century Skills 2006a). In fact, many knowledge-based companies—among them Microsoft, Google, Dell, GlaxoSmithKline, Time Warner, Bell, Adobe—now define competency in terms of possessing not only such traditional skills such as the ability to think analytically and critically, to communicate clearly, to collaborate with others, and to carry out research, but also such new skills as global and environmental awareness; financial, entrepreneurial, business and economic literacy; civic literacy; acceptance of responsibility for one's health and wellness; and information and media literacy.

The culture that is emerging as countries move from the industrial to the post-industrial age is often referred to as the *knowledge society*. In such a society, knowledge (or intellectual capital) becomes a more important factor in driving economic growth than such traditional (and more tangible) assets as labour, land and money. Whereas industrial societies focused on extracting and using natural resources to manufacture products, knowledge societies are based on developing and exploiting new forms of knowledge. A knowledge society will see a major decline in so-called blue-collar jobs and an increase in jobs in the creative, technology and service-based industries. Such a society will also develop new business practices and new patterns of work (Florida 2002).

In the knowledge society, the economy will become increasingly integrated on a global scale. Such an economy depends on the ability to digitize information of all kinds (including money) and move it around the world at enormous speeds. Already Canadian universities such as McGill are beginning to digitize their library collections, thereby providing students with access to thousands of articles and online journals. The University of

Whereas industrial societies focused on extracting and using natural resources to manufacture products, knowledge societies are based on developing and exploiting new forms of knowledge.

Calgary recently invested $200 million in the Taylor Family Digital Library. The ability to disseminate information so readily changes people's understanding of time and space and causes the boundaries between countries to break down. The knowledge society will also create new ways of presenting information and new forms of money. People will connect with each other in new and different ways and will develop new and much more complex forms of personal identity.

Schools need to be reconceptualized as knowledge-producing rather than knowledge-consuming entities.

Knowledge societies are *not* societies that value knowledge more than other societies. (All societies value knowledge and have always done so.) Nor are they societies that depend on more people knowing more than was the case in the past. Rather, knowledge societies are societies in which knowledge is the primary source of economic growth. Furthermore, the knowledge that drives economic growth is *not* knowledge in the traditional sense of something developed and stored in the minds of experts and capable of being organized into disciplines.[13] Rather, it is more like a form of *energy* that is dynamic and capable of making things happen. [14] Its value lies not in what it *is* (or what it can explain) but in what it can *do*. [15] In other words, the "new" knowledge is a process, not a product. It cannot be pinned down or measured, but it is always changing. Furthermore—and this is important from the standpoint of education—it is produced not in the minds of individuals but in the *interactions between people*.

This concept of knowledge differs considerably from the one on which the present education system was based. As a result, revising the present education system by tacking on new ideas of applying technology will not be sufficient to prepare students to function in the knowledge society. What is needed, instead, is a *paradigm shift in educational thinking*.

An obvious starting point is to replace the current system, with its focus on content and assessment, with one that emphasizes real learning and the creation of genuinely new knowledge. As Bigum (2003) puts it, schools need to be reconceptualized as knowledge-*producing* rather than knowledge-*consuming* entities. Secondary education, in particular, needs to move away from the industrial age, one-size-fits-all, production-line model of education to an approach that takes into account the learning needs of individuals. To participate successfully in 21st-century society, people will need to continue learning long after they leave school. To be perpetual learners, they need to know quite a lot about learning: how they themselves learn, how others learn and how to help other people learn. They need to be able to learn in groups as well as on their own, and they need to know how to create new knowledge.

Although students in the post-industrial age will still need to learn the so-called old knowledge that constitutes the present curriculum, their reasons for learning it will be different. Students will learn old knowledge not for its

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[13] See Gilbert (2005) for a detailed account of the new knowledge.

[14] This concept of the new knowledge is based on the work of Manuel Castells, particularly his book *The Rise of the Network Society* (Castells 2000).

[15] The French philosopher Jean-Francois Lyotard uses the term *performativity* to describe the ability of knowledge to do things (see Lyotard, Bennington and Massumi 1984).

own sake or so that it can be preserved and passed on but so that they can use this knowledge to develop *new* knowledge. To do this, they need to understand the big picture, not necessarily all the details. They need to understand how different knowledge systems are constructed, how they work and what their particular strengths and weaknesses are. Traditionally, only those who pursued higher education developed this kind of knowledge (usually in the context of a specific discipline). In a post-industrial society, however, *everyone* will need this kind of understanding.

