High Performing Districts in the Application of 21st Century LearningTechnologies

Review of the Research

Prepared for the College of Alberta School Superintendents

Sharon Friesen, PhD

Galileo Educational Network, University of Calgary

Jennifer V. Lock, PhD

University of Calgary

April 2010

CASS
College of Alberta School Superintendents

This is the second in a series of research papers commissioned by the College of Alberta School Superintendents designed to extend evidence informed school system leadership practice in the province of Alberta.

Additional information may be found at www.cass.ab.ca

Contact Dr. Jim Brandon
Director of Leadership Capacity Building
College of Alberta School Superintendents
jim.brandon@cass.ab.ca
1200, 9925 – 109 Street
Edmonton, Alberta T5K 2J8

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Introduction

The ways people live and work in today's world have significantly changed as the result of three dominant forces: i) the rise of globalization that has led to an economy driven by education and knowledge resulting in the need for increasing knowledge creation, ii) new findings about learning from the learning sciences which stress active engagement in new and different learning environments, and iii) the pervasiveness of networked digital technologies. Globalization, as a force impacting education, transcends socio-economic and political barriers. This is due in part to the advances of information and communication technologies. "The digital revolution, fired by the engines of Information and Communication Technologies, has fundamentally changed the way people think, behave, communicate, work and earn their livelihood. It has forged new ways to create knowledge, educate people and disseminate information" (UNESCO, 2005a).

The three forces highlighted above have dramatically impacted education. Currently, schools and school districts throughout the world are either calling for or undergoing significant changes. For example, here in Alberta, one way that globalization manifests itself in schools is in the form of increased diversity. An influx of ethnically diverse student populations in many schools has resulted in an urgent need to increase English as an Additional Language (EAL)programs. A culturally and linguistically diverse student population is now common in many school districts.

New findings from the learning sciences are bringing about changes to how educators understand learning. Education is in a time of transition in which older models of teaching and learning live side-by-side with new understandings of how people learn, new curricula, new knowledge, new pedagogies and new technologies. Entrenched images of schools as places in which information is dispensed to students through a one-size fits all curriculum and testing regime no longer fit with new findings about learning (Sawyer, 2006, 2008).

In addition, inexpensive, ubiquitous networked digital technologies, with an accompanying increase in freely available online content, are straining a system of education that was created for societies in which information and content were scarce. Most students in Alberta have access to an abundance of information at the click of a mouse or the tap of an app (application). This has been met with a range of reactions leading some educators to advocate for information literacy programs, others to block selected sites, some to focus their attention and resources on purchasing or providing pre-formatted content and still others to open networks and insist on teaching users to be responsible, ethical users.

> The research that has been carried out so far, especially in the areas of education, scientific research and new technologies, is still massively dependent on a fragmented vision of existing interactions and a strong technological determinism. Interest in the short-term impact of the introduction of new technologies into education and learning might lead to neglecting a deeper study of the new contents of education, their qualities and their formats. That development could become alarming at a time when education sometimes tends to give a high importance to the management of information pre-formatted by online content providers at the expense of the development of analytical skills and critical judgement. (UNESCO, 2005b, p. 21)

As leaders consider the role of networked digital technologies within their schools, it is important for them to focus their attention beyond merely the ability to access and retrieve information in the form of content. While the quality of content and information literacy are important, "The concept of knowledge societies[1] encompasses much broader social, ethical and political dimensions" (UNESCO, 2005b, p.17). "What really matters in the new age, isn't information at all. What is really significant is the relationships between people, and between people and organisations, that are made possible by the new modes of communication" (Gilbert, 2005, pp.120-121).

Currently, there is general agreement that the continued emergence towards knowledge societies will have profound effects on all aspects of our institutions and will create an ever-increasing need for learning, creativity and innovation (Hargreaves, 2003; Murgatroyd, in press; OECD, 2008, UNESCO, 2005a,b; Wagner, 2008). Such an emphasis has led some to argue that as a global society, we are going to need to be both a knowledge society and an innovation society—and therefore, must become a learning society (Hargreaves, 2003; UNESCO, 2005b). Regardless of the name, we are currently living during a time of societal transition.

Creating schools and school districts for today requires educators who are attuned to the demands of a knowledge society (UNESCO, 2005b). Learning is a key value in knowledge and innovation societies, for "what people learn, how they learn, and what they do with what they learn, is of primary importance" (Friesen, 2007, p. 147). Acknowledging this fact will mean that schools will need to broaden their focus from managing information exchanges to engaging learners, all learners—youth and adult alike—in collaborative knowledge building activity (Bransford, Brown & Cocking, 2000; Gilbert, 2005; Hargreaves, 2003; Hargreaves & Shirley, 2009; Jardine, Friesen & Clifford, 2006; Papert, 2004; Sawyer, 2008; Scardamalia & Bereiter, 2003; UNESCO, 2005b; Wagner, 2004). From within school structures and processes designed to meet the needs of the industrial past, educational leaders are called upon to invent new learning environments, new education systems to address

[1] The term "knowledge society" was used for the first time by Peter Drucker in 1969. Widespread use of the term began in 1990's.

our contemporary society. It is becoming clearer to many leaders, that simply improving the current one-size-fits-all system will not get their districts to where they need to go. District leaders in Alberta have experienced outside efforts to strengthen or improve an outdated system through the imposition of increased standardization and accountability measures. However, the research is clear, leaders need to formulate a directional shift as efforts to improve the obsolete are actually likely to make things worse (Fullan, Hill & Crevola, 2006; Gilbert, 2005; Hargreaves & Shirley, 2009; Harris, 2008).

21st Century Learning

More and more leaders recognize that the competencies[2] needed to thrive in today's society are different than those needed for industrial societies. However, for some, it is not that change is needed but rather, the nature of the changes being asked for that remains somewhat elusive. In many regards, this is to be expected because 21st century learning is not a single thing requiring a singular change. Rather, it is a multifaceted idea, consisting of advances from the learning sciences, combined with advances in networked digital technologies.

We have identified several documents that we believe district leaders will find useful in order to: i) grasp an understanding of 21st century learning, and ii) illuminate some of the ways they might make progress towards creating 21st century organizations.

1. Binkley et.al. (2010) working with the research group, Assessment and Teaching of 21st Century Skills (ATC21S), approach 21st century learning through a focus on the following skills:

   Ways of thinking

   - Creativity and innovation
   - Critical thinking, problem solving, decision making
   - Learning to learn, metacognition (knowledge about cognitive processes)

   Ways of working

   - Communication
   - Collaboration (teamwork)

[2] A competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilising psychosocial resources (including skills and attitudes) in a particular context. Competencies involve a mobilisation of cognitive and practical skills, creative abilities and other psychosocial resources such as attitudes, motivation and values (OECD, 2005, p.4).

Tools for working

- Information literacy
- Information and communication technology literacy

Living in the world

- Citizenship - local and global
- Life and career
- Personal and social responsibility - including cultural awareness and competence (Binkley et.al., 2010, p.1).

Embedded in this list of skills are a number of research findings from the learning sciences. However, to fully understand the impact of this list of skills on learning it is important to understand these skills within the context of knowledge-building classrooms, not as add-ons to existing timetables.

2. The U.S. Department of Education's national education technology plan (2010) "presents a model of 21st century learning powered by technology with goals and recommendations in five essential areas: learning, assessment, teaching, infrastructure, and productivity" (p. 4). This broader model of 21st century learning embraces advances from the learning sciences as well as the ways in which technology makes it possible for educators to enact these advances.

Learning

"The model of 21st century learning described in the U.S. Department of Education's (2010) national education technology plan calls for engaging and empowering learning experiences for all learners. The model asks that we focus what and how we teach to match what people need to know, how they learn, where and when they will learn, and who needs to learn. It brings state-of-the art technology into learning to enable, motivate, and inspire all students, regardless of background, languages, or disabilities, to achieve. It leverages the power of technology to provide personalized learning instead of a one-size-fits-all curriculum, pace of teaching, and instructional practices." (U.S. Department of Education, 2010, p.4).

Assessment

"The model of 21st century learning requires new and better ways to measure what matters, diagnose strengths and weaknesses in the course of learning when there is still time to improve student performance, and involve multiple stakeholders in the process of designing, conducting, and using assessment. In all these activities, technology-based assessments can provide data to drive decisions on the basis of what is best for each and every student and that in aggregate will lead to continuous improvement across our entire education system." (U.S. Department of Education, 2010, p.5).

Teaching
"Just as leveraging technology can help us improve learning and assessment, the model of 21st century learning calls for using technology to help build the capacity of educators by enabling a shift to a model of connected teaching. In such a teaching model, teams of connected educators replace solo practitioners and classrooms are fully connected to provide educators with 24/7 access to data and analytic tools as well as to resources that help them act on the insights the data provide." (U.S. Department of Education, 2010, p.6)

Infrastructure
"An essential component of the 21st century learning model is a comprehensive infrastructure for learning that provides every student, educator, and level of our education system with the resources they need when and where they are needed. The underlying principle is that infrastructure includes people, processes, learning resources, policies, and sustainable models for continuous improvement in addition to broadband connectivity, servers, software, management systems, and administration tools. Building this infrastructure is a far-reaching project that will demand concerted and coordinated effort." (U.S. Department of Education, 2010, p.7)

Productivity
"To achieve the goal of transforming education, we must rethink basic assumptions and redesign our education system. We must apply technology to implement personalized learning and ensure that students are making appropriate progress through our K-16 system so they graduate. These and other initiatives require investment, but tight economic times and basic fiscal responsibility demand that we get more out of each dollar we spend. We must leverage technology to plan, manage, monitor, and report spending to provide decision-makers with a reliable, accurate, and complete view of the financial performance of our education system at all levels. Such visibility is essential to meeting the goals for educational attainment within the budgets we can afford." (U.S. Department of Education, 2010, p.8)

3. After extensive consultation with Albertans and informed by current research, the Inspiring Education Steering Committee created a vision for education for 21st century learning (Alberta Education, 2010b). This vision encompasses three qualities and abilities: engaged thinker, ethical citizen and entreprenuial spirit.

Engaged Thinker
"An engaged thinker is someone who thinks critically and makes discoveries; who uses technology to learn, innovate, communicate, and discover; who works with multiple perspectives and disciplines to identify problems and find the best solutions; who communicates these ideas to others; and who, as a life-long learner, adapts to change with an attitude of optimism and hope for the future." (Alberta Education, 2010b, p.7)

Ethical Citizen
"An ethical citizen builds relationships based on humility, fairness and open-mindedness; who demonstrates respect, empathy and compassion; and who through teamwork, collaboration and communication contributes fully to the community and the world." (Alberta Education, 2010b, p.8)

Entrepreneurial Spirit
"An entrepreneurial spirit creates opportunities and achieves goals through hard work, perseverance and discipline; who strives for excellence and earns success; who explores ideas and challenges the status quo; who is competitive, adaptable and resilient; and who has the confidence to take risks and make bold decisions in the face of adversity." (Alberta Education, 2010b, p.8)

The Inspiring Education (2010b) vision for Alberta's education system is strongly oriented towards creating engaged, ethical, creative, innovative 21st century learners.

From the brief overview of the above 21st century learning models, plans and initiatives, it is clear that today's learning contexts means new expectations for students, teachers and administrators.

Before leaving this section, we want to turn for a moment to a discussion about two areas that tend to dominate conversations about 21st century learning: 21st century skills and digital technologies. Currently there is an abundance of literature on 21st century skills from a number of different organizations. The lists generally set out skills which include critical-thinking, analytical thinking, creative thinking, collaboration, teamwork and communication, etc. (Binkley et.al., 2010; enGauge, 2009; Standards for the 21st Century Learner, 2007; Partnership for 21st Century Skills). Many of the skills contained in these lists have been part of educational lexicon since the early 1960's, while others on the list are new skills. There is general agreement among researchers that both old skills and new skills are needed for the 21st century. There is also general agreement that the learning contexts, in which these skills must be cultivated, are different from those that dominated in previous centuries. Twenty-first century skills, are a component of 21st century competencies, not an addition to 20th century structures, curriculum and pedagogies. You can't create 21st century learning by merely adding a set of skills onto industrial pedagogy, just as you can't create a butterfly by gluing wings onto a caterpillar. Today's students need to be able to work creatively with ideas from a variety of disciplines turning those into useable knowledge in order to participate in and contribute to knowledge intensive societies (Bransford, Brown & Cocking, 2000; Dede, 2007b; Gilbert, 2005; Hargreaves, Jardine, Friesen & Clifford, 2006; Papert, 2004; Sawyer, 2008; Scardamalia & Bereiter, 2003; UNESCO, 2005b; Wagner, 2004). Dede (2007b) contends

> a frequently neglected cluster of 21st-century skills is *collective problem resolution via mediated interaction*. In much of 21st-century work, problem

> *finding* (the front end of the inquiry process: making observations and inferences, developing hypotheses, and conducting experiments to test alternative interpretations of the situation) is crucial to reaching a point where the work team can do problem *solving*. Individual and collective metacognitive strategies for making meaning out of complexity (such as making judgments about the value of alternative problem formulations) are vital. Some of the time, team members communicate face-to-face; other times they communicate across barriers of distance and time using various media like videoconferencing or email (mediated interaction). Knowledge is grounded in a setting and distributed across a community, rather than abstract and isolated within individuals. (p.16)

Some district leaders have focused on the acquisition and use of a variety of digital technologies, including network infrastructure, learning object repositories, learning management systems, video conference networks and lap top programs, etc. believing that the technology, itself, was strong enough to bring about a change. For some, such a focus on digital technologies have led to equating 21st century learning and the acquisition of 21st century skills. While networked digital technologies are a necessary part of 21st century learning, they, in and of themselves, do not necessarily guarantee the kind of learning adovcated by the learning sciences. In fact, despite increased use of technologies, some researchers report the full potential of computers has not been realized and instructional practices have not significantly changed (Brown & Hill, 2009; Cuban, 2001; Cuban, Kirkpatrick & Peck, 2001; Fox & Henri, 2005). This research strongly suggests that simply using technology in schools today or having access to technology is not enough to lead to 21st century learning.

New contexts advocated by the learning sciences have implications for the ways in which top performing school districts were identified for this literature review. To be included, it was not sufficient that districts merely identified or focused on students acquiring 21st century or on the acquisition of digital technologies. The application of learning technologies needed to be put in service of: (i) building 21st century competencies in the ways identified by Dede (2007b) by all adults and students alike, across the school district and (ii) creating innovation and creativity through collaborative knowledge building activity as identified by the learning sciences (Bransford, Brown & Cocking, 2000; Gilbert, 2005; Hargreaves, Jardine, Friesen & Clifford, 2006; Papert, 2004; Sawyer, 2008; Scardamalia & Bereiter, 2003; UNESCO, 2005b; Wagner, 2004). "You can't just spinkle 21st century skills on the 20th century donut. It requires a fundamental reconception of what we're doing" (Walser, 2008, p.3).

