CLOUD COMPUTING

What is cloud computing and why is it important for Adult Literacy?

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A report on emerging technologies for adult learning
prepared for AlphaPlus

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This report reflects the opinions of the authors and does not reflect the position of either AlphaPlus or Athabasca University. Please direct correspondence to Dr. Rory McGreal, **rory@athabascau.ca**

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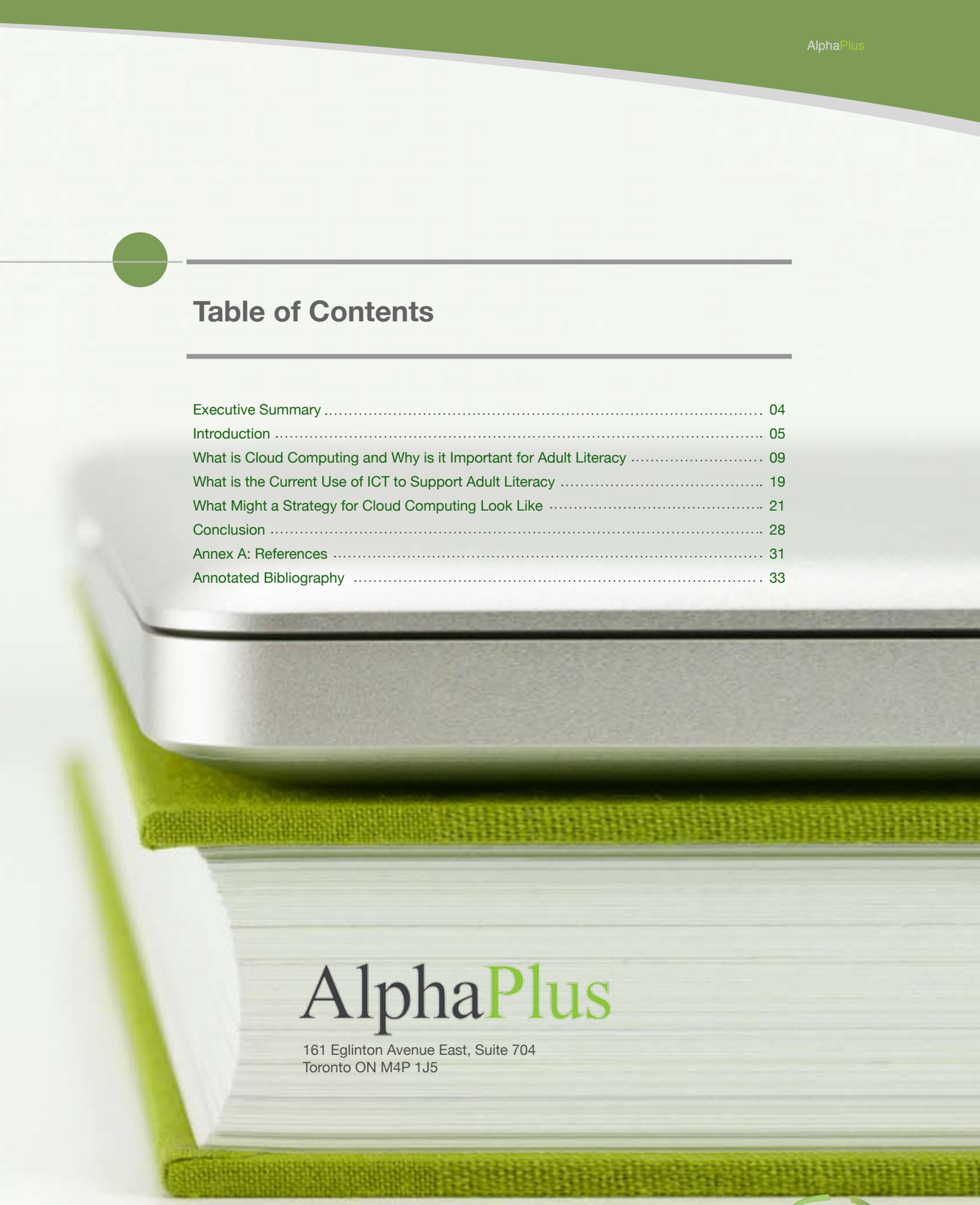

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Foreword

At AlphaPlus, we are constantly tapping into new ideas, monitoring trends, pursuing best practices and researching the latest developments in technology and adult education. We are currently working on several research projects to be published in 2011-12; these projects are related to digital technologies and their potential impact(s) on the adult literacy field. This research supports our commitment to uncover best practices and to address gaps in integrating technology in adult education.