The demand for new knowledge will have major implications for both pedagogy and curriculum at all levels of schooling. Digital technologies will not drive the creation of knowledge but they will be a fundamental pedagogical tool in the knowledge-age education system. To enable students to acquire the new knowledge, schools in the 21st century will need to do the following:

- Focus on meaningful learning tasks that challenge students to achieve results that matter to an authentic audience
- Take a project-based approach to curriculum delivery, which will help students understand the connections between seemingly unrelated areas of knowledge
- Ensure that students have equitable access to learning resources and tools as well as to teachers, experts, mentors and knowledge guides
- Focus on teamwork, collaborative learning and networks
- Encourage students to participate, both face to face and online, in the local community and in the wider international community. Doing so will help students appreciate the truly intercultural nature of Alberta's communities
- Provide students with ready access to a wide range of digital resources (images, music, text, video) available from libraries and other knowledge repositories
- Encourage teachers (whether in the role of coach, guide, mentor or instructor) to establish communities of interest, pursue professional development and participate in professional organizations
- Restructure the school day by moving from several short periods to one to three long periods
- Engage students not just in the process of learning but also in the design of learning

In 2007, the Canadian Council on Learning (CCL) and the Canadian Educational Association (CEA) embarked on a multiyear initiative to transform the environment in which students learn (Friesen 2009). The efforts at transformation were based on the following principles:

1. *Teachers are designers of learning.* Rather than teaching to the test, teaching the textbook or delivering the provincial curriculum "as written," teachers use their training, their professional experience and their participation in communities of practice to design meaningful learning experiences tailored to meet the unique needs of their students. Teachers understand that the community has entrusted them with the task of designing

"Perhaps one of our greatest challenges in public education will be to address the psychological issues that young people face. For example, while multitasking and virtual networking are commonplace in youth culture, the resulting effects of a sedentary lifestyle cannot be ignored; there is a growing concern over declining health and well-being of youth. Twenty-two per cent of Alberta children are considered overweight; 8 per cent are considered obese."

—Alberta Teachers' Association 2009b, 34

meaningful and memorable learning activities that help students to improve their skills, knowledge and understanding.

2. *The work that students are asked to undertake is worth their time and attention*. The learning that students engage in is personally meaningful, intellectually challenging and capable of sustaining their interest over time. In other words, the learning tasks are authentic and are intended for an authentic audience.
3. *Assessment practices improve student learning and guide teaching.* Students and teachers work together to create assessment criteria. They also undertake continuous assessment activities designed not only to improve learning but also to foster student engagement and collaboration. Students also help to assess their peers, a skill that they will need in the 21st-century workplace (Wiliam et al 2004).
4. *Teachers encourage students to develop a variety of interdependent relationships*. Teachers encourage students to connect with other students; to participate in communities of interest; and to access (both in person and online) local, regional and global sources of knowledge related to the subjects they are studying. Such connections foster collaboration, cooperation, engagement and the development of social skills (Gilbert 2005). Teachers should also participate in peer networks at the local, regional and global levels.
5. *Teachers improve their practice in the company of their peers.* Working closely with their peers on an ongoing basis helps teachers to become more effective and innovative in their teaching practice. In addition to constituting a professional development opportunity, participating in a community of practice is an integral part of transforming the teaching–learning process in a way that improves student learning.

These principles, if followed, are the key to transforming schools in a way that will enable them to adequately prepare students to function in the knowledge economy of the 21st century. Teachers working in such schools will clearly need not only access to technology but facility in integrating that technology seamlessly into their teaching practice.

The CCL–CEA project is only one example of the many experiments in school transformation that are under way in Alberta. In 2007, for example, the Association embarked on a collaborative project with Canadian Rockies Regional Division No 12, the Alberta Assessment Consortium and the University of Alberta to develop, with the assistance of classroom teachers, a set of performance-based indicators to measure the extent to which students understand the true meaning of community engagement and responsible citizenship. Needless to say, these measures involve much more than simple test scores. Many of the projects undertaken in conjunction with the Alberta Initiative for School Improvement have also focused on transforming education in a way that addresses the needs of 21st-century learners.

Although attempts to transform schools at a deep level are clearly happening, they are difficult to initiate and even more difficult to sustain. Those that succeed are almost invariably ones in which (1) the school is the locus of change and (2) the jurisdiction provides support (McRae and Parsons 2008).