Review Methods

Selection Criteria

Many research as well as conceptual articles, research reports and books were examined for this literature review. The following outlines the process used to select academic and/or professional literature for the review. One of the challenges in such a review is determining the criteria for identifying 21st century organizations. A number of research sources were particularly helpful in this regard (ATC21S, 2009; Bolstad & Gilbert, 2006; Bransford, Brown & Cocking, 2000; Dede, 2007a, 2007b; Harris, 2008; Mulford, 2008; OECD,2008; Sawyer, 2008; Stoll, 2009). The criteria for selecting high performing districts, established from the research literature, were:

- Districts in which digital learning technologies were utilized by adults and students alike to build 21st century competencies, of which 21st century skills is a component.
- Districts in which digital learning technologies are readily accessible by adults and students at the point of learning.
- Districts involved in knowledge building activity, where innovation and creativity were developed throughout the organization.

Search Procedure

A rigorous search of publically available academic and professional literature occurred from the end of January to mid March, 2010. Key words such as knowledge, knowledge building, knowledge organization, technology, information and communication technology, school superintendent and leadership were used in mining for resources that were relevant, appropriate and current. The following search strategies were conducted within the identified data sources:

- Manual searches of relevant journals, published research reports and books.
- Electronic searches on the following databases: Academic Search Complete, CBCA Education, ERIC, Google Scholar, Education Research Complete, ProQuest Dissertations and Theses, and WorldCat.
- Internet searches using Google search engine.

Analysis

Through the use of GoogleDocs, the authors identified and shared potential resources and began to co-create a reference list based on their independent, strategic literature searches. Multiple reads and co-reading of the documents occurred, along with scholarly discussions to verify and validate key concepts and information being brought forward from the literature to be captured in the review. The following criteria were used in the selection of the literature:

- Robust research that included either qualitative and qualitative methodologies.
- Reports, articles and books written by academics and/or professional organizations known nationally and/or internationally within the scholarly community.
- Literature published internationally, nationally and provincially.
- Priority was placed on literature published within the past three to five years.

Literature Review

"We have lots of good school districts in our country. We have just a few great school districts. Getting from good to great is a quantum leap. Technology plays such a significant role in that. - Dr. John Morton, Superintendent, Newton (KS) Public Schools" (Consortium for School Networking Initiatives, n.d.)

Pervasiveness of Technology: Technology Context for Education

A number of themes emerged in the research literature on characteristics of 21st century high performing school jurisdictions. These themes highlight the need for district administrators to attend to a number of aspects of the learning environment so that policy decisions are made for today and guide the work of tomorrow.

1. Emerging technology trends
2. Technical infrastructure
3. Pedagogical practices needed for technology-rich environments.

Emerging Technology Trends

We live in a time of rapidly changing technology that is impacting the way we live and the way we learn. The Canadian Council on Learning (2009) reported that in 1998, one in four households in Canada had Internet access and less than 30% of Canadian households used mobile phones. Within the past ten years, there has been significant growth and use of personal computers, broadband internet and mobile phones. "In 2006, three-quarters of Canadian households had a personal computer, 67% had cell phones and seven in 10 cell-phone users claimed to have their wireless device with them at all times" (p. 22). Statistics Canada (2008) reported that in 2007, 73% of Canadians age 16 and older used the internet, with many on a daily basis. Further, 85% of people in Calgary aged 16 and older used the Internet and 78% in Edmonton. In 2007, most individuals reported using the Internet at home, 41% at work, 20% at school and 15% at a library. The most popular online activities from home was email and general browsing. Many users also banked, paid bills and ordered goods and services online.

The advancements in technology from Web 1.0 to Web 2.0 and to Web 3.0 are shifting the way we work. Web 1.0 was dominated by browsers containing static screensfull of information, with the user working in isolation. The second generation of the Internet, Web 2.0 is different because it "it is more interactive, allowing users to add and change context easily, to collaborate and communicate instantaneously in order to share, develop, and distributed information, new applications, and new ideas" (Scrhum & Levin, 2009, 183). With applications such as wikis, blogs, voice threads, RSS feeds, social networking (e.g., MySpace, Facebook), and Google Apps, users can work online with multiple users within a collaborative space. These applications also permit users to access open source resources. Web 3.0 is viewed as "Semantic Web technologies integrated into, or powering, large-scale Web applications…The base of Web 3.0 applications resides in the Resource Description Framework (RDF) for providing a means to link data from multiple websites or databases" (Hendler, 2009, pp. 111-112).

Over the past several years, with greater access and connectivity in schools, we have seen a rapid growth in the use of Web 1.0 in the form of Internet-based content (e.g., LearnAlberta) and virtual libraries. More peripheral apparatuses are being used to support teaching and learning, such as electronic interactive whiteboards, digital still cameras and digital video cameras. Communication and collaboration technologies that support distributed learning[3] have resulted in an expanded use of learning and content management systems, webconferencing applications, and videoconferencing. Web 2.0 interactive and collaborative technologies becoming more common place in some school districts. OECD (2009) reported that while there is "much hype about Web 2.0 and its educational potential very little is known about ... the impact of creating and nurturing virtual social networks (p.15).

According to *The 2010 Horizon Report* the following technologies were identified as being the focus within innovative work around the world and show promise for greater impact on education:

- Mobile computing – the use of network-capable devices (e.g., laptop, personal digital assistant, smart phones) are gaining widespread use in educational institutions and will require addressing concerns about privacy, access and classroom management.
- Open Content – which is expected to reach mainstream use in the year. Variety of open content is expected to reach the mainstream use within the year. In many

[3] Distributed learning is a model which offers multiple channels of learning and teaching through a variety of delivery formats and mediums—print, digital (online), and traditional delivery methods—allowing teachers, students, and content to be located in different, non-centralized locations. Distributed learning connects students with teachers across the province, and in so doing, provides choice, flexibility, and authentic learning experiences. Distributed learning includes all forms of learning where, by design, students and their teachers may be separated in time and/or space for some or all of their interactions (Alberta Education, Distributed Learning Resources Branch http://www.education.gov.ab.ca/dlrb/default.html)

parts of the world, open content reflects a significant shift in the way students learn.

- Electronic Books – within the past year, there has been a major upswing in acceptance and use.
- Simple Augmented Reality – augmented or virtual reality that is now accessible to many and requires no specialized equipment.
- Gestured-Based Computing – used in consumer market, but is having a growing number of prototype applications in training, research and study. These digital devices are controlled by movements of the finger, hand, arm and body.
- Visual Data Analysis –are a way of understanding and displaying patterns within large data sets through visual interpretation. Models can be manipulated in real time and provide new opportunities to explore (Johnson, et al., 2010).

Further to these, Bonk (2009) identified three converging macro trends:

1. "The availability of tools and infrastructure for learning (the pipes)
2. The availability of free and open educational content and resources (the pages)
3. A movement toward a culture of open access to information, international collaboration, and global sharing (a participatory learning culture)" (p. 52).

Bonk argued that the "convergence of these three macro trends has put in motion opportunities for human learning and potential never before approached in recorded history" (p. 52).

> The laying of the vast technological pipes with an overflowing store of educational content is only part of the story. In effect, though people perpetually explore online content and materials to learn, a final ingredient is needed to truly open education for more democratic participation and personalization. That component has to do with culture and psychology as much as technology. Thus, the third macro trend electrifying all of human kind today is the creation of a culture that collaboratively builds, negotiates, and shares such knowledge and information: a participatory learning culture. If the resources and infrastructure are in place but he education community, as well as society as a whole, fails to maximize their power, then millions of unique learning possibilities will be lost. (Bonk, 2009, p. 53)

With the evolution of technology and the development of robust infrastructures, we see emerging new trends in how the technology is supporting learning. For example, over the past decade there as been a growth of e-learning in Canada that can be attributed to the following factors:

- advancements in digital technology that are enriching interactivity and the media content of the web;
- increasing global reach of the knowledge-based economy and society;

- increasing bandwidth and better delivery platforms and repositories;
- increased availability of a growing selection of high-quality e-learning products and services—such as content providers, authoring tools, training management systems, portals, delivery systems and integrated solutions;
- emerging technology standards that facilitate compatibility and usability of e-learning products;
- integration of knowledge management and e-learning into a more unified vision for enterprises whose goal is to increase their learning productivity; and
- increased sophistication of e-learning users—citizens, lifelong learners, students in K–12 (kindergarten to grade 12, or elementary and secondary school) and post-secondary education, workplace managers and human resources specialists, etc. (Canadian Council on Learning, 2009, p. 34)

Sixth Sense[4] technology looms on the forefront of the emerging technologies. The power of Sixth Sense lies in its potential to connect the real world with digital information creating the seamless integration between the two worlds.

It is important for district leaders to attend to emerging technologies as they consider ways in which they lead and support their organizations to become 21st century knowledge-intensive organizations. The computer is a new medium of representation and creation in our society. Historically, every new medium has expanded people's sense of what is "real." Each new medium brings with it new realities. For example:

- When photography came into being people were confronted anew with unanswerable questions, reframing what they knew, and reframing the familiar. Photographs elevated what people could see and know about in the world. They elevated people's level of thinking and understanding. The pictures could not have been taken without the technology of the camera and people could not have seen or known in the same way as they did before photography.
- The clay tablets that Moses carried down from the mountain showed people in ways that orality could not that laws could be cast in stone, transferred to future generations, thought about, rationalized.
- Print and the printing press reframed how people thought about ideas, organized ideas and thoughts, added clarity to ideas, and carried ideas to the masses.

In highlighting the need to attend to emerging technologies, we are not saying that district leaders need to be knowledgeable about the end applications. However, we are saying that district leaders need to be working with and attending to the

[4] Sixth Sense technology was introduced by Pranav Mistry during a TED Talk http://www.ted.com/talks/lang/eng/pranav_mistry_the_thrilling_potential_of_sixthsense_technology.html

instructional core[5] and the ways in which emerging technologies impact, change, threaten, enrich or enhance the instructional core.

Technology Infrastructure

Technology infrastructure supports the design, deployment and use of both individual technology-based components and the systems of such components. As such, it plays a central role in the learning and innovation process and the promotion of the diffusion of technologies. Thus, it is an important element contributing to the operation of innovation systems and innovation performance in any 21st century school district (Antonelli, Link & Metcalfe, 2009).

Building the technology infrastructure is not a one time financial investment or event. Rather, it is the ability to grow the infrastructure in fiscally and educationally responsible ways that support the teaching and learning and administrative demands of a knowledge organization.

Hannafin's (2008) technology audit within a K-12 environment reflected many of the challenges schools and school jurisdictions encountered with technology infrastructure. Focus groups in Hannafin's (2008) study noted concerns about hardware and network performance. He found that the infrastructure had become outdated. The district had no cycle for replacement and no systematic policy was in place for purchases and upgrades. Further, access to computers was reported to be a major obstacle for teachers. From this audit, it was evident the impact first-order and second-barriers to change (Ertmer, 1999) had on how technology could support learning and innovation.

Brown (2010) reported that one of the common dilemmas are the competing interests of central office and individual school sites in terms of technology management which is often referred to as "enterprise" versus decentralized configuration. A highly centralized model of technology management occurs within an enterprise configuration where schools comply to central office decisions and services. Brown (2010) noted, "if compliance and accountability are too tightly controlled, the outcome is alienated employees who become passive and do not continue to seek creative solutions to problems" (p. 53). Brown went on to note, with a decentralized model allowing for greater local discretion, there is enhancement of creativity in problem solving and individual solutions. Yet, within the decentralized model, there are certain functions that are better handled efficiently and effectively from central location (e.g., email). The tension between central and school site technology management opens a space for the examination of what needs to be customized to be responsive to local needs and demands (e.g., curricular demands) and what is best addressed through a centralized process (e.g., security and bulk purchasing).

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[5] The essential interaction between teacher, student and content that creates the basis of learning. (Elmore, 2003).

A relative new comer to infrastructure is internet-based computing called cloud computing. As reported in the *2010 Horizon Report,* "technologies we use are increasingly cloud-based[6], and our notions of IT support are decentralized" (Johnson, et al., 2010, p. 4). New challenges are presented when data no longer reside on locally maintained servers. A move towards more cloud computing within a district might mean that Information Technology (IT) support might be deployed to meet different demands at the local and district level. While some opportunities are made available when a school district is not required to develop and main numerous servers to support teaching and learning. District leaders need to be aware that a move to cloud computing requires that new policies and practices be in place.

Pedagogical Practices

The introduction of teaching practices to create the types of learning environments advocated by the learning sciences which are made possible by the mindful infusion of networked digital technologies requires a significant change in pedagogical practices (Bransford, Brown & Cocking, 2000; Friesen, 2009; Koehler & Mishra, 2008; Sawyer, 2006; Scardmalia, et.al., 2010). When educational technologies are embedded in robust 21st century knowledge-building environments they "offer ways of teaching and learning that can transform children's educational experiences, not only making it more personal and allowing them to develop more broadly, socially as well as academically, but also opening up the possibilities for creativity, raising aspirations and making connections" (Galloway, 2009,p. 64). Given the potential of the power of technology to enable, extend and deepen innovative learning spaces, district leaders need to ask to what extent is this the reality within their school districts?

With the massive investment in technology, this is a necesary and relevant question. However, it is one that is complex and not easy to answer. The complexity of this question has been examined through OECD (2003) results and the UNESCO report (2005b) .

The analysis of OECD's PISA results (2003) highlighted the correlation between technology use and educational attainment. This correlation PISA revealed a weak but positive relationship between the use of technology at school and academic attainment. Other correlations were also established with regard to student access to technology, students' previous experience with technology use, frequency of use and confidence level in ability to carry out daily tasks using a computer and/or the Internet. Most interesting was the correlation between home use and academic

[6] Cloud computing is internet-based computing whereby shared resources, such as documents, spreadsheets, calendars, email, concept-maps, etc.; software applications, such as Google docs, spreadsheets, etc.; and other information are provided to computers and other devices on-demand, like a public utility.

attainment which was greater than the case of school use in most countries, even when allowances were made for the effects of the different socio-economic contexts. In particular, students who did not have access to a computer at home tended to be lower achievers than the others, and secondly, it would also seem to be the case that students using computers at home less often had below-average results. This finding suggests that students' use of computers to support learning whether at home or at school, increases students' academic attainment.

The OCED (2009a) examined the impact of technology on learners through an examination of empirical studies in the areas of cognitive skill development, social values and lifestyles and education performances. Evidence from research on the impact of digital media use on cognitive skills found impact in this area were difficult to generalize, as studies were always placed in context and set in relation to a number of factors such as age, gender, socio-economic background, time spent in computer activities, preference for certain activities" (p. 8). It was noted, that digital media contained features that provided opportunities for enhancing various cognitive skills.