The research will be disseminated in Canada and internationally, and seeks to create a heightened awareness and to spark a discussion around technology and its ability to support adult education practitioners and learners in acquiring the digital skills needed in today's society. The constant integration of digital technologies will create new demands in our lives and in relation to adult literacy; there is an increasing need to learn and adapt to ever-changing environments. Technology can be used to acquire necessary digital skills, reduce IT costs, enhance access to learning, engage learners, and enable adults to learn regardless of their literacy skill levels or location.

Specifically, this report presents a concept of what a 'Learning Cloud' could look like for the adult literacy sector and the benefits it could provide adult literacy programs. Cloud computing offers an intriguing technology to address the increasing cost and complexity of providing computing services in adult education institutions and organizations. Adult literacy organizations would benefit from having an affordable computing infrastructure and from access to computing software/programs over the Internet from a cloud computing provider. Other opportunities identified in the report include increased access to learning via the Internet and Internet-based tools such as Web; the opportunity for community collaboration; and a centralized online space where adult educators and learners could share a large volume of resources, workspaces, tools, forums, and more.

Other research topics to be published in the upcoming year include social networking in Adult Basic Education and adult literacy, exploring the use of digital media with adult learners, incorporating digital technology in the Literacy and Basic Skills Sector, and practices attached to digital technology in community-based adult literacy settings. In addition, two Francophone research papers will be published: one paper that speaks to the changing nature of technology and its impact on adult basic education using Moodle and another paper that explores the motivation of adults in using technology for workplace training.

We welcome and encourage your feedback and insight to help us uncover greater uses and possibilities for the integration of technology in the field of adult education.

Peter Rogers
Board Chair

Michael Coteau
Executive Director

Executive Summary

"What is Cloud Computing and Why is it Important for Adult Literacy?" was commissioned by AlphaPlus to examine how cloud computing can sustain the promise of adult learning. The report includes a review of recent literature on cloud computing, on the role of technology in literacy, and on the characteristics of adult literacy in Canada.

Cloud computing portends two fundamental changes in the way organizations will do their computing. The first is a shift from maintaining an in-house computing infrastructure to purchasing computing over the Internet from a cloud computing provider. The cloud provider operates a facility or "server farm" consisting of a large number of computers connected to the Internet. In addition to achieving economies of scale, cloud utilities are usually located near power sources to reduce energy costs. The second change is accessing computing power on demand – paying only for what they use and drawing on the server farm's enormous capacity when large amounts of computing resources are required. This elasticity will facilitate computationally intense peak periods, while keeping costs down during normal work or vacation periods; thus, a cloud user benefits by not having to build their own infrastructure yet being able to meet peak processing needs at an affordable price.

"There is a shift from maintaining an in-house computing infrastructure to purchasing computing over the Internet from a cloud computing provider."

Adult Literacy training in Canada is fractioned by the federal-provincial constitutional division, by languages, and by the divisions between institutional and community service models. Federal funding is particularly time limited and intermittent as it is tied to short-term employment initiatives. This resulting mix creates instability in the capacity of literacy providers to sustain literacy programs. On the other hand, literacy providers have been forming regional (provincial) literacy communities, and these in turn affiliate at the national level, thus there may be sufficient goodwill to pool resources to work on a multi-faceted cloud computing coalition.

Low-cost cloud technology offers many possibilities to encourage individualized and group literacy learning opportunities. The growing access to the Internet has seen information and computer technologies (ICT) become a new type of literacy that is embedded in the daily lives of Canadians as they send email, text message, blog their thoughts, and watch informal videos on YouTube. Access to the Internet and services on the Internet is enhanced through the growing use of smartphones for mobile connections.