Systemic Barriers to Transformative Change

Among the system barriers to transformative change are these:

The persistence of bureaucratic accountability regimes: Accountability regimes are characterized by high-stakes testing at prescribed grades coupled with a proliferation of learning objectives, usually specified by third parties. One jurisdiction in Alberta, for example, has identified 216 objectives for successful completion of the Grade 7 science curriculum, 60 per cent of which are highly likely to appear on a high-stakes test during the year. Such an overemphasis on accountability tends to reduce creativity and stifle learning, especially at the primary level (Alexander 2009). In 2005, Alberta Education introduced a new social studies program that was supposed to focus on several literacies and involve new classroom assessment practices. Such an approach was fundamentally at odds with the province's 20-year history of using centrally administered diploma examinations to gauge student progress. In the end, the new program produced only modest changes in classroom assessment practices and no changes in the government's accountability pillar. Of the 67 learner outcomes specified for Grade 9 social studies, 22 can be assessed using multiple-choice questions. On a larger scale, only portions of 6 of the 20 broad student learning outcomes defined in Alberta Education's *Guide to Education* (Alberta Learning 1997) can be measured using paper-and-pencil tests.

The deprofessionalization of teaching: Educational jurisdictions that emphasize accountability and employ a state-imposed curriculum tend to diminish the professional role that teachers play in the delivery of education. This devaluation is especially ironic given that teachers are now better educated that at any time in the past (Hargreaves and Lo 2000). Researchers from the United States (McNeil 2000), Australia (Groundwater-Smith 2005) and Canada (Leithwood 2006) have shown that large-scale testing programs and other command-and-control mechanisms tend to narrow the curriculum and reduce teaching to little more than an effort to boost test scores. Teachers, in such regimes, are not encouraged to develop innovative instructional practices.

Adherence to a top-down model of change management: Some governments (notably the United States and Great Britain) impose new initiatives on such a regular basis that school jurisdictions have neither the time nor the resources to undertake changes at the local level. Because this approach ignores issues of local importance, it seldom produces changes that improve student learning.

Role confusion and mission creep: Hargreaves and Lo (2000) observe that the roles of teachers, social workers, educational psychologists, counsellors, nutritionists and others are beginning to blur. Increasingly, teachers are expected to accept responsibility for their students' social development, a role that, in the past, was performed almost exclusively by parents. Faced with

Accountability regimes are characterized by high-stakes testing at prescribed grades coupled with a proliferation of learning objectives, usually specified by third parties.

such role uncertainty, teachers tend to become more rigid in defining their responsibilities. Governments in Britain, Canada and the United States, by intervening in the day-to-day work of the school, tend to foster systemwide confusion about which professional group is responsible for what. Decisions about what should happen in schools are often made by a national or regional government hundreds of miles from the school. These decisions, in turn, are conveyed to school boards or local authorities, whose offices may be a mere hundred miles from the school. The school board then passes the decision on to the school principal who, in turn, issues instructions to the school staff. Such a multilayered approach to responsibility and accountability virtually ensures that schools do not change, even if they want to.

The inculcation of a culture of compliance: Teachers and school administrators feel obliged to comply with a host of externally imposed expectations: health and safety regulations; the demands of the provincial curriculum; privacy requirements; and targets and objectives set by their school district. Complying with such requirements tends to inhibit innovation and limit the possibilities for change. The Alberta government has recently expressed an interest in establishing business partnerships with Cisco, Intel and Microsoft to develop a method of assessing the skills that students will need in the 21st century.[16] Without consulting school communities about their priorities for improving student learning, this vaguely defined initiative will almost certainly do more harm than good.

Fragmentation: The school day, as it is currently structured, tends to be fragmented. The curriculum, for example, is divided into different domains (science, language arts, mathematics and so on) that are often disconnected from one another. On the basis of ethnographic studies, Wragg (1994) reports that students find such fragmentation disruptive.

In addition to facing these systemic barriers, schools are hampered in their efforts to change by such other factors as a lack of resources, ineffective capital planning, an inconsistent technology infrastructure (weak in some regions and strong in others) and a shortages of skilled ICT teachers in certain disciplines. Considered individually, these barriers may not seem insurmountable. However, in combination they are more than enough to prevent most school systems from achieving transformative change.

In retrospect, Alberta's piecemeal approach to educational reform since the mid-1960s and its emphasis on continuous improvement have limited opportunities for school improvement. True transformation will require breaking with the past and rethinking the way in which schools operate. Technology will undoubtedly play a crucial role in this transformation but only if the teaching–learning process itself is rethought to address the needs of 21st-century learners.

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[16] This initiative is discussed in Alberta Education's draft paper "Transforming Education: Assessing and Teaching 21st Century Skills." Ministry officials continue to extol the virtues of online testing programs. One of the ministry's fiscal priorities is to digitize its provincial testing programs, thereby augmenting what it calls its "data warehouse."

Unpacking the Chimera of Transformative Change

In Greek mythology, the chimera was an imaginary animal composed of the parts of many different animals. Today, chimeras are a real possibility, thanks to the science of gene manipulation. In both cases, the chimera is a human artifact that embodies our best hopes and worst fears. Those who promote the use of technology in education have created a modern chimera—known variously as the "21st-century learner" or "the digital native"—to describe individuals (typically young people) who are on the cutting edge of change. By contrast, those who are trying to catch up (typically older people) are labelled simply as "others."