Second, the report noted there appeared to be no conclusive evidence with regard to the effects of ICT on academic achievement.

> There is insufficient evidence to affirm either the superiority or inferiority of technology-rich methodologies. This would seem to be the outcome of two systematic reviews of literature conducted recently, one of which concludes that "in general and despite thousands of studies about the impact of technology use on student attainment, it is difficult to measure and remains reasonably open to debate" (Infodev, 2005), and the other, that "some studies reveal a positive correlation between the availability of computer access or computer use and attainment, others reveal a negative correlation, whilst yet others indicate no correlation whatsoever between the two" (Kozma, 2006). (OECD, 2009b, p.8)

While some researchers reported gains in academic attainment, the analysis of the studies to date, reported "no consistent relationship between the technology availability and use, on the one hand, and educational attainment, on the other" (OECD, 2009a, p. 13). However, they also noted that this was not to say that there were no impressive developments anywhere, but they tended to be discrete, isolated and hardly scaled up, thus not having a real systemic effect. References to various examples of studies reflected the inconsistency in terms of the positive relationship in the teaching of math, as well as the same inconsistency was noted in the analysis of the relationship between the home use of computers and academic attainment. It is evident that the question "is not which new technology leads to increased productivity, but which new technology-supported methodologies improve student performance over traditional ones, if any at all, and which other factors intervene" (OECD, 2009a, p.13).

Researchers reported that one reason for the mixed results of the effects of ICT on academic attainment might be that "they [teachers] are teaching means that can be

used with a wide range of methodologies and strategies – and also because insufficient effort has been made about evaluating a relationship as complex as the one between ICT access, frequency of use at school and out of school, and academic achievement" (OECD, 2009a, p. 11). The no effects of ICT on academic achievement might be that the technologies are merely being tacked onto more conventional industrial pedagogies (Brown & Hill, 2009). In a measurement of effects on eight different meta-analysis 335 studies and 61 controlled experiments, Kulik (2003) showed that school attainment does improve with the use of digital technologies but only if certain pedagogical conditions are met. These findings are consistent with findings from Jacobsen, Saar and Friesen (2010) and Friesen, et.al. (2009).

What becomes increasingly evident, analyzing the relationship between technology, both access and use, and learning outcomes is not simple. Numerous studies have conducted that examine technology use in school (e.g., interactive whiteboards, podcasting, wikis, etc). "Time taken to embed the use of technology, school-level planning and learners' skills and models of learning are all important in mediating the impact of technology on outcomes. Some new findings add more positive evidence of the benefits of technology for learning" (Becta, 2009b, p. 24). While others report mixed and sometimes contradictory findings (OECD, 2003, 2009a,b). What remains clear is that teachers and leaders continue to struggle to create the types of learning environments that the learning sciences advocate made possible and powered by networked digital technologies and researchers continue to search for ways to adequately capture, analyze and interpret these new environments. A number of researchers (Friesen, et.al., 2009; Jacobsen, Saar & Friesen, 2010; OECD, 2009a,b; Sawyer, 2006, 2008) recommend that leaders gain a clear understanding of 21st century teaching and learning advocated by the learning sciences so they can recognize, encourage and support it in their school districts thereby ensuring that digital technologies are used to create 21st century learning environments.

Policy Priorities to Support 21st Century Learning with Technology

School district leaders are charged with creating policies to act as blueprint for a consistent course of action as it pertains to 21st century learning powered by technology. As leaders wrestle with significant changes that new ways of teaching, learning and leading place on structures and processes, questions need to be asked about how educational priorities are designed to frame policy decisions.

While some districts still have an emphasis on teaching all students technical skills, the research is clear, that in most OECD countries a majority of students acquired the technical skills required to manage computers and the internet outside schools and without any external support—mostly by discovery and trial and error (OECD, 2006). Being attuned to these findings helps leaders make decisions about where to invest time, support and valuable human and monetary resources (OECD, 2009b).

The report by International Society for Technology in Education (ISTE), the Partnership for 21st Century Skills and the State Educational Technology Directors

Association (SETDA) (2007) recommended renewed emphasis on technology in education with action to be taken on three fronts:

1. Use technology comprehensively to develop proficiency in 21st century skills.
2. Use technology comprehensively to support innovative teaching and learning.
3. Use technology comprehensively to create robust education support systems (p. 3).

The Consortium of School Networking (CoSN) conducted a survey on Web 2.0 technologies in 2009, in which 1200 school district administrators from the United States participated. The district administrators reported they were advancing the effective use of Web 2.0. The majority reported accepting a high level of responsibility for modeling Web 2.0 use, teaching Web 2.0 safety, preparing students to be ethical and effective users, and educating parents about Web 2.0. The following is a summary of the key findings:

1. The nation's school district administrators were overwhelmingly positive about the impact of Web 2.0 on students' lives and on their education.
2. Keeping students interested and engaged in school was the top priority for Web 2.0 use in American schools.
3. The majority of district administrators believed that student use of Web 2.0 should be limited to participation on approved educational websites.
4. The majority of school districts banned social networking (70%) and chat rooms (72%) while allowing prescribed educational use for most of the other Web 2.0 tools (e.g., blogging, using wikis, sharing music or sound files, sharing visual media, posting messages, participating in virtual worlds, playing interactive games, creating polls or surveys, etc.).
5. While reporting low levels of general use, curriculum directors described significant opportunities for use of Web 2.0 tools in curricula and teaching materials.
6. Curriculum directors reported that Web 2.0 was used most effectively at all grade levels in the content areas of social studies, writing, science, and reading.
7. While there was broad agreement that Web 2.0 applications held educational value, the use of these tools in American classrooms remained the province of individual pioneering classrooms.
8. Web 2.0 was outpacing K-12 education's current capacity to innovate."

(Lemke, Coughlin, Garcia, Reifsneider, & Bass, 2009, pp. 7- 11)

Evidence from Lemke, et al.'s (2009), survey identified the ways in which technology can and needs to be used to foster the rich, robust learning. A number of researchers have described this rich, robust learning as students learning in meaningful ways requiring pedagogical practices directed towards: (i)nurturing active and in-depth learning, (ii) requiring authenticity, iii) fostering collaboration, iv) utilizing prior knowledge and experience, iv) using formative assessment, v) organizing knowledge around key concepts and connections and vi) supporting the development of meta-cognitive skills (Bransford, Brown & Cocking, 2000; Darling-Hammond, 2008; Friesen, 2009; Sawyer, 2006, 2008; Willms, Friesen & Milton, 2009). Meaningful learning with digital technologies should primarily be used by the learner in constructing knowledge, rather than a medium to deliver instruction (Jonassen, et al., 2008; Scardamalia, et al., 2010).

What was interesting from Lemke's, et al.'s (2009) survey was that "most school districts, policies and practices regarding Web 2.0 are only now evolving. While district administrators recognize the promises of Web 2.0 for learning, they are extremely wary of the potential pitfalls" (p. 19).

To move onto this new 21st century learning landscape requires a shift in thinking and practice and the ways it is enabled, supported, enriched and deepened by technology and the infrastructure. Becta (2009a) reported that organizations are finding that it is not sustainable to use a blocking and banning approach designed to limit exposure to risk. Rather, the organization needs to "focus on a model of empowerment; equipping learners with the skills and knowledge they need to use technology safely and responsibly and managing the risks, whenever and wherever they go online; and to promote safe and responsible behaviours in using technology" (Becta, 2009a, p. 2).

Policies to support learning environments based on findings from the learning sciences, which require networked digital technologies, require a number of policy shifts within school districts. District leaders will need to ensure that policy is focused on the creation of 21st century learning environments.

Changing Nature of Learning and Learners: Learning Contexts for Education

We will now turn our attention to two factors driving the need for change in schools: i) the changing nature of the student body and ii) the changing nature of recent discoveries from the learning sciences on learning itself.

This generation, sometimes called New Millennium Learners (NML) (OECD, 2007, 2009) understand the power of social networks, cloud based computing and technology and have a high level of absorption for such technologies in terms of facilitating work and social transactions, changing work practices and engaging in global conversations (OECD, 2009a). "They will have these skills despite their school systems, which are in general currently appear largely unable to engage these

technologies in powerful ways in the pursuit of learning, knowledge and understanding" (Murgatroyd, in press).

As noted earlier in this report, the learning sciences have contributed significantly to societies changing understanding of the nature of learning. Learning sciences investigations are developing new models of how knowledge-building activity develop both innovation and creativity (Bransford, Brown & Cocking, 2000; Sawyer, 2006, 2008; Scardamalia, et al., 2010). Some of the ideas arising from this research, such as scaffolding, have been part of the educational landscape for sometime (Vygotsky, 1987). Vygotsky's idea of the zone of proximal development (ZPD), which is closely related to scaffolding, is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (Vygotsky, 1978, p.86)". Practices such as scaffolding, based on ideas from ZPD are an essential component of the 21st century learning environment. Csíkszentmihályi's (1990) research, both paralleling and building on Vygotsky (1978) research, demonstrated how the combination of challenge and skill, the two components of scaffolding, are related to each other in order to foster creativity and innovation within people.

Gardner's research (2006) highlighted five minds or dispositions that people need to thrive in the coming world. These five minds are:

- The disciplined mind: mastery of major schools of thought (mathematics, science, history) or professional craft.
- The synthesizing mind: ability to integrate ideas from disparate disciplines or spheres into a coherent whole and to communicate that integration to others
- The creating mind: building on the previous two, a creating mind has the capacity to uncover and clarify new problems, questions, and phenomena
- The respectful mind: awareness and welcoming of and appreciation of differences among humans
- The ethical mind: more abstract than respectful mind; fulfillment of one's roles and responsibilities as a worker and citizen (p. 3).

What is clear from the learning sciences research literature, noted here and previously in this report, is its potential implications for educational policies, structures, processes and practices.

Millenium Learners' Experience Learning in School

"The CERI Project on the New Millenium Learners (NML) started in 2007 with the global aim of investigating the effects of digital technologies on learners, particularly of school age, and providing some recommendations on the most appropriate institutional and policy responses from the education sector" (OECD, 2009a, p.3). This scientifically-based research, while still ongoing has surfaced some important preliminary findings with implications for school district leaders. They note that while many school districts have invested heavily in building network infrastructures, they remain under utilized in schools for learning purposes.

Research (OECD, 2009a) focused on the nature of student activity in schools revealed students spend 52% of their class time copying from a book or the board and 33% of their time listening to a teacher. What becomes quite apparent from this research study is how little student activity involved innovation or creativity—knowledge building activity. This research suggested students requiring new competencies (knowledge and skills) to participate in and contribute to their world today do not seem to be building them in school.

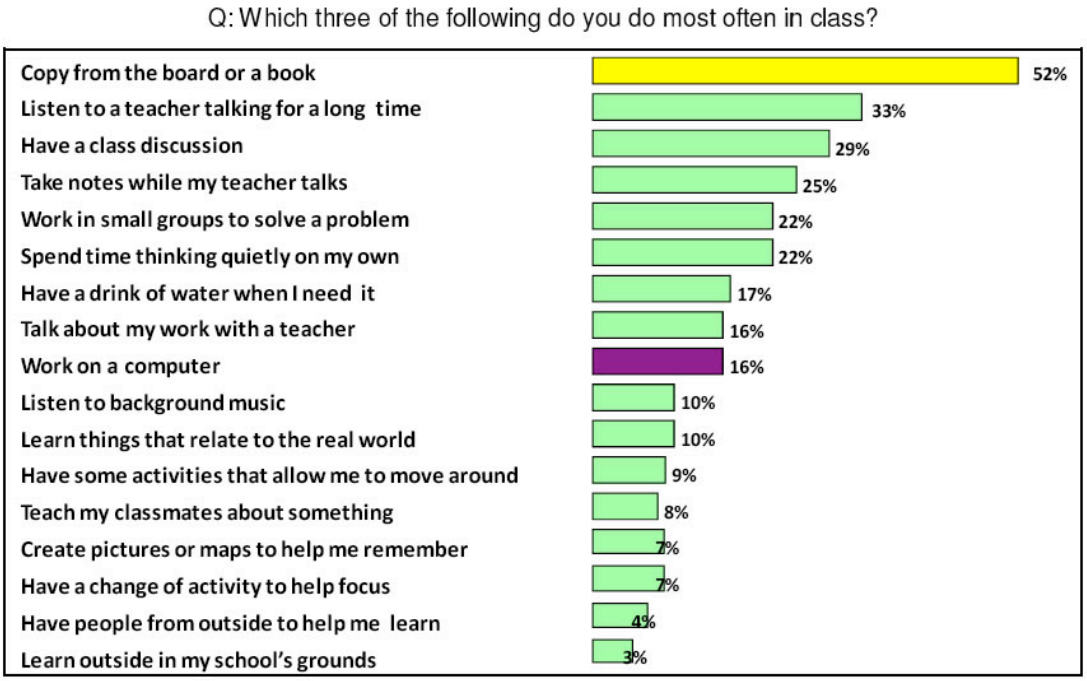

Figure 1: Survey results from what activities students in school do most often (OECD, 2009a, p.17)

This research also indicated that NML preferred to work in groups.

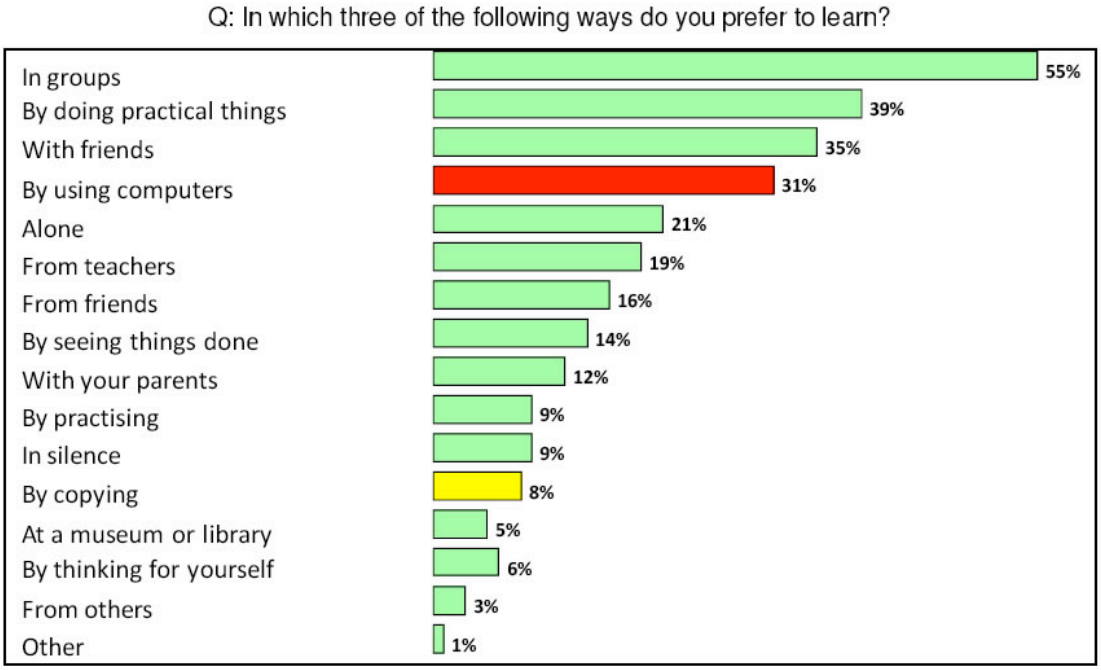

Figure 2: Students' reported preferred ways to learn (OECD, 2009a, p.17)

When comparing these two charts, it is fairly obvious that there is a mismatch between the ways in which students spend most of their time in school learning and the ways in which they prefer to learn. We think it is important to note, that the ways they prefer, are part of the 21st century skills set—teamwork and collaboration (ATCS21, 2010; Dede, 2007a,b) and a necessary component of a vibrant knowledge-building classroom (ATCS21, 2009; Bransford, Brown & Cocking, 2000; Sawyer, 2008; Scardamalia & Bereiter, 2006).