In its submission to the minister of education regarding the *School Act* review, the Alberta Teachers' Association offered this summary of the learning process:

> Learning is a collective and highly relational activity that is dependent on a community of learners, in which certificated teachers create the conditions for student engagement to flourish. As highly skilled and knowledgeable professionals, Alberta teachers endeavour to support students in active and inquiry-oriented processes that engage them socially, emotionally, culturally and intrapersonally. The curriculum content, activities and resource materials that support these learning experiences need to be developmentally appropriate and to allow for suitable differentiation according to the learning needs and capabilities of the student. (Alberta Teacher's Association 2009c, 5)

In considering the government's current approach to implementing technology in Alberta schools, two questions arise: First, does Alberta Education see technology as a way of transforming the culture of schools from one of compliance (accountability and adherence to a prescribed curriculum) to one of innovation? Second, does Alberta Education regard technology as a way of engaging students by making learning less artificial and fragmented and more authentic and integrated?

With reference to the first question, numerous studies have demonstrated that the culture and leadership of a school play an important role in determining student performance. Schools that are characterized by high levels of engagement, collaboration, respect and adherence to values tend to have better student performance (De Witt et al 2003; Gaziel 1997; Murgatroyd 1991; Murgatroyd and Morgan 1993; Sullivan, Reynolds and Murgatroyd 1987). Crucial to building and sustaining a school's culture is the quality of the leadership (Fullan 2001). Both positional and situational leadership must be considered, as well as the "rules" of the organization (Mills and Murgatroyd 1991). Implementing technology can shift an organization's situational leadership, making the organization more receptive to dynamic innovation and less concerned about following rules.

With reference to the second question, technology can affect how deeply students are engaged in learning and whether the curriculum is integrated or

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Schools that are characterized by high levels of engagement, collaboration, respect and adherence to values tend to have better student performance.

fragmented. In more traditional schools, the curriculum tends to be fragmented into discrete subjects, each of which has many learning objectives. In progressive schools, by contrast, learners create knowledge and pursue activities that require a comprehensive understanding of an issue or subject. Because this approach obliges students to integrate knowledge from different areas, it deepens their understanding of an issue, problem or challenge.

Alberta Education's recent—and deeply flawed—effort to implement a distributed (or distance) learning strategy was driven, at least in part, by the promise that technology could enable students to learn anywhere at any time and at any pace. Such a promise, while compelling on the surface, was doomed to fail because it did not take into account the complex needs of Alberta's diverse school communities and the limitations of our current vision of schools and curriculum.

Fundamentally, education is about relationships and leadership and not, as the ministry seems to believe, about applying tools. Leadership is embodied not in a particular position, but in the many relationships that exist at all levels of the K to 12 education system. For that reason, IT leadership should not be considered in isolation from all other relationships in the system. Nevertheless, in many jurisdictions, the IT department, which tends to be largely male-dominated, is allowed to decide how technology is to be used in schools. Indeed, more than 80 per cent of teachers who describe themselves as IT leaders are male. Yet, 75 per cent of elementary teachers in Alberta are female. This kind of discrepancy between those making the decisions about technology and those using the technology raises questions about who gets to take up the leadership mantle in Alberta.

From the outset, Alberta Education's distributed learning strategy was mired in what Hargreaves and Shirley (2009) characterize as "third-way" thinking. That is, the strategy focused on technology rather than on the underlying and complex cultural interplay between the student, the teacher and the curriculum. Attempts to render the learning experience more flexible in terms of time and place than that offered in the traditional classroom raise a number of basic concerns. First, depending on where they live, not all students have access to the new technologies. Second, teachers (who are generally positive about the potential of distributed learning) do not always receive the professional development they need to take full advantage of the new technologies. Third, distributed learning teachers report that their efforts are not always adequately recognized by the education profession at large. Finally, the fact that the boundaries around instruction are less defined than is the case with conventional face-to-face instruction requires a new understanding of the responsibilities of teachers and students. With the provision of adequate funding and support, however, these challenges can be overcome.

Aside from these practical concerns, the biggest challenge facing Alberta Education's distributed learning strategy has been the lack of a shared vision about the fundamental purpose of education. As mentioned earlier, the Grade 7 curriculum in Alberta identifies about 1,300 learner outcomes.

As Figure 2 illustrates, education systems can be thought of as existing along two continuums. The first is a measure of system coherence, which can range,

on the one hand, from a culture of compliance in which bureaucratic dictates are accepted without question to, on the other, a culture that fosters ingenuity. The second measures the integrity of the educational program, which can range, on the one hand, from a state of fragmentation in which the curriculum is divided into discrete subjects to, on the other, one of synergy in which all subject areas are regarded as interrelated. The four resulting quadrants each reflect some aspect of current practice in Alberta schools. The three shaded quadrants are typical of Scenarios 1 and 4. The top right-hand quadrant illustrates Scenarios 2 and 3.

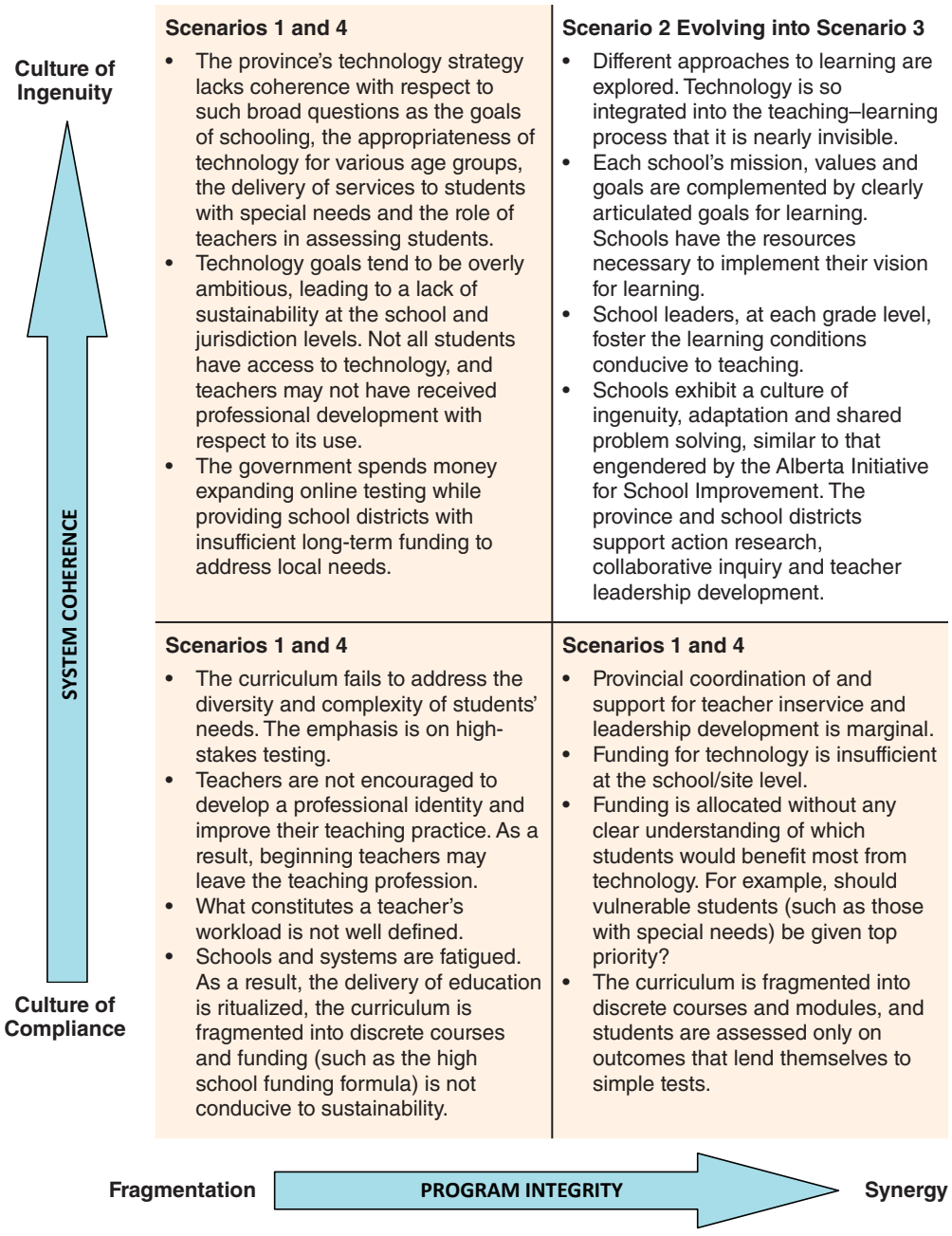
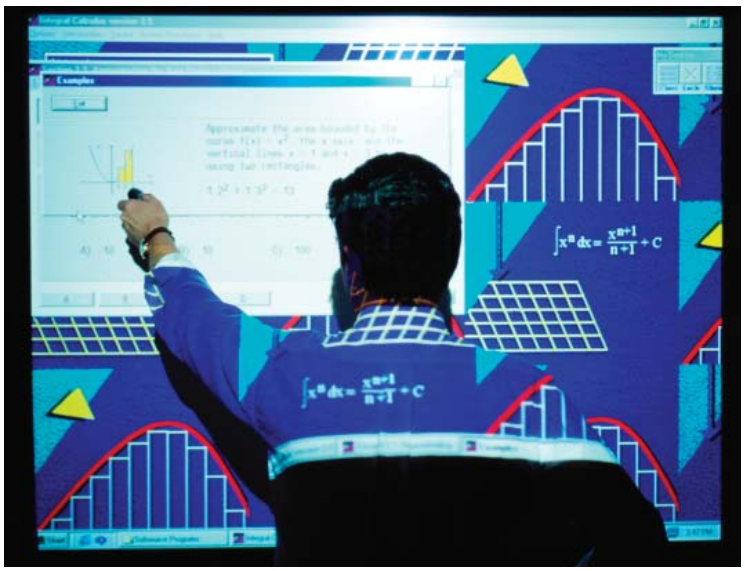