A study by Willms, Friesen & Milton (2009) commissioned by the Canadian Education Association (CEA) found only 37% of Canadian secondary school students were intellectually engaged[7] in school. While 33% of the students reported finding school work boring or of little relevance and 25% of students feeling apprehensive or anxious about learning[8]. This study also found that between 50 and 70 percent of the differences in the levels of student engagement among the 93 schools were a result of school and classroom climate factors. Matters of intellectual engagement are important for NML as it is a key requirement and outcome of 21st century learning.

[7] A serious emotional and cognitive investment in learning, using higher-order thinking skills (such as analysis and evaluation) to increase understanding, solve complex problems, or construct new knowledge. (Willms, Friesen & Milton, 2009, p. 8)

[8] Data in this study were analyzed using Csíkszentmihályi (1990) skill-challenge construct.

Changing Role of Teachers

Clearly there is wonderful and difficult news in today's world for teachers. Teachers are being re-invited into the world and the ways that knowledge lives and works in the world. This vibrancy and vitality of knowledge has the potential to enliven classrooms and lead to intellectually vibrant, imaginative and deeply disciplined work. However, the research is also clear, it means that teachers need to learn new ways, ways that require teachers to learn the ways in which knowledge is created and verified, practiced and demonstrated, made public, critiqued, and handed on (Bransford, Brown & Cocking, 2000; Gardner, 2006; Friesen, 2009; Friesen & Jardine, 2009; Sawyer, 2006, 2008; Scardamalia, et al., 2010).

The basis of this shift, a shift from industrial scope and sequence curricula which views knowledge as a long line of information pieces to imagining knowledge as a *field* (Friesen & Jardine, 2009). The tasks of teaching and learning involves entering into these living fields and:

> 'learning the landscape.' In this metaphor, learning is analogous to learning to live in an environment: learning your way around, learning what resources are available, and learning how to use those resources in conducting your activities productively and enjoyably. Knowing where one is in a landscape requires a network of connections that link one's present location to the larger space. Traditional curricula often fail to help students "learn their way around" a discipline. (Bransford, Brown & Cocking, 2000, p. 139)

Instead of being thought of as composed of discreet and disconnected bits and pieces of data and information, the learning sciences envision, knowledge as organized into living fields, living disciplines of knowledge. No longer can teaching be adequately understood as simply the imparting and management of facts and procedures and the testing of students to determine how many of these facts and procedures had been retained (a teaching practice known as instructionism [Sawyer, 2006]). The role of the teacher is changing, in part, because our understanding of knowledge is changing (Bransford, Brown & Cocking, 2000; Clifford & Friesen, 1993; Clifford & Marinucci, 2008; Gilbert, 2005; Jardine, Friesen & Clifford, 2006, 2008; Sawyer, 2008; Scardamalia, 2005; Scardamalia & Bereiter, 2006; Scardamalia, et.al. 2010).

It is into this place, this living field of knowledge creation, that digital technologies need to reside. This point has been made several times within this paper (see pp. 16 & 17) but bears repeating. There is much work to be done by district and school leaders, as research revealed it is rare to find such environments within education (OECD, 2009a,b; Willms, Friesen & Milton). In order to use technology to create knowledge-building environments, teachers need to know how various disciplines

> use the technologies to create knowledge, verify evidence, collect data, communicate findings, etc. "Instead of applying technological tools to every content area uniformly, teachers should come to understand that the various affordances and constraints of technology differ by curricular subject-matter content or pedagogical approach" (Koehler & Mishra, 2008, p. 22).
>
> Koehler and Mishra (2008) conducted design-based experiments. They found that effective technology integration required the intersection among the bodies of knowledge that are represented by pedagogical content knowledge, technology content knowledge and technological pedagogical knowledge and the intersection of all three knowledge types to be that of technological pedagogical content knowledge. Based on their findings Mishra and Koehler (2006) created the Technological Pedagogical Content Knowledge (TPACK) framework that "can be used to design pedagogical strategies and an analytic lens to study changes in educators' knowledge about successful teaching with technology" (p. 1046). "TPACK-competent teachers exhibit best practices in pedagogy, content, and technology. They understand the true nature of effective teaching and learning with technology" (Nelson, Christopher & Mims, 2009, p. 85).

TPACK provides an organizational and analytical structure for examining what teachers must do for integration of technology. However, from a research perspective, the challenge remains the ability to measure the components.

> Researchers have noted the need to develop reliable assessment approaches for measuring TPACK and its components to better understand which professional development approaches do(or do not) change teachers' knowledge, as well as deepening the collective sensitivity to the contexts in which these approaches work (or do not work). (Schmidt, et al., 2009-10, pp. 126-127)

A number of researchers (Angeli & Valanides, 2009; Koehler & Mishra, 2005; Koehler, Mishra, & Yahya, 2007) have used various means to measure TPACK (e.g., surveys). For example, in Archambault and Crippen's (2009) study using a survey-based approach to measure TPACK with online teachers reported the challenge of measuring each of the components. "[I]t seems that from the onset, measuring each of these domains is complicated, muddled, and messy" (Archambault & Crippen, 2009, p. 83). Schmidt, et al. (2009-10) developed a survey instrument to assess TPACK which was pilot tested with pre-service teachers. Results of the study suggested modifications to the instrument, however the "results indicate that this is a promising instrument for measuring preservice teachers' self-assessment of the TPACK knowledge domain" (p. 135).

The strength of the TPACK is that it provides a framework to examine what knowledge teachers need to have to integrate technology. Research strongly suggests that TPACK can be used to guide and inform professional learning of teachers. The challenge is in how to measure the impact of it on teaching and learning. Developing sound research questions and selecting appropriate

instruments to measure the impact is no small matter. According to Polly and Brantley-Dia (2009), "research that hopes to analyze teachers' TPACK during teaching must collect data during teachers' practice. This includes data from classroom observations, videotapes of teaching and classroom artifacts…researchers must consider the methodologies that are best suited for this line of inquiry" (p. 47). Careful attention must be given to the research design, if the results are to have any validity and can better inform future decisions and policies. New assessment instruments now being researched and developed by ATCS21 (2009) may soon assist educators with this pressing problem.

There are many challenges facing teachers in creating new learning environments. Bransford, Brown and Cocking (2000) have challenged teachers to create 21st century classrooms that are knowledge-centered, assessment-centered, learning-centered. They have argued that digital technologies are resources that support these activities within community-centered collaborative learning environments. Larson, Miller and Ribble (2009-2010) have invited teachers to focus the conversation in how technology fits within their classrooms to best meet their students' needs. While Peck, Cuban and Kirkpatrick (2002) have argued that returns on investment are affected by a host of factors that have nothing to do with the technology itself, rather are impacted by such things as subject compartmentalization or uncomfortableness with working in teams; that is, structures, practices and processes designed to educate students for an industrial society.

What remains clear is that while a significant amount of resources, in terms of hardware, software, networking, personnel and professional learning, have gone into the effective use of teaching and learning with technology over the past fifteen years, teachers and administrators, schools and districts, are still at the beginning stages of creating truly 21st century classrooms.

Changing Role of Administrators

School and district administrators, charged with leading schools and the adult learners in them, face a daunting challenge, charting a learning direction that is unfamiliar to most of them. With the growing awareness that incremental improvements to existing structures and practices are no longer adequate many leaders are starting to realize their efforts to improve need to be rethought and redirected (Fullan, Hill & Crevola, 2006; Gilbert, 2005; Hargreaves & Shirley, 2009; Harris, 2008; Wagner, 2006, 2008).

McKinsey and Company (2007) identified a key aspect that defines effective school leadership that of being able to "to develop principals into drivers of improvement in instruction" (p.33). Like other researchers (Elmore, 2006; Fullan, Hill & Crevola, 2006; Gilbert, 2005), they too noted, that while a focus on improvement is a necessary condition, it is insufficient to bring about the changes needed for the 21st

century. "In order to improve instruction, school systems need to find ways to change fundamentally what happens in classrooms" (McKinsey & Company, 2007, p. 30).

Nussbaum (2010) studied the importance of applications and quality of content in advancing mobile devices in the service of learning across seven countries. His study revealed that one of the barriers to making significant change was lack of leadership to plan, implement and support ICT projects.

The research to this point strongly indicates that district and school leaders attend closely to matters related to the instructional core and the ways in which technology impacts the instructional core. The practice of leaders requires the ability to form strong leading and learning relationships through the work of building strong learning organizations—knowledge society organizations (Elmore, 2006; Harris, 2008; Stoll, 2009). For district leaders this means guiding and coaching school leaders and teachers to build stronger, and different, practices. Throughout an organization, attention needs to be paid to research from the learning sciences regarding the requirements of a 21st century learning environment (Bransford, Brown & Cocking, 2000; Sawyer, 2008; Scardamalia, et.al., 2010). Finding ways to open spaces—reorganize schedules, timetables, etc.—where adults in schools can come together within a 21st century learning environment is essential in order to a) learn from and with each other (knowledge-centered), b) provide constructive, helpful feedback based on clear criteria and strong evidence (assessment-centered), and c) improve and change together (learner-centered). For district and school leaders this means seeding the creation of research informed, evidence-based

> organizational structures, processes, and norms that make instruction transparent, so that it can be analyzed and changed in response to feedback about its effects. It means modeling inquiry and learning as the central dimensions of practice, creating expectations that the improvement of practice is a continuous process. It means developing practices of challenge and support that help people deal with the social and emotional difficulties entailed in improvement and change. And it means using the basic features of the organization—structures, processes, norms, resources—as instruments for increasing the knowledge and skill of people in the organization.
>
> The practice of improvement consists of making the familiar strange: objectifying practice, treating organizations as instruments. (Elmore, 2006, p.13)

From their study of exemplary programs, Darling-Hammond, Meyerson, LaPointe and Orr (2010) identified the following common components:

- Research-based content, aligned with professional standards and focused on instruction, organizational development, and change management.
- Curricular coherence linking goals, learning activities, and assessments around a set of shared values, beliefs and knowledge about effective organizational practice.
- Field-based internships that enable the application of leadership knowledge

and skills under the guidance of an expert practitioner.
- Problem-based learning strategies, such as case methods, action research, and projects that link theory and practice and support reflection.
- Cohort structures that enable collaboration, teamwork and mutual support.
- Mentoring or coaching that supports modeling, questioning, observations of practice and feedback.
- Collaboration between universities and school districts to create coherence between training and practice as well as pipelines for recruitment, preparation, hiring and induction (Darling-Hammond, LaPointe & Meyerson, 2010).

Darling-Hammond, et al. (2010) also found the following other factors that contribute to program effectiveness:
- Vigorous recruitment of high-ability candidates with experience as expert, dynamic teachers and a commitment to instructional improvement.
- Financial support for pre-service candidates to enable them to undertake an intensive program with a full-time internship
- District and/or state infrastructures supporting specific program elements and, often, embedding programs within a focused school reform agenda (p. 43).

The components and factors that Darling-Hammond, et al. (2010) identified reflects a different space and place of leadership as compared to what occurred in twentieth century schools. One of the purposes of twentieth century schools was to sort and rank people (Gilbert, 2005; Sawyer, 2006; Willms, Friesen & Milton, 2009). This was accomplished through many different standardization mechanisms (Friesen & Jardine, 2009). Research highlighted to this point in this section of the report strongly orients district and school leaders to the types of leadership needed to create and lead organizations for a knowledge society.

A number of researchers have identified characteristics of high performing school districts (Harris, 2008; Leithwood, 2008; McKinsey & Company, 2007; Mulford, 2008). These studies reported that districts that made positive contributions to student achievement also underwent some significant structural and policy changes. Harris (2008) found that when district leaders attempted to make changes by merely tacking innovations, such as distributed leadership, onto the structures and core purposes of twentieth century schooling, progress towards creating knowledge-building organizations was thwarted. She noted "we cannot have twentieth century structures shaping twenty-first century leadership practices" (Harris, 2008, p. 6). Tacking on, rather than embracing the power and potential of distributed leadership to bring about genuine change, will most likely result in leaders who "monitor teachers and their work to ensure a set of pre-determined standards are met" (Fitzgerald & Gunter, 2007, as cited in Harris, 2008, p.10). That is, it will propel us back into 20th century orientations of educational administration and management.

Harris (2009) noted that distributed leadership is constituted through the

interaction of leaders, teachers, and the situation as they influence transforming and improving instructional practice in service of student learning. "Distributed leadership is a powerful way to understand leadership activity in schools in more complex and interconnected ways" (Diamond, n.d.).

Murphy, et.al., (2006) found that learning-centered leadership report involves "creating powerful, equitable learning opportunities for students, professionals, and the system, and motivating or compelling participants to take advantage of these opportunities" (p. 3). They reported that the touchstones for this type of 21st century leadership to support learning within technology-enhanced learning environments included the ability of leaders to (a) stay consistently focused on learning the core of schooling: learning, teaching, curriculum, and assessment; and (b) make all the other dimensions of schooling (e.g., administration, organization, finance) work in the service of a more robust core and improved student learning. This finding is supported by a number of other researchers (Elmore, 2006; Leithwood, 2008; McKinsey & Company, 2007; Wagner, 2006).

Building on the work of many researchers identified to this point in the report, Mulford (2008) asked the following question: "How can we best develop the attitudes and skills that will enable people to work in less hierarchical workplace, to operate well with others, including the technological networks of the digital age, and to be flexible and continually learning?" (p.10).

> The way schools are organized and run needs to consistent with the broadening outcomes and the balance of, or selection between, the forces on them. Schools and their leaders will need to move from the bureaucratic and mechanistic to organic living systems, from thin to deep democracy, from mass education to personalization through participation, and from hierarchies to networks. (Mulford, 2008, p.18)

The changing roles of district and school administrators to develop leadership practices to support high performing school jurisdictions and schools in the 21st century, will involve a clear understanding of 21st century learning, both the requirements needed for strong learning, which come from the learning sciences, and an understanding of the ways in which networked digital technologies enable, enhance, extend and deepen that learning. The research is clear that attending to the instructional core is essential but needs to be contextually situated within the a knowledge building organization. Mulford (2007) contended "changing the organization, and leading schools and school systems, so they become communities of professional learners is not for the faint of heart" (p. 37).

Comparing Alberta Principal Quality Practice Guideline and ISTE Standards

Both Alberta and the International Society for Technology in Education (ISTE) have identified standards for administrators. Alberta identified seven leadership

dimensions described in the Alberta Principal Quality Practice Guideline (Alberta Education, 2009). In comparing the Alberta dimensions to the ISTE National Educational Standards and Performance Indicators for Administrators (2009), we found they mapped well to each other. The parallel between the Alberta and ISTE indicates the need for administrators to inspire and develop a shared vision, develop capacity and proficiency, nurture a learning community and/or learning culture, manage resources in ways to foster and support systemic improvement, and understand and respond to a societal context. The ISTE standards bring an explicitness required of administrators to integrate, model and support educational technology in teaching and learning.

Alberta Principal Quality Practice Guideline (2009) **Leadership Dimensions**	**The ISTE National Educational Technology Standards (NETS•A) and Performance Indicators for Administrators (2009)**
Fostering effective relationships	
Embodying visionary leadership	Visionary leadership
Leading a learning community	Digital-age learning culture
Providing instructional leadership	Excellence in professional practice
Developing and facilitating leadership	
Managing school operations and resources	Systemic improvement
Understanding and responding to the larger societal context	Digital citizenship

Beyond Best Practice: Creating Next Practice

Both educational (Scardamalia, 2003, 2004) and business (Grafton & Ghoshai, 2005) research literature are clear that knowledge-building organizations must have processes and mechanisms in place to move themselves beyond best practice. It is important to note that research does not support doing away with sharing best practices. In fact, Grafton and Ghoshai (2005) reported that organizations that failed to have mechanisms in place to share best practices quite rapidly became "complacent laggards" (p. 49). Research is also clear, that while organizations need to have mechanisms in place to facilitate the sharing of best practices, it is not sufficient, by itself, to create innovation. Scardamalia (2003, 2004) has provided a set of criteria to assist classroom teachers, as well as district and school administrators, to identify what is meant by best practice and beyond best practice, or next practice, in knowledge-building classrooms.

One of the hallmarks of a knowledge intensive organization, be it a classroom, school, district or business, is its ability to continually innovate. Scardamalia and Bereiter (2002) noted that sustainable innovation, knowledge building work defined as the production and continual improvement of ideas that are of value to the community, was the collective responsibility of all members of the community

(Scardamalia, 2002). Sustained innovation that led to next practice required, that members of the community have mechanisms and processes in place to: i) improve upon and build upon on each others ideas, ii) take on the higher-level responsibilities for goals, strategy, evaluation, and so on, and iii) formulate and solve authentic problems of understanding and seek information that contributes to solving these problems. Networked digital technologies enable an organizations ability to develop next practice.

Davidson and Goldberg (2009) argued "that the single most important characteristic of the Internet is its capacity to allow for a worldwide community and its endlessly myriad subsets to exchange ideas, to learn from one another in a way not previously available. We contend that the future of learning institutions demands a deep, epistemological appreciation of the profundity of what the Internet offers humanity as a model of a learning institution" (pp. 1-2).

The advent of collaborative technologies has created a participatory culture (Jenkins, et al., 2009) which enables people to collaborate with each other across time and distance to: (i) build on each others' ideas, (ii) work together to solve problems, address issues, pose new problems, entertain new questions, (iii) put forward evidence and (iv) engage in elaborated forms of communication to mobilize new understandings.

Davidson and Goldberg (2009) argued there is a difference between participatory learning and instructional technology. Instructional technology "is usually a toolkit application that is predetermined and even institutionalized with little, if any, user discretion, choice or leverage. It tends to be top-down, designer determined, administrately driven, commercially fashioned. In participatory learning, outcomes re typically cutomizable by participants" (p.13). "Participatory learning begins from the premise that new technologies are changing how people of all ages learn, play, socialize, exercise judgment, and engage in civic life" (p. 12). Reflecting upon the requirements to develop next practice (Grafton & Ghoshai, 2005; Scardamalia, 2002, 2003, 2004; Scardamalia & Bereiter, 2002) it becomes clear that both school districts and schools, themselves, need to move beyond instructional technologies.

Many researchers noted, the distinction between knowledge and skills is problematic within the 21st century learning (Dede, 2007a; Sawyer, 2008; Scardamalia & Bereiter, 2006). Research from the learning sciences has established that knowledge and skills are richly intertwined (Sawyer, 2006). Rather than considering knowledge as content on which skills act as a process, learning environments informed by the learning sciences seeks to problematize the division between knowledge and skills. For example, applying mathematics as a perspective on understanding the world requires recognizing situations in which mathematical models might apply. This is neither a process-free content nor a content-devoid process, but a complex knowledge-skill mixture, an 'understanding.' Categorizing what students' need for the 21st century as understandings based on interwoven content knowledge and process skills, known as competencies, is a more accurate depiction of how the mind works than the separation between these that current

frameworks typically impose, and how students actualize those understandings in practice are *performances*.

Creating mechanisms and processes to enable and foster the creation of next practice within school districts will require that new structures, process and practices be designed. The research in this section strongly implies that innovation is not just a process but also an outcome—next practice.

School Districts as Knowledge Building Organizations

> Teachers and schools are part of a command and control model of school systems which is as outdated for knowledge intensive organizations. It is difficult to imagine a social organizational system which appears as immune to real change as, for example, the school systems of Britain, the United States and Canada. The knowledge driven organization which demands innovation and creativity from all employees is not a description of many aspects of school systems. (Murgatroyd, in press, p. 4)

National College for School Leadership's (2006) Networked Learning Communities initiative (see Figure 3) demonstrated three ways to think about knowledge. Building on the research from the section on Next Practice in this report, school district leaders would need to consider how to link each of these knowledge domains to create a collaborative knowledge-building organization.

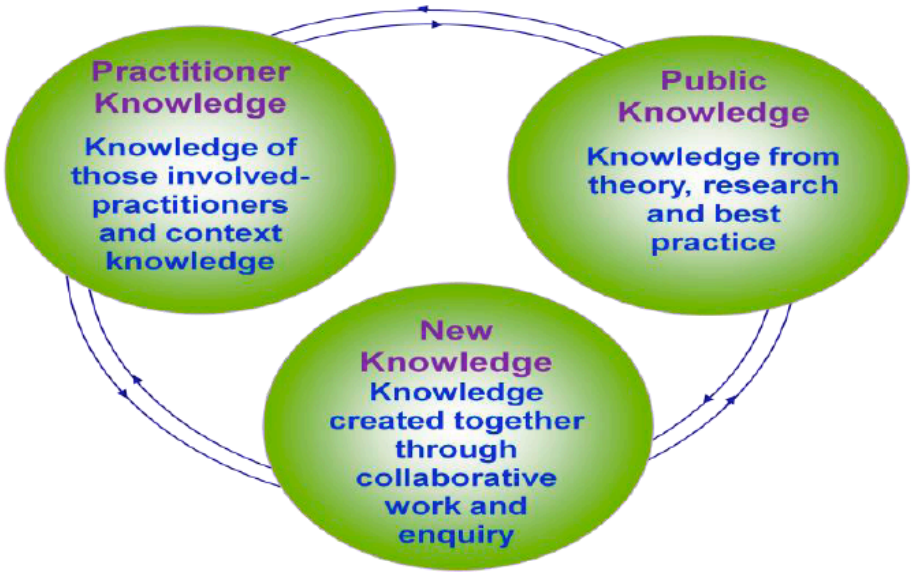

Figure 3: Three Fields of Knowledge (NCSL, 2006)

In addition to the research on next practice, these three interconnected fields of knowledge resonate strongly with research from the learning sciences (Bransford, Brown & Cocking, 2000; Sawyer, 2006, 2008; Scardamalia, 2002, 2003, 2004; Scardamalia, et al., 2010). Educational researcher Stoll (2009) contended that the way forward is to link the three areas with what she calls knowledge animation. "Knowledge animation provides the collaborative processes for new knowledge creation by ensuring that what is known is connected to what people know through collaborative and dialogic processes" (Stoll, 2009, p. 5).

Learning From and With Districts

The research to this point in the report is clear in addressing the multifaceted, multidimensional aspects that district leaders need to consider when designing, implementing and assessing new practices, structures, processes and policies to create school districts that equip young people with an education for today's world. The research is also clear that networked digital technologies are essential within knowledge intensive organizations.

Learning Our Way Forward

To provide district leaders with some images of what various districts have done or are doing to create organizations for today's knowledge society, we have selected a number of school districts in which educators and researchers have collaborated in sustained ways to study and invent next practice. Our list is selective, not exhaustive. The districts represented here are ones that have published research findings. We acknowledge that many districts are currently making strong efforts to reinvent and reengineer themselves. Many school districts have started to learn their way forward in creating knowledge intensive organizations enabled and powered by networked digital learning technologies.

And while all the districts we selected are making progress, we think that it is also important to note, that all the districts, have a significant way to go to create a knowledge intensive organization in which all people within the organization, youth and adult alike, are required to engage in collaborative knowledge-building—innovation.

Alberta: Emerge One-to-One Laptop Learning Project

The Emerge One-to-One Laptop Learning Project funded by Alberta Education from 2007 – 2010 has been designed to investigate the efficacy of laptops for teaching and learning in the 21st century. Each of the 20 jurisdictions selected a specific target population or 21st century skill set as a focus for their three-year grant award. Researchers conducting the provincial study used a mixed method of evaluation in

which data were collected from surveys of students, teachers, administrators, and project leads, as well as data from site observations in each of the jurisdictions.

In the Alberta Education (2010a) report it was noted that the status of establishing 21st century learning environments was documented in this study by tracking the level of systemic change in classrooms, schools, and jurisdictions using the Metiri Group's Dimensions21 framework. This framework includes the following seven interdependent indicators for 21st century learning measured through teacher and administrator surveys: *Forward Looking, Shared Vision; Systems Thinking; 21st Century Skills and Learning Approaches; 21st Century Learning Environment; Educator Proficiency with 21st Century Learning; Access and Infrastructure*; and *Accountability/Results*.

With regard to level of jurisdictional and provincial readiness for systemically advancing 21st century learning and effective uses of technology in learning, the data showed over the two years progress in six of the seven dimensions of readiness for 21st century learning. It was only the *Forward Looking, Shared Vision* dimension that did not progress, rather it remained consistent. From the data, there was a difference between administrators and teachers. Administrators were comfortable with the Emerge project vision for their jurisdiction in which the grant was awarded. However, for teachers the data showed it was in the second year that they became more familiar with what the vision meant in their classrooms which was then reflected in their commitment to their jurisdiction's Emerge vision (Alberta Education, 2010a).

Overall, the trend data for the first two years has demonstrated that Emerge jurisdictions are fairly well staged to succeed. Most jurisdictions have established sound technology systems to support 21st century learning. Through the project, the jurisdictions have made progress in creating and supporting 21st century learning environments. Policies and practices have been established that support new approaches to learning within the technologically-enhanced learning environment (e.g., wireless network, laptops) (Alberta Education, 2010a).

Alberta, Foothills School District: iLearn

In the Fall of 2007, the Foothills School District developed a pilot laptop initiative in three schools across the school district. These three schools served different communities within the district. The laptop computers were in carts which served both as storage and recharging stations. These cart could be easily moved from class to class. Wireless infrastructure was put in place to support the laptop initiative.

Learning leads were hired for each of the schools. These were teacher leaders who were experienced with teaching and learning with technology and high respected by teachers. Ongoing job-embedded professional learning for teachers was built into the program. In addition, professional learning days in which the staffs from the

three schools came together to share practices and discuss problems of practice were built into the three year project. Principals from the three schools, a superintendent, a technology lead as well as a researcher met once a month in the initial year of the initiative.

Findings from the three year longitudinal design-based research study found:

Teaching:

1. A statistically significant improvement in teachers' attitudes towards inquiry-based practices in the areas of authenticity, academic rigour, technology use, connecting with experts and integration of technology as measured on the Galileo Educational Network's Inquiry Rubric[9]. This improvement over the three years demonstrated a shared vision for the initiative, a shared common language, solid knowledge of the criteria for successful integration of technology within discipline-based inquiry approaches to knowledge building and a shared commitment to improving instructional practices.

2. A statistically significant increase in students' intellectual engagement when teachers designed authentic tasks, employed academically rigourous, highly responsive instructional practices.

3. A strong positive correlation, 0.97, between students' intellectual engagement and teachers ability to design and teach through authentic tasks, employ academically rigourous instructional practices, and conform instructional practices to the learning needs of each student.

4. An increased demand on access to technology as teachers became more proficient in creating knowledge building environments.

5. Teachers became more critically reflective about their practice and improved their practice the more opportunities they had to make their work public.

Leadership

1. A strong vision for 21 century learning with technology at the district level, both in policy documents and in practice. Researchers found that the merging of technology and instructional support into a division called Learning Services ensured that: i)good infrastructure and support were in place, ii) reliable technical and learning support was provided for the maintenance of technical systems, both hardware and software, iii) professional development was in place and at the place where teachers needed it. Creating this strong forward oriented vision in both policy documents and in practice ensured: i) that unit called Learning Services and Technology Services lined up and moved forward in the same direction, and

[9] Galileo Network's Inquiry Rubric can be found at http://www.galileo.org/research/publications/rubric.pdf

ii) key educational stakeholders actively participated in and took ownership of the new district initiative.

2. Each of the school leaders articulated a strong vision for 21 century learning with technology in each school. This vision aligned with the district vision and yet also reflected each unique school context and staff. This manifested itself in the following ways:
    a. Principals were knowledgeable about their teaching staff strengths and needs.
    b. Staff knew the vision for the initiative, had collaboratively created it and reported they were "on board."
    c. Leaders work was ongoing to continually cultivate the shared vision among all staff and to increase instructional and leadership practices that reflected that vision.
    d. Principals drew upon research in making decisions about technology, professional development, etc.
    e. Principals articulated a clear vision of the features of discipline-based inquiry and the ways in which networked digital technologies enabled, supported, strengthened and deepened knowledge-building practices.
    f. Principals created an alignment between this initiative and other school, district, and provincial goals and projects to ensure coherence.