Figure 2: System Coherence and Program Integrity

The biggest challenge facing Alberta Education's distributed learning strategy has been the lack of a shared vision about the fundamental purpose of education.



One approach to technology that definitely does not transform schools into learning-rich environments is what a number of authors (Brown and Murray 2003; Cuban 2001; Oppenheimer 2003; Robertson 2003; Warshauer 2003) have called technological determinism. In this approach, decision makers simply introduce new technologies into schools in the expectation that they will, on their own, trigger beneficial and meaningful educational change. The literature is filled with case studies of schools in which computers and other equipment have been introduced into classrooms without any real understanding of how these technologies will affect learning. These accounts, which make for depressing reading, highlight the vast gap that exists between the dreams of the techno-promoters and the realities of students' everyday experiences (Peck, Cuban and Kirkpatrick 2002).

Technological determinism, with its promise of "learn anywhere/any time," can never lead to sustained transformational change. To use technology in a way that maximizes student learning, teachers require professional development. The ratio between the amount of time that teachers spend instructing and the amount of time that they spend receiving job-embedded professional development varies widely from country to country (Darling-Hammond 2009, 15). In South Korea, teachers spend approximately 35 per cent of their day instructing students and the remainder of the day engaged in professional development activities. In OECD countries, by contrast, teachers spend approximately 85 per cent of their day instructing students. Professional development is especially important for beginning teachers. New Zealand, certainly not one of the wealthiest jurisdictions in the world, manages to provide its beginning teachers with the equivalent of 20 per cent release time. Alberta contemplated embarking on such an initiative but backed out when world energy prices declined.

To truly transform schools we need to focus less on teaching and more on learning. Hollow promises about how technology will enable students to "learn anywhere/anytime" do little to foster student learning. Rather than using technology to reinforce and amplify traditional instructional methodologies, we need to focus on redesigning our fragmented curricula so that they emphasize problem-based learning. Doing so, in turn, requires not only that we understand what constitutes real learning in the 21st century but also that we provide teachers with the professional development required to

implement that vision. Bolstad and Gilbert (2006) suggest that, to support transformative change, technology must inspire, improve capability, provide enabling tools and support innovation (see Figure 3).

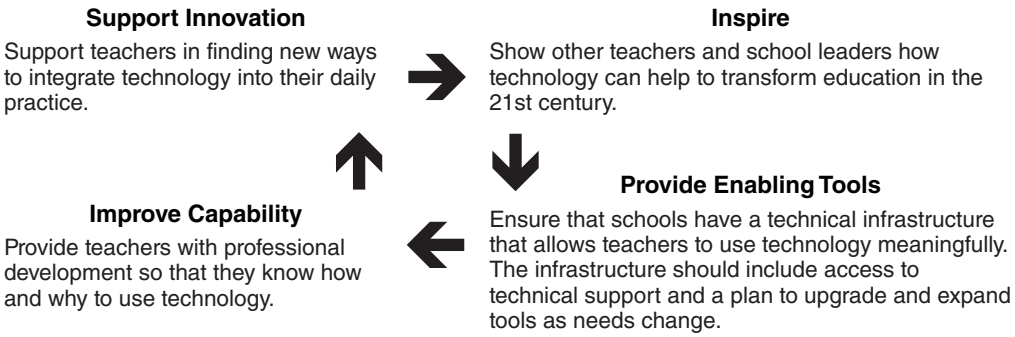


Figure 3: The Learning Loop for Change in Schools Using ICT

Some of the projects that Alberta Education currently supports already exhibit elements of this model. These projects typically focus on so-called 21st-century skills and aim to transform the process of learning in a way that is consistent with the Association's real learning first strategy. An example of such a project is the Emerge One-to-One Laptop Learning Initiative. Bolstad and Gilbert (2006) warn, however, that unless all four elements are present, efforts at infusing technology can have unintended consequences, as Table 1 illustrates:[17]