3. There was a growing culture of expectation/responsibility about learning with technology. Each principal was aware of the need for both pressure and support to build capacity (i.e., alignment of district and school vision, PD that focused on learning with technology as well as some learning about the technology, research based decision making about PD, resource/technology acquisition, staffing – getting the right people on the bus).
    a. Principals worked to ensure that each teacher had access to their own technology, time to learn how to use it, professional development time and different types of professional development and support to help them to design meaningful learning opportunities for students.
    b. Principals developed and maintained leadership capacity as an ongoing priority. The principal and other leaders supported others to engage in dialogue about the new initiative and the development of a coherent set of strategies that would improve equity, raise student achievement and maximize the new initiative
    c. Principals held the staff responsible and accountable for progress toward meeting the identified goals.
    d. Principals used their vision for their school which encompassed the vision for the iLearn initiative to make decisions about staffing. They encouraged people who do not align themselves with the vision to request a transfer.

4. Principals were educational technology leaders. Principals described their role as follows:

a. Instructional Leadership – ensuring alignment of vision, PD, structured time for professional dialogue, ongoing conversations with teachers about designing meaningful learning and assessments for learning, responding to emergent needs and long term planning, ready access to support.
b. "Engaged Supervision"—opportunities for teachers to share best practices, maintaining a high level of visibility in the classrooms, connecting teachers with each other, providing teachers with timely specific feedback by pointing out strong, 21st century practices, creating places where teachers could learn together from one another, and creating a culture of sharing, openness and trust with the expectation that it was okay and necessary to take risks.
c. Resource Acquisition – putting the technology in the hands of teachers and students. All decisions about resource allocation were made in service of the vision of the school.
d. Management - managing the increasing demand for technology as the intiative grew over the three years, responding to demand (i.e., making sure the laptops were used for meaningful, authentic work – like media production, collaborate with others, create simulations, or publish work over using the computers to word process 'good copies' or going online to conduct Internet searches.)
e. Evaluation – using a broad array of measures, both quantitative and qualitative to assess progress towards the vision. Principals consistently worked with evidence to inform next steps. They routinely asked for evidence to support that students were benefiting, that teachers and students were doing meaningful and authentic knowledge-building work with the technology. (Friesen, et al., 2009)

Foothills School District is now in their fourth year iLearn initiative. While they are continuing with their initiative and are clear that they still have work to do to ensure students are immersed in 21st century learning environments. One of the lessons they have learned is that mobile carts cannot keep up with knowledge-building instructional practices. Researchers have recommended the district look for alternatives.

Alberta, Calgary Science School: Personalized Learning Initiative

The Calgary Science School is a board-governed, publicly funded charter school in Calgary, Alberta. In Fall 2005, the Calgary Science School embarked on a one-to-one laptop initiative. What began with the Grade 6 students grew to include all grades and students within three years. Researchers from Galileo Educational Network and the University of Calgary were brought in during the inception phase of the laptop initiative creating a three-year design-based longitudinal research study. Using this type of research design provided a strong, collaborative working relationship

throughout the three years. Research findings from one year informed the subsequent year ensuring that all parts of the initiative and all people within the initiative made progress.

The school provided personalized, professional development in the form of mentorship for all teachers throughout the three years. In addition to the personalized professional development, teachers, in second year of the initiative, came together in grade teams to collaboratively analyze student work and their own practice against current research literature and evidence from knowledge-building classrooms. This practice created robust professional learning communities. As teaching practice started to move into a public realm, teachers started to work collaboratively to support each other towards changed and improved practices. Both personalized professional learning and collaborative knowledge-building professional learning have now become part of the culture of the school.

Findings from the third year indicate:

1. Leaders:
    a. Use data to inform their decision-making. They use current research literature as well as research conducted in the school.
    b. Have developed a strong vision for discipline-based inquiry and technology that is grounded in teaching and learning.
    c. Are deeply committed to improving the learning of all students and teachers.

2. Teachers:
    a. Value being part of a professional learning community.
    b. Benefitted from making learning visible to colleagues and sharing discipline-based inquiry studies to build capacity.
    c. Improved their instruction by making teaching and learning open, public and transparent.
    d. Were provided the opportunity to engage in rich dialogue about assessment.
    e. Made significant progress in creating technology-rich, discipline-based inquiry learning environments in terms of the eight dimensions of inquiry[10].

3. Teaching:
    a. There was a strong correlation (0.97) between intellectual student engagement and instructional practices (authenticity of task, cognitive investment required and supported, and instructional style). This finding emerged in the second year in this and the initiative in

[10] The ten dimensions of inquiry can be found at http://www.galileo.org/research/publications/rubric.pdf

Foothills School District and was further corroborated in the third year of this study.

Student Learning

a. When students were provided with well-designed, meaningful work to do, scaffolded with continuous feedback and opportunities to improve learning, exemplary products and performances emerged.
b. The most exemplary examples of student work emerged from learning environments that were student-centered, knowledge-centered, assessment-centered, and community-centered.
c. Using technology enabled students to build knowledge helping them think differently and gain deeper understanding of important ideas and concepts.
d. Students gained technological proficiency for learning purposes throughout the three years.
e. Students continued to score above provincial mean on standardized testing at Grades 6 and 9.

4. Assessment for Learning:
    a. Learning deepened, with strong evidence of deep understanding and students produced high quality products and performances, when assessment was continuous and intentionally woven into teachers' instructional designs.
    b. Technology made it possible to make the teaching and learning goals as well as assessment criteria public.

5. Technology Use:
    a. The type of platform and network architecture that was available was important to the sustainability and success of the initiative.
    b. Learning was more fluid with ubiquitous access to laptops.
    c. Pervasive access to technology enabled students to connect with experts and expertise beyond the classroom.
    d. Technology facilitated diverse learners and enabled more authentic forms of assessment to emerge.
    e. Technology helped make learning visible and provided meaningful opportunities for parents to support the learning of their children.

(Jacobsen, Saar, & Friesen, 2010)

The Calgary Science School is now in their fourth year of a district/school-wide technology application learning initiative. They are continuing with their initiative and are clear that they still have work to do to ensure all students are immersed in 21st century learning environments.

Eastern Townships: Enhanced Learning Strategy (ELS)

The Eastern Townships School District (ETSB) in Quebec, Canada implemented a one-to-one laptop initiative, entitled the Denis McCullough Initiative – Enhanced Learning Strategy for all students in Grades 3 – 11 in 2003.

The school district articulated the philosophy and vision behind the laptop project.

> The philosophy for the DMI-ELS revolved around the fact that a 1:1 laptop initiative would empower students in an anytime/anywhere environment. It would also drive a change in the classroom where, in a socio-constructivist environment, teachers would have the capability to engage in project/problem-based learning and individualized instruction to meet most students' needs. Technology has the potential to open up the world for studens in a stimulating, creative and inquiring way. We believe that with this medium, studens will engage, be motivated and want to come to and stay in school until they have successfully completed their program. We also believe that with this approach, students will learn how to learn and discriminate, thus turning information and fact into knowledge. (Sclater, et al., 2005, p. 2)

The district entered into a relationship with Apple Computers to purchase computers for all students in Grades 3 – 11. They created wireless networks in all the district schools. They wired the lockers in all the secondary schools so students would be able to charge their laptops in a secure environments. They purchased charging carts for the elementary schools. Committed to the success of the initiative, Ron Canuel, Director General of the Eastern Townships School Board, ensured that extensive resources in terms of professional development was available to all teachers within the initiative. A learning lead was appointed in each of the schools and a ELS Director was employed at the district level to ensure the entire initiative made progress.

Researchers from Concordia University were selected to study the first year of the innovation. The researchers conducted a quasi-experimental study to determine the effects of one-to-one laptop computing on math and reading. They selected a neighbouring district as a control district. After the first year, researchers found that students in the experimental district (Eastern Townships School Board) scored higher than the control district in reading. Students in the reading classes also reported using computers more frequently than in the control group. In contrast, the math scores in the control district were higher than the experimental group. Neither the experimental or control groups reported high levels of computer use in math.

With good endorsement and encouragement from parents and the popular media, ETSB moved into its second year of the initiative. They provided all teachers with increased professional development in use of the laptops as well as in each of the content areas.

The objectives of ELS were to enhance teaching, engage students in learning and increase student achievement. In the second and subsequent years, these objectives provided a beacon for keeping the initiative strongly focused. Ribaux (2010) reported the ELS initiative had achieved the following outcomes within the eight years of the Enhanced Learning Initiative: i) improved literacy and numeracy, (ii) reduced dropout rate and (iii) equalized the 'playing field'.

Ribaux (2010) reported the following lessons learned:

Lesson 1:

- Education really doesn't like change. 10-15% of individuals won't like anything to do with change, plain and simple.
- You must focus on the Mid- Adapters to ensure success. As for the Late Adapters, be patient.

Lesson 2:

- If the technology (infrastructure to support laptops) is not reliable (95% regular, sustainable and supported), then the teachers will simply put the machines to the side.
- Create a "sense" of openness to the Internet. Too many filters also serves as a major deterrent.

  At the ETSB, there are no filters!

Lesson 3:

- The curriculum must support the integration of technology and become transformational, in both learning and teaching contexts.
- Teacher P.D. must focus on the integration of new pedagogy, as well as in integrating technology into the classroom.
- Be careful: "Younger" vs "Seasoned" teachers.

Lesson 4:

- Departmental and School Leadership: "Pragmatic" buy-in and not "Philosophical" buy-in.
- Some members of your management team will see a technology initiative as simply more work.
- Constant supervision/monitoring so that the "Fall Back" syndrome does not appear.

Lesson 5: (Critical Component)

- EVALUATION DRIVES INSTRUCTION. In establishing any new context for learning and expecting teachers to move to a transformational situation, the entire evaluative rubric for each subject must be completed, PRIOR to the deployment. Otherwise, the technology usage will simply mirror traditional, Socratic teaching methods.

Reality 6: The Most Important One
B.I.P.P.

- B: Beliefs
- I: Ideologies
- P: Philosophies
- P: Pedagogy

The greatest hurdles that will come or have come your way are founded in these four domains, with the first three predominating all exchanges, conversations, debates and inquiries. All new initiatives in Education, including technology, either flourish or flounder in the first three sections.

The Eastern Townships School Board is now in their ninth year of a district-wide technology application learning initiative. They are continuing with their initiative and are clear that they still have work to do to ensure students are immersed in 21st century learning environments.

eMINTS: Intructional Practices

ISTE Policy Brief (2008) identified several states that have implemented sound strategies for the integration of educational technology. These states (e.g., Missouri's eMINTS program, Michigan's Freedom to Learn program, and Texas' Technology Immersion Pilot) have shown statistically significant gains in elementary and middle years with regard to achievement in reading, math, and science when comparing participating and non-participating students.

"eMINTS is designed to transform the instructional process by supporting elementary teachers as they develop student-centered, inquiry-based instructional practices using a wide range of multimedia and computer technology" (eMINTS Evaluation Team, 2007, p. 2). The eMINTS instructional model enables educators to

- create classrooms where all students are motivated to succeed socially and academically,
- fully incorporate technology investments into teaching and learning,
- complement existing preK-16 curriculum with critical-thinking requirements found in national, state and local curriculum standards and
- build enthusiasm and creativity into daily teaching (eMINTS National Center, 2009).

Through quasi-experimental studies involving the use of the Missouri Assessment Program (MAP), results have revealed statistically significant differences in the performance of eMINTS students compared to non-eMINTS students in various subject areas (ISTE, 2008). For example, the analyses of the 2005 MAP results for 2004 showed "enrollment in an eMINTS classroom is beneficial for increasing MAP scores for both the Communication Arts and Mathematics tests" (eMINTS Evaluation

Team, 2007, p. 25). This outperforming of students in eMINTS classrooms reflect the benefit and impact such an initiative is having on teachers' teaching and student learning.

Maine: Maine Technology Learning Initiative

In Spring 2002, Grade 7 students and their teachers in nine Exploration Schools were provided laptop computers supported by wireless infrastructure. The state provided teachers, in the initiative, with professional development to introduce the laptop and basic computer skills. In addition teachers received extensive ongoing professional development in an inquiry focused project-based learning in each of the respective content areas. Professional development in the academic content areas has continued to present day.

Two hundred and forty (240) schools across the state received laptop computers. Concurrently, the Department of Education initiated a professional development network consisting of several new roles and regional positions. Each of the schools nominated a Lead Teacher who received specialized training in leadership. Lead Teachers used eMints as a basis for their mentorship to Maine teachers.

The Maine Technology Learning Initiative (MTLI) is now in its eighth year. Researchers from the University of Southern Maine have reported learning gains in literacy, mathematics and science (Silvernail, 2005; Silvernail & Gritter, 2007). In addition, student engagement appeared to be higher among those who were working directly with their laptops to complete their projects. A 2009 study to assess science achievement, "the post-assessment and the student interviews revealed that many of the students found the technology-rich project to be more challenging and time-consuming; however, many of the students also agreed that the project was more fun and engaging" (Berry & Wintle, 2009, p. i).

The state of Maine is now in their eighth year of a state-wide technology application learning initiative. They continue to expand their initiative from middle school into the high schools and are clear that they still have work to do to ensure all students are immersed in 21st century learning environments.

Indianapolis, Lawrence Township: Twenty-First Century Learning

The Metropolitan School District of Lawrence Township (MSDLT), in 2000, developed a digital literacy proposal based on a call for districts to "develop innovative, systemic, and transforming approaches to preparing students to thrive in an increasingly competitive, high-tech, global society" (Capuano & Knoderer, 2006, p. 113). Their Digital Age Literacy Initiative was developed based on three paradigm-shift goals:

- "Content: broaden the scope of literacy to include digital age skills

- Process: Implement a systemic professional development framework.
- Context: Reinvent the district as a professional learning community" (Capuano & Knoderer, 2006, p. 114).

Digital age literacy coaches were trained and worked with teachers and principals in the implementation of 21st century skills. Evidence was gathered through the work of coaches facilitating action research with classroom teachers and with the use of a Self-Directed Learning Inventory instrument developed in partnership with the Metiri Group. Rubrics were developed that integrated the 21st century skills. Further, the Mankato Survey offered as self-assessment tool for teachers and students to use in relation to class use of technology. Random sample of MSDL fifth-, eighth- and twelfth-grade teachers and students in 2001 and again in 2004 completed the Mankato Survey. Different students completed the survey with each administration, "changes in scores reflect change in the system not changes in individuals students. The overall conclusion were that there were significant gains in spreadsheet use, research, and information searching and technology presentation for all students (elementary, middle and high school) and consistent significant gains in nearly all categories for middle and high schools students" (Capuano & Knoderer, 2006, p. 119).

To address sustainability of this work required district commitment. To support the ongoing learning of teachers and students, the district has been "reinventing itself as a professional learning community…The district recognizes that functioning as a professional learning community is key to sustaining and institutionalizing the initial work of the Digital Age Literacy Initiative" (Capuano & Knoderer, 2006, p. 119). However, with ending of the funding before the start of the 2007-2008 year and with coaches returning to classrooms, the district acknowledged that the model of professional development will look different, but are "certain that through the work of the building administrator and teacher leaders, professional growth will occur around twenty-first century learning" (Capuano & Knoderer, 2006, p. 124).

Summation: Learning From and With Districts

Research from these seven initiatives highlight the various ways that schools, districts and states are incorporating research findings from the learning sciences to create 21st century learning environments that are enabled and supported by networked digital technologies.

We analyzed each of the initiatives to determine the features that these initiatives have had in common.

Teachers within each of these initiatives were designers of learning. They developed: i) strong authentic discipline-based inquiry work for students, ii) scaffolded the work with robust instructional practices that conformed to the learners and assessment practices that assisted and aided each child to improve, grow and thrive in their learning, and iii) called upon networked digital technologies

to create knowledge-building classrooms. Teachers created strong relationships with i) their students, ii) other teachers, and iii) created processes so that student build strong relationships with each other and with experts in the field as they learned together. They worked with peers to critically reflect on their practice and work on improving their practice in the company of their peers.

A framework articulating these features are documented in a publication by the Canadian Education Association, *Teaching Effectiveness: A Framework and Rubric* (Friesen, 2009).

Leaders in these initiatives:

1. Collaboratively created a shared vision. There was proactive leadership and support for the implementation of technology within a strong vision for learning. Districts, schools and states that experienced the greatest gains had clearly articulated a vision of learning from the learning sciences.
2. Ensured all those involved in the initative have access to current networked digital technologies, software and telecommunications.
3. Ensured all those involved in the initiative were skilled in the use of technology for learning.
4. Ensured those involved in the initiative had consistent access to professional development to support technology use in teaching and learning.
5. Ensured those involved in the initiative were provided with technical assistance for maintaining and using the technology.
6. Ensured those involved in the initiative were knowledgeable in their subject matter and current in the content standards and teaching methodologies in their discipline(s).
7. Ensured that teaching in all settings encompassed student-centered approaches to learning.
8. Ensured there was continuous assessment of the effectivess of technology for learning by creating a collaborative community involving researchers.
9. Garnered and maintained community support throughout the initiative.
10. Ensured policies were in place to sustain and strengthen the initiative.

A framework articulating these features are documented in a publication by the International Society for Technology in Education , *Essential Conditions* (ISTE, n.d.).

Through our analysis, we observed that many districts identified in this review of the literature had components of these key features in place in their districts. The challenge for leaders in these districts remain finding ways to make all the various components cohere into an integrated, unified whole.

When we examined the literature on different ways leaders, in particular district leaders, had taken up this challenge, we observed two distinct methods: a linear approach and a complex approach. The linear approach was marked by charting a vision and aligning all parts of the system towards that vision. Some of these leaders appeared to disregard the need to collect evidence the initiative unfolded.

The second approach, a complex systems-based approach, consisted of leaders who deeply understood that the whole of the project was different from the sum of its parts. While they too created a vision, they knew that to create a change of the magnitude they were envisioning required that they needed to: i) pay attention to what was emerging and evolving which necessitated collecting evidence along the way and making decisions informed by both research and evidence, and ii) create structures and processes that were adaptable. They understood at the deepest level that a knowledge-building organization is created through its connections and relationships, not its flow chart. This led to a mindset of inquiry, not certitude. These leaders set in motion short term processes towards the vision, collecting relevant and timely evidence at every step throughout the project, which they then used to monitor progress and create the next steps towards the vision, fully responsive to what was emerging. Hargreaves and Shirley (2009) call this way of leading, the fourth way. Westley, Zimmerman and Patton (2006) also document this way of leading in *Getting to Maybe: How The World is Changed.*

Using Data To Inform District-Level Decisions and Policies

As administrators chart a direction for moving their schools and districts towards excellence beginning with their first step, careful consideration needs to be given to the type of measures and evidence they will use to inform and guide progress. The notion of what constitutes good data needs to be questioned and examined as well as the selection of appropriate and multiple, multifaceted measures. For example, a survey, cannot by itself, provide adequate evidence to inform decisions. As such, time and attention needs to be paid in identifying:

1. What needs to be learned?

2. What constitutes evidence of 21st century learning in a technology-rich environment?

3. What are the appropriate data instruments to gather the identified evidence?

4. What are the mechanisms for analyzing the evidence and identifying emerging trends over time?

5. How are the data being used to mark progress to feed forward into the creation of next steps? This is how are data used to prototype the way forward.

These five items need to be in place as districts create a prototyping design for a complex knowledge-building environment. Strong evidence, along with iterative feedback loops are essential for creating sustainable innovation within school districts.

What Does This Mean For School Districts – Implications

Given the review of the literature, what are the implications for school districts and schools in creating and leading high performing schools in the application of 21st century learning technologies?

Building on the analysis of the section: What Does This Mean For School Districts – Implications (pg.43), we find the following two frameworks could be useful to assist district and school administrators in both evaluating their own progress, as well as setting goals for creating knowledge intensive organizations. In one of these documents, Friesen (2009) has outlined five principles of effective teaching for 21st century teaching. These five principles for designing 21st century learning have an emphasis on teaching and learning for deep understanding through productive inquiry in 21st century knowledge-building environments. In the *Teaching Effectiveness: Framework and Rubric* each principle outlines a number of criteria along with accompanying levels within each to show progress on a continuum.

The other document, ISTE's National Educational Technology Standards (NETS) has provided a framework for evaluating the Essential Conditions for technology integration. The Essential Conditions rubric (ISTE, n.d.) has outlined ten conditions with accompanying levels within each to show progress on a continuum from initiates to exceeds.

The two frameworks speak to technology integration and collaborative knowledge-building learning environments. However, competencies and capacity to enact the changes required to make progress on the various continuums requires leadership practices for "knowledge driven organization[s] which demand innovation and creativity from all employees" (Murgatroyd, in press, p. 4). Here the research by Hargreaves and Shirley (2009) and Wheatley, Zimmerman and Patton (2006) is most helpful. We acknowledge the type of change we discuss in this literature review takes time and commitment as demonstrated in each of the districts noted in this report. Progress towards excellence is hard work and also hard fun.

Conclusion

Schools and school districts are undergoing a significant change as they recreate themselves as knowledge organizations. This new context means new expectations and new ways of creating, changing and informing structures, practices, decisions, processes and policies. As district leaders design creative and innovative collaborative knowledge-building organizations enabled by technology, they must have in place strategies and measures to protoype themselves forward in sustainable ways.

References

Alberta Education. (2010a). *Emerge One-to-One Laptop Learning Initiative: Year Two Report*. Prepared by the Metiri Group and the University of Calgary for Alberta Education, School Technology Branch. Retrieved March 20, 2010, from http://education.alberta.ca/media/1225874/emerge%20year%20two%20report%20final.pdf

Alberta Education. (2010b). *Inspiring education: A dialogue with Albertans.* Edmonton, AB: Alberta Education.

Alberta Education. (2009). *The principal quality practice guideline: Promoting successful school leaderships in Alberta*. Retrieved March 6, 2010, from http://education.alberta.ca/media/949129/principal-quality-practice-guideline-english-12feb09.pdf

Angeli, C. & Valanides, N. (2008). TPCK in pre-service teacher education: Preparing primary education students to teach with technology. Paper presented at the annual meeting of the American Educational Research Association, New York City, NY. Retrieved March 12, 2010, from http://punya.educ.msu.edu/presentations/AERA2008/AngeliValanides_AERA2008.pdf

Antonelli, C., Link, A., & Metcalfe, S. (2009). *Network infrastructure*. New York, NY: Routledge.

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States *Contemporary Issues in Technology and Teacher Education*, *9*(1), 71-88.

ATCS21S (2010). Assessment and teaching of 21st century skills: Status report as of January 2010. Retrieved March 10, 2010 from http://www.atc21s.org/GetAssets.axd?FilePath=/Assets/Files/db85f4fb-e589-40a3-8d08-cc60dfd2a73a.pdf

Becta. (2009a). Harnessing technology, safeguarding future education and skills learners in a digital world. Further education and Skills. Retrieved February 12, 2010, from http://publications.becta.org.uk/download.cfm?resID=41331

Becta. (2009b). Harnessing technology review 2009: The role of technology in education and skills. Retrieved February 12, 2010, from http://publications.becta.org.uk/download.cfm?resID=41329

Berry, A & Wintle, S. (2009). *Using laptops to facilitate middle school science learning: The results of hard fun.* Center for Education Policy, Applied Research, and Evaluation.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M. & Rumble, M. (2010). Draft white paper 1: Defining 21st century skills. Assessment and Teaching of 21st Century Skills. Retrieved March 10, 2010 from http://www.atc21s.org/GetAssets.axd?FilePath=/Assets/Files/6cb2492b-f903-42c4-a408-cc6107a046ab.pdf

Bolstad, R. & Gilbert, J. (2006). Zooming in on learning in the digital age: A literature review. Wellington, NZ: NZCER Press.

Bonk, C.J. (2009). *The world is open: How web technology is revolutionizing education*. San Francisco, CA: Jossey-Bass.

Bransford, J., Brown, A. & Cocking, R. (2000). *How people learn: Brain, mind, experience and school.* Washington, DC: National Academies Press.

Brown, C., & Hill, J. (2009). Connecting Media Specialists, Students, and Standards Through Web 2.0. In M. Orey, V.J. McClendon & R. Branch, (Eds.), *Educational Media and Technology Yearbook* (Vol. 34, pp. 211-229). New York, NY: Springer.

Brown, R. (2010). Administration of technology: Teaching, learning and resource management. In R. Papa, *Technology Leadership for School Improvement* (pp. 45 – 59). Thousand Oaks, CA: SAGE.

Capuano, M. & Knoderer, T. (2006). Twenty-first century learning school systems: The case of the Metropolitan School District of Lawrence Township, Indianapolis, Indiana. *New Directions For Youth Development, 2006* (110), 113- 125.

Canadian Council on Learning. (2009). *State of E-Learning in Canada. Retrieved September 1, 2009, from http://www.ccl-cca.ca/pdfs/E-learning/E-Learning_Report_FINAL-E.PDF*

Clifford, P. & Friesen, S. (1993). A curious plan: Managing on the twelfth. *Harvard Educational Review* 63(3), 339-358.

Clifford, P. & Marinucci, S. (2008). Testing the waters: Three elements of classroom inquiry. *Harvard Educational Review,* 78(4), pp. 675-688.

Consortium for School Networking Initiatives (CoSN). (n.d.) Empowering the 21st century superintendent. Retrieved March 12, 2010, from http://www.cosn.org/superintendents/

Cuban, L. (2001). *Oversold and Underused: Computers in the Classroom* (2 ed.). Cambridge, MA: Harvard University Press.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High Access and Low Use of Technologies in High School Classrooms: Explaining the apparent paradox. *American Educational Research Journal, 38*(4), 813-834.

Csikszentmihalyi, Mihaly (1990). *Flow: The Psychology of Optimal Experience*. New York, N.Y.: Harper and Row.

Darling-Hammond, L. (2008). Introduction: Teaching and learning for understanding. In L. Darling-Hammond, B. Barron, P.D. Pearson, A.H. Schoenfeld, E.K. Stage, T.D. Zimmerman, G.N. Cervetti, & J. L. Tilson, J. L.. *Powerful Learning: What We Know About Teaching for Understanding* (pp. 1 – 9*).* San Francisco: Jossey-Bass.

Darling-Hammond, L., Chung Wei, R., Andree, Al, Richardson, N., & Orphanos, S. (2009). Professional learning in the learning progression: A status report on teacher development in the United States and abroad. National Staff Development Council. Retrieved December 23, 2009, from http://www.nsdc.org/news/NSDCstudy2009.pdf

Darling-Hammond, L., Debra Meyerson, D., Michelle LaPointe, M., & Orr, M. (2009). *Preparing principals for a changing world: Lessons from effective school leadership programs*. San Francisco, CA: Jossey-Bass.

Davidson, C.N. & Goldberg, D.T. (2009). *The future of learning institutions in a digital age*. The John D. and Catherine T. MacArthur Foundation. Cambridge, MA: The MIT Press. Retrieved February 12, 2010, from http://www.scribd.com/doc/13476078/The-Future-of-Learning-Institutions-in-a-Digital-Age

Dede, C. (2007a). Transforming education for the 21st century? New pedagogies that help all students attain sophsitcated learning outcomes. Commissioned by the NCSU Friday Institute. Retrieved March 12, 2010, from http://www.gse.harvard.edu/~dedech/Dede_21stC-skills_semi-final.pdf

Dede, C. (2007b). Reinventing the role of information and communication technologies in education. *Yearbook for the National Society for the Study of Education*, 106(2), pp. 11-38.

Diamond, J. (n.d.) A new view: Distributed leadership. Retrieved March 10, 2010 from http://www.uknow.gse.harvard.edu/leadership/leadership002a.html.

Elmore, R. (2003). School reform from the inside out. Cambridge, MA: Harvard University Press.

Elmore, R. (2006). Leadership as the practice of improvement. Paper presented at International Conference: *International perspectives on School Leadership for Systemic Improvement.* Retrieved February 7, 2010 from http://www.oecd.org/dataoecd/2/9/37133273.pdf

eMINTS National Center. (2009). Experience unlimited possibilities for learning. Retrieved March 12, 2010, from http://www.emints.org/about/emintsfactsheet.pdf

eMINTS Evaluation Team. (2007). Analysis of 2005 MAP results for eMINTS students. Evaluation Team Policy Brief. eMINTS National Center. Retrieved March 12, 2010, from http://www.emints.org/evaluation/reports/map2005.pdf

enGauge 21st Century Skills (2009). Retrieved March 29, 2010 from http://www.ncrel.org/engauge/skills/engauge21st.pdf

Ertmer, P.A. (1999). Addressing in first and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 53*(4), 35-39.

Fox, R., & Henri, J. (2005). Understanding Teacher Mindsets: IT and Change in Hong Kong Schools. *Educational Technology & Society, 8*(2), 161-169.

Friesen, S. (2009). *Teaching effectiveness: A framework and rubric.* What Did You Do In School Today? Toronto, ON: Canadian Education Association.

Friesen, S. (2007). Inside an accessible classroom. Research report conducted for and presented to Alberta Education.

Friesen, S. & Jardine, D. (2009). On field(ing) knowledge. In S. Goodchild & B. Sriraman, eds. *Relatively and Philosophically E[a]rnest: Festschrifte in Honour of Paul Ernest's 65th Birthday. The Montana Mathematics Enthusiast: Monograph Series in Mathematics Education*. Charlotte NC: Information Age Publishing, pp. 149-175.

Friesen, S., Saar, C., Jacobsen, M. & Martin, B. (2009). iLearn: Teaching and learning in a mobile laptop computing environment. Research report presented at board meeting February 2009.