Missing Element	Result
Inspiration: Teachers and school leaders don't understand what is possible with technology or, if they do, these possibilities are not clearly linked to transforming education in a way that addresses the needs of 21st-century learners.	Teachers don't see *how* technology can fit into (or change) their teaching practice nor *why* or *if* it should. Technology is used mainly by enthusiasts to do old things in new ways. Pilot projects might be developed, but they don't get taken up into mainstream practice. Most practice doesn't change.
Enabling tools: Teachers and students do not have sufficient access to the types and quality of ICT tools they need to achieve their goals.	Even if they understand how technology can fit into (or change) their teaching practice, teachers have insufficient technology to accomplish their goals.
ICT capability: Teachers don't have enough, or the right kinds, of professional development to help them use technology.	Teachers either don't see *how* technology can fit into (or change) their teaching practice or *why* (or *if*) it should. Even if they understand the potential of technology, they do not have the facility to do what they want to do (or what they want their students to do) with technology. They are overwhelmed by the demands of the curriculum and see technology as a way of delivering the content of the mandated curriculum.
Support for innovation: Innovators are left to work things out on their own often in spite of, not because of, the wider school structures. They do much of this work in isolation or in their spare time.	Although pilot projects might be developed, they are not absorbed by the mainstream. As a result, most practice does not change. Innovators eventually suffer burnout.

Table 1: Problems That Can Occur When the Learning Loop Is Incomplete

"The 'anyone, anywhere, anytime' catchphrase is not only misleading when taken literally; its limitations are equally clear when identity, place and time are understood in more abstract and figurative terms."

—Friesen 2008

17 Adapted from Bolstad and Gilbert (2006).

To implement technology in a way that transforms learning, teachers need tools, professional development, support and inspiration. They also need to take into account the requirements of the entire school. However, while these elements are *necessary*, they may not be *sufficient* to transform learning.

To use technology to develop pedagogies consistent with the needs of learners, teachers require not only appropriate professional development but also a sophisticated understanding of how the entire teaching–learning process must change. In critiquing the naïve notion that technology alone can address all the community and global challenges facing the human race, philosopher and motorcycle shop owner Matthew Crawford (2009) urges the education community to rekindle the concept of *craftsmanship*, the idea that knowledge and competence should be based on one's immediate engagement with the physical world through what he calls the development of "manual competencies." His book, *Shop Class as Soulcraft—An Inquiry into the Value of Work*, calls into question the value of educational reforms that create artificial environments in which students are disengaged from the (sometimes) intractable problems of the real world. Crawford's work highlights the irony of earlier education policies that, on the one hand, stressed the importance of producing "knowledge workers" for the 21st century and, on the other, presided over the closure of vocational education and fine arts programs, a development that destined an entire generation of students "toward the most ghostly kinds of work."

Crawford's concept of civic life and human agency sheds light on what a Scenario 3 classroom would look like. In the real world, we cannot correct problems by simply pressing a delete button or by ignoring each other and "the natural debts we owe to the world." Indeed, "to live wakefully is to live in full awareness of this, our human situation" (p 208). Used appropriately in the classroom, technology will help students to enhance their relationships with other people, a skill that will become the true indicator of successful learning.

With its abundance of natural resources, Alberta is one of the richest jurisdictions on the planet. At the same time, 1 out of 12 Alberta children lives in poverty (Alberta Teachers' Association 2009a). The recent economic crisis has made Albertans aware of the vulnerability associated with global interdependence. For every 10-cent drop in the price of natural gas, Alberta stands to lose $126 million in tax revenue. Amid this volatility and uncertainty, people struggle for meaning and connection. Some turn to technology for answers. Indeed, there are now 3 billion cell phones in the world, and the number of text messages sent and received each day exceeds the population of the entire planet. But technology, however complex and advanced, can never substitute for human relationships and human ingenuity.

Future Directions

To ensure that technology is used in schools in a way that optimizes learning and helps to build a vibrant democratic society, education partners in Alberta will need to work together. Crawford's reminder that we need to focus on "the natural debts we owe to the world" and on our relationships with one another suggests that education, which is all about forging relationships, surely represents our greatest single hope for bringing about the kind of province that we want.

Here are some ways in which the education ministry could help transform the education system so that it truly addresses the needs of 21st-century learners:

1. Create a learning consortium to review leading practices and test new practices with respect to renewing and transforming the curriculum. Such a consortium would promote what is sometimes called *lateral capacity*, the notion that schools can learn from one another and, in so doing, create a shared sense of identity beyond the individual school. The consortium might, for example, explore how technology could be used to support (a) problem-based work in schools, (b) more inclusive schools and (c) students pursuing independent inquiry. The consortium could also foster school–university partnerships to undertake pilot projects aimed at improving learning outcomes in high-needs schools.