Fullan, M. Hill, P. & Crevola, C. (2006). *Breakthrough*. Thousand Oaks, CA: Corwin Press.

Galloway, J. (2009*). Harnessing technology for every child matters & personalized learning.* New York, NY: Routledge

Gardner, H. (2006). *Five minds for the future.* Boston, MA: Harvard University Press.
Gilbert, J. (2005). *Catching the knowledge wave? The knowledge society and the future of education*. Wellington, NZ: NZCER Press.

Grafton, L. & Ghoshai, S. (2005). Beyond best practice. MIT Sloan Management Review, 16(3), pp.49-57.

Hannafin, R. (2008). K-12 technology audit: lessons fro school leadership. *International Electronic Journal for Leadership in Learning, 12*(6). Retrieved March 12, 2010, from http://www.ucalgary.ca/iejll/vol12/hannafin

Hargreaves, A. (2003). Teaching in a knowledge society: Education in the age of insecurity. New York, NY: Teachers College Press.

Hargreaves, A. & Shirley, D. (2009). The fourth way: The inspiring future for educational change. Thousand Oaks, CA: Sage.

Harris, A. (2008). Distributed school leadership: Developing tomorrow's leaders. New York, NY: Routledge.

Hendler, J. (2009). Web 3.0 Emerging. *Computer, 42*(1), 111 – 113.

Infodev (2005). *Knowledge Maps: ICTs in Education. What do we know about the effective uses of information and communication technologies in education in developing countries?* Washington, DC: The International Bank for Reconstruction and Development / The World Bank.

ISTE (International Society for Technology in Education). (2009). *The ISTE national educational technology standards (NETS-A) and performance indicators for administrators.* Retrieved March 6, 2010, from http://www.iste.org/Content/NavigationMenu/NETS/ForAdministrators/2009Standards/NETS-A_2009.pdf

ISTE (International Society for Technology in Education). (n.d.). Essential conditions rubric*. ISTE National Educational Technology Standards (NETS)*. Retrieved March 12, 2010, http://electronicportfolios.com/reflect/EssenCondRubric.pdf

ISTE (International Society for Technology in Education). (2008). *ISTE Policy Brief—Technology and Student Achievement—The Indelible Link*. Retrieved March 12, 2010, from http://www.iste.org/Content/NavigationMenu/Advocacy/Policy/59.08-PolicyBrief-F-web.pdf

ISTE (The International Society for Technology in Education), the Partnership for 21st Century Skills and the State Educational Technology Directors Association (SETDA). (2007). Maximizing the Impact: The pivotal role of technology in a 21st century education system. Retrieved March 12, 2010, from http://www.setda.org/c/document_library/get_file?folderId=191&name=P21Book_complete.pdf

Jacobsen, M., Saar, C., & Friesen, S. (2010). Teaching and learning in a one-to-one mobile computing environment**:** A research report on the personalized learning initiative At Calgary Science School. Report delivered to the Board of the Calgary Science School, March 2010.

Jardine, D., Clifford, P., & Friesen, S. (2008). *Back to the Basics of Teaching Learning: Thinking the World Together*, 2nd Edition. New York: Routledge.

Jardine, D., Friesen, S., & Clifford, P. (2006). *Curriculum in abundance.* New York: Routledge.

Jenkins, H., Clinton, K, Purushotma, R. Robinson, A., & Weigel, M. (2009). Confronting the challenges of participatory culture: Media education for the 21st century. The John D. and Catherine T. MacArthur Foundation Reports on Digital Media and Learning. The MIT Press, Cambridge, MA. Retrieved February 12, 2010, from http://mitpress.mit.edu/books/full_pdfs/Confronting_the_Challenges.pdf

Johnson, L., Levine, A., Smith, R., & Stone, S. (2010). *The 2010 Horizon Report.* Austin, Texas: The New Media Consortium. Retrieved February 12, 2010, from http://www.nmc.org/pdf/2010-Horizon-Report.pdf

Jonassen, D. H., Howland, J., Marra, R. M., & Crismond, D. (2008). *Meaningful learning with technology* (3rd Ed.). Upper Saddle River: Prentice Hall, Inc.

Koehler, M.J. & Mishra, P. (2008). Introducing TPCK. In AACTE Committee on Innovation and Technology (Ed.), *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators*, pp. 1-29. New York, NY: Routledge for the American Association of Colleges for Teacher Education.

Koehler, M.J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy, and technology. *Computers and Education, 49*(3), 740-762.

Kozma, R. B. (2006). Monitoring and Evaluation of ICT for Education Impact: A Review. In D. Wagner, R. Day, T. James, R. Kozma, J. Miller & T. Unwin (Eds.), *Monitoring and Evaluation of ICT in Education Projects. A Handbook for Developing Countries*. Washington, DC: The International Bank for Reconstruction and Development / The World Bank.

Kulik, J. A. (2003). *The effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say*. Arlington, VA: SRI International.

Larson, L., Miller, T. & Ribble, M. (2009). 5 considerations for digital age leaders. *Learning and Leading with Technology, 37*(4), 12-15. Retrieved January 14, 2010, from http://ezproxy.lib.ucalgary.ca:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=45566293&site=ehost-live

Leithwood, K. (2008). Characteristics of high performing school Districts *A review of empirical evidence.* A report prepared for the College of Alberta School Superintendents, September, 2008.

Lemke, C., Coughlin, E., Garcia, L., Reifsneider, D., & Baas, J. (2009). *Leadership for Web 2.0 in Education: Promise and Reality.* Culver City, CA: Metiri Group. Commissioned by CoSN through support from the John D. and Catherine T. MacArthur Foundation. Retrieved December 23, 2009, from http://www.cosn.org/Portals/7/docs/Web%202.0/CoSN%20Report%20042809Final%20w-cover.pdf

McKinsey & Company. (2007). *How the world's best performing school systems come out on top.* Retrieved February 7, 2010 from http://mckinsey.com/clientservice/socialsector/resources/pdf/Worlds_School_Systems_Final.pdf

Mishra, P. & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A framework for teacher knowledge. *Teachers College Record*. 108(6), 1017-1054.

Mulford, B. (2008). The leadership challenge : Improving learning in schools. *Australian Education Review.* Retrieved March 1, 2010 from http://research.acer.edu.au/aer/2

Murgatroyd, S. (in press). Wicked problems and the work of the school. *European Journal of Education*.

Murphy, J., Elliott, S., Goldring, E. & Porter, A. (2006). *Learning centered leadership: A conceptual foundation.* Wallace Foundation.

NCSL. National College for School Leadership (2006) *Learning about learning networks*. Retrieved March 10, 2010 from http://networkedlearning.ncsl.org.uk/knowledge-base/programme-leaflets/learning-about-learning-networks-UK.pdf

Nelson, J., Christopher, A. & Mims, C. (2009). TPACK and Web 2.0: Transformation of teaching and learning. *TechTrends, 53*(5). 80 – 85.

Nussbaum, M. (2010). Looking into the future: the importance of applications and quality content. Paper presented International Conference on 1-to-to Computing in Education: Current Practices, International Comparative Research Evidence and Policy Implications. Vienna, Austria, Feb 22-24, 2010.

OECD (Organization of Economic Cooperation and Development). (2003). PISA (Programme for International Student Assessment). Learning for tomorrow's world. Retrieved March 10, 2010 from http://www.oecd.org/dataoecd/1/60/34002216.pdf.

OECD (Organization of Economic Cooperation and Development). (2005). *The selection and definition of key competencies: Executive summary*. Paris, FR: The Organization of Economic Cooperation and Development.

OECD (Organization of Economic Cooperation and Development). (2006). Are students ready for a technology-rich world? What PISA studies tell us. Paris: .OECD

OECD (Organization of Economic Cooperation and Development). (2008). New millennium learners: *Initial findings on the effects of digital technologies on school-age learners.* Paris: OECD. Retrieved March 10, 2010 from http://www.oecd.org/dataoecd/39/51/40554230.pdf

OECD (Organization of Economic Cooperation and Development). (2009a). The new millennium learners: Main findings. Paris: OECD. Retrieved March 3, 2010 from http://www.nml-conference.be/wp-content/uploads/2009/09/NML-Preliminary-Findings.pdf

OECD (Organization of Economic Cooperation and Development). (2009b). Reframing the policy expectations about technology in education. Paris: OECD. Retrieved March 3, 2010 from http://www.nml-conference.be/wp-content/uploads/2009/09/Reframing-Policy-Expectations-about-ICT-in-Education.pdf

Partnership for 21st Century Skills. Retrieved March 29, 2010 from http://www.21stcenturyskills.org/

Papert, S. (2004). Will Going Digital Improve or Transform Education? Paper presented *New Futures for Learning in the Digital Age*, Dublin, Ireland, May 17, 2004.

Peck, C., Cuban, L., & Kirkpatrick, H. (2002). Techno-promoter dreams, student realities. *Phi Delta Kappan*, 83 (6), pp.472 – 480. Retrieved March 10, 2010 from http://www.pdkintl.org/kappan/k0202pec.htm.

Polly, D. & Brantley-Dias, L. (2009). TPACK: Where do we go now? TechTrends, 53(5), 46 – 47.

Ribaux, G. (2010). Eastern Townships School Board: 1:1 leading change in public education. Paper presented International Conference on 1-to-to Computing in Education: Current Practices, International Comparative Research Evidence and Policy Implications. Vienna, Austria, Feb 22-24, 2010. Retrieved March 10, 2010 from http://www.bildung.at/nml-conference2010/files/Vienna%20Presentation%20February%2022nd%202010.pdf

Sawyer, R.K. (2008). Optimizing learning: Implications of learning sciences research. In OECD (Ed) *Innovating to learn: Learning to innovate.* Centre for Research and Innovation: OECD. pp.45-62.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Eds.), *Liberal education in a knowledge society* (pp. 76-98). Chicago: Open Court.

Scardamalia, M. (2003). Knowledge building environments: Extending the limits of the possible in education and knowledge work. In A. DiStefano, K. E. Rudestam & R. Silverman (Eds.), *Encyclopedia of distributed learning* (pp. 269-272). Thousand Oaks, CA: Sage Publications.

Scardamalia, M. (2004). CSILE/Knowledge Forum®. In A. Kovalchick & K. Dawson (Eds.), *Education and technology: An encyclopedia* (pp. 183-192). Santa Barbara, CA: ABC-CLIO, Inc.

Scardamalia, M., & Bereiter, C. (2002). Knowledge building. In *Encyclopedia of education,* New York: Macmillan.

Scardamalia, M. & Bereiter, C. (2003). Knowledge building. In *Encyclopedia of education*. (2nd ed., pp.1370-1373). New York: Macmillan Reference, USA.

Scardamalia, M. & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences. New York: Cambridge University Press.

Scardamalia, M., Bransford, J., Kozma, B. & Qyekknakzm E. (2010). White Paper 4: New assessments and environments for knowledge building. ATCS: Assessment & Teaching of 21st Century Skills. Draft White Papers. Retrieved February 12, 2010, from http://www.atc21s.org/GetAssets.axd?FilePath=/Assets/Files/294f3563-71d2-457d-9308-cc60dffe39f4.pdf

Schmidt, D.A., Baran, E., Thompson, A.D., Mishra, P. Koehler, M.J. & Shin, T.S. (2009-10). Technological pedagogical context knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education, 42*(2), pp.123 – 149.

Schrum, L. & Levin, B.B. (2009). *Leading 21st century schools: Harnessing technology for engagement and achievement.* Thousand Oaks, CA: Corwin.

Sclater, J., Sicoly, F., Grenier, A., Abrami, P. & Wade, A. (2005). ETSB-CSLP laptop research partnership Schoolnet report: Preliminary study. Retrieved March 03, 2010 from http://doe.concordia.ca/cslp/Downloads/PDF/SchoolNet-ExecSum.pdf.

Silvernail, D. (2005). Does Maine's middle school laptop program improve learning? A review of evidence to date. Center for Education Policy, Applied Research, & Evaluation. Retrieved March 03, 2010 from http://usm.maine.edu/cepare/pdf/MLTI705.pdf

Silvernail, D. & Gritter, A. (2007). Maine's middle school laptop program: Creating better writers. A research brief. Center for Education Policy, Applied Research, & Evaluation. Retrieved March 03, 2010 from http://usm.maine.edu/cepare/Impact_on_Student_Writing_Brief.pdf

Standards for the 21st Century Learner (2007). Retrieved March 29, 2010 from http://www.ala.org/ala/mgrps/divs/aasl/guidelinesandstandards/learningstandards/standards.cfm

Statistics Canada. (2008). Canadian internet use survey: 2007. *The Daily*. Retrieved March 12, 2010, from http://www.statcan.gc.ca/daily-quotidien/080612/dq080612b-eng.htm

Stoll, L. (2009). Knowledge animation in policy and practice: Making connections. Retrieved March 1, 2010 from http://www.oise.utoronto.ca/rspe/UserFiles/File/Publications%20Presentations/AERA%2009%20knowledge%20animation%20paper%20Stoll.pdf

UNESCO (2005a). Why a summit on the information society. *World Summit on the Information Society*. Retrieved March 1, 2010 from http://www.itu.int/wsis/basic/why_print.html

UNESCO (2005b). Towards knowledge societies. Retrieved March 1, 2010 from http://*unesdoc.unesco.org/images/0014/001418/141843e.pdf*

U.S. Department of Education (2010). *Transforming American education: Learning powered by technology*. Draft National Educational Technology Plan 2010, Executive Summary. Washington, DC: Office of Educational Technology, U.S. Department of Education. Retrieved March 30, 2010 from http://www.ed.gov/sites/default/files/NETP-2010-exec-summary.pdf.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. New York, NY: Harvard University Press.

Vygotsky, L. (1987). Thinking and speech. In L. S. Vygotsky, *Collected works* (vol. 1, pp. 39-285) (R. Rieber & A. Carton, Eds; N. Minick, Trans.). New York: Plenum. (Original works published in 1934, 1960).

Wagner, T. (2008). *The global achievement gap: Why even our best schools don't teach the new survival skills our children need and what we can do about it*. New York, NY: Basic Books.

Wagner, T. (2006). *Change leadership: A practical guide to transforming our schools*. San Francisco, CA: John Wiley & Sons Inc.

Walser, N. (2008). Teaching 21st century skills. *Harvard Education Letter*, 24(5), 1-3.

Wardlaw, C. (2009). Mathematics in Hong Kong/China: Improving on being 1st on PISA.

Wheatley, F., Zimmerman, B., & Patton, M. (2006). *Getting to maybe: How the world is changed*. Toronto, ON: Random House.

Willms, D., Friesen, S., & Milton, P. (2009). *What did you do in school today? Transforming classrooms through social, academic and intellectual engagement.* Toronto, ON: Canadian Education Association.