2. Establish a new targeted fund (comparable to AISI but with more focus on local decision making) to help transform 10 schools, in partnership with their respective communities, into major centres of professional development, research and innovation. With the assistance of additional staff, these schools would be encouraged to adopt the most promising practices emanating from AISI and would have at their disposal the technology they believe they need to make a difference. They would also be exempt from the requirements of the curriculum and the province's accountability pillar.

3. In consultation with the education partners, establish priorities with respect to future government investments in digital technology. These priorities might include expanding SuperNet, acquiring laptops for schools and engaging in long-term principled business partnerships. One option is to purchase a provincewide licence for *Intelligence Online*, which would allow teachers to collaborate with other teachers throughout the province in creating project-based activities. Another option is to negotiate a deal with vendors that would enable all high school students in the province to purchase powerful laptops at a discounted price. Providing vouchers to economically disadvantaged students would help close the digital divide.

4. Redesign, in consultation with the faculties of education, the Association and other education partners, Alberta's current programs of study. The focus of these revisions should be to reduce the amount of content that teachers must cover for each subject and increases the amount of content that teachers are expected to create through project-based learning. These

"Our modern economy privileges pure profit, momentary transactions and rapid fluidity. Part of craft's anchoring role is that it helps to objectify experience and also to slow down labor. It is not about quick transactions or easy victories. That slow tempo of craftwork, of taking the time you need to do something well, is profoundly stabilizing to individuals."

—Sennett 2009

revisions will result, over time, in the development of an outcome-based curriculum that focuses less on teaching and more on learning.

5. Work with the education partners to enhance teachers' leadership skills. Doing so will ensure that teachers have the skills necessary to transform their teaching practice from one that is based on instruction to one that uses technology to engage students in project-based activities. Ingenuity and leadership are the most powerful technologies we have.

6. Ensure that every community in Alberta has broadband access, whether wired or wireless, to the Internet. Transformative changes in education are not possible when Internet access in a community is limited to the school or the public library. Alberta could borrow a page from Finland, which became the first nation to make access to the Internet a constitutional right.

7. In collaboration with jurisdictions, universities, colleges and the Association, fund field research to determine the kinds of technologies that optimize student learning. This research could explore such topics as the learning needs of students in diverse communities, the social and physiological impacts of technologies on the well-being of children, and leading practices in curricular innovation. The government could offset the cost of this research by establishing business partnerships.

"The staggering truth is that almost everything that we've accomplished in the 20th century can be attributed to our public education system."

—Lois Hole, former Lieutenant-Governor of Alberta

Conclusion

The much-anticipated release of Alberta Education's report on *Inspiring Education: A Dialogue with Albertans* presents a timely opportunity to step back and ask some important questions about education in Alberta. How effective have earlier provincial education policies been in transforming the teaching and learning process, and what is the legacy of those policies? Do schools have the information and communications technology necessary to equip today's students with the skills that they will need to fulfill their career ambitions and develop the attributes needed to become engaged citizens in a vibrant democracy? What is the next step in developing a strategy for infusing technology in Alberta schools?

Past efforts at using emerging technologies in the classrooms have tended to focus on the pipeline rather than on the interrelationship between curriculum, pedagogy and technology. A case in point is Alberta Education's attempt, over the last couple of years, to launch a distributed learning strategy. The initiative has floundered largely because the government has taken into account neither the interrelationship among the various branches of the education ministry nor the diverse needs of Alberta's 1,950 schools. What is needed, by contrast, is an open and thoughtful discussion about the purposes of schooling and the kind of citizens that we want our schools to produce. Rather than deploying distracting catch phrases such as "technology leadership," "21st-century skills," "personalized (customized) learning," and "learning anytime, anywhere and at any pace," education partners need to focus on how the current industrial model of schooling needs to change to more accurately reflect today's realities. We require a more sophisticated and thoughtful approach to learning and technology that recognizes the complexities and unique learning needs of Alberta students.

By pursuing the seven directions for the future outlined above, Alberta has an opportunity to become a global leader in learning. All these directions, however, are premised on the notion that, before investing time and money in technology, policymakers need to examine the various ideologies that have driven attempts at technology integration in the past and then ask themselves what is really the most fundamental question of all, namely, what kind of society do we want to create in Alberta and what kind of teaching and learning will get us there?

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"We live in a moment of history where change is so fast that we begin to see the present only when it is already disappearing."

~ R.D. Laing

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