In addition to calling for free online space and an email account for every adult literacy learner, the report sees cloud computing as an opportunity for community collaboration to share resources and promising practices in the cloud thus bolstering literacy services across Canada. Finally, it speculates that the future cyberspace for adult literacy could include new literacy appliances – smartphone applications to help read signs, turn text into voice, and help individuals with literacy challenges function better in a text laden world.

Introduction

Adult literacy in Canada has been called a patchwork of large and small adult education providers: community colleges, school boards, and independent community-based literacy organizations (Movement for Canadian Literacy, 2007). Funding for adult literacy comes from several pockets, including different provincial and/or federal government departments as well as charitable organizations. Much of the federal funding is short-term in response to shifting government priorities. Indeed, Crooks et al. (2008) suggests that the ongoing funding search, with the attendant application and reporting activities, detracts from the ability to provide more effectively planned and sustainable adult education programs. A major challenge for adult literacy providers is that while their client base has huge human and economic potential, adults with low literacy skills are not perceived as large contributors to the economy and are too often funded intermittently on a project-by-project basis or as an afterthought. Without deep pockets to exploit technologies, nor exposure to the use of technologies for teaching, adult literacy providers remain very traditional in their use of face-to-face pedagogy and have limited opportunities to learn the potential benefits of technology enhanced learning and cloud computing.

While there are some formal education settings for basic literacy programs in Canada, much of the provision for on-going literacy training is in informal community settings. Informal learning and semi-formal community-based learning are the dominant modes of adult learning within small businesses, trade unions, cooperatives, industrial and commercial enterprises, hospitals, correctional facilities, and religious and cultural organizations. There are no statistics on the amount of informal learning that is occurring, but there is general agreement that it is growing rapidly (Cross, 2007). Computer technology can assist with literacy training, but the degree of technology integration and interoperability required to provide seamless service is becoming too complex for smaller colleges and community organizations to manage efficiently. Many computer service departments struggle to provide basic ICT services. Cloud computing can be used to address the increasing cost and complexity of providing state-of-the-art e-learning services. The cloud also makes it possible to develop and deploy large scale sophisticated data analytics that could be valuable tools in understanding and personalizing adult learning. Such new approaches are required if adult education institutions and organizations are to effectively meet the demands of learners and other stakeholders for ever more sophisticated services, while still working within the growing budgetary constraints of both the organization and the adult learning sector as a whole. Cloud computing can form a major part of an effective solution to this problem.

“Cloud computing can be used to address the increasing cost and complexity of providing state-of-the-art e-learning services.”

Many institutions and companies are already adopting cloud computing, a term that refers to accessing and using the Web servers and software housed in large industrial scale computing centres. These commercial “utilities” offer computing services at a fee that is far cheaper than what most organizations would pay to implement and maintain their own computing infrastructure. To lower energy costs, cloud providers locate their data centres near power sources to lower staff costs per machine and install vast numbers of computers in each server farm. Many institutions already benefit from these economies of scale by outsourcing email to Google or to Microsoft.

The second benefit of cloud computing is in having large data processing resources available "on demand." Scientists with analyses that might take hours or days to execute on a single computer can speed up the processing by tasking the cloud to provide the equivalent of hundreds of computers for a few minutes. Lower costs and flexible computing-on-demand are the two key advantages of cloud computing. The impact is already being felt in some institutions and businesses; cloud computing will soon spread to other areas of the economy and to adult literacy organizations that become aware of its benefits.

Cloud computing can be an industrial scale replacement of the "cottage industry" approach to institutional computing that now exists within institutions and organizations. The capital costs of computing can be eliminated and operational costs reduced. Once using the cloud, the in-house physical space is no longer required and the energy consumed is decreased, yet computing capacity is greatly increased. Because the server farm has redundant servers, service should become more reliable and the elasticity of the supply allows users to increase or reduce capacity as needed (Powell, 2009).

At first glance, cloud computing seems like an entirely technical issue since adult literacy educators, like most consumers, are blissfully unaware of the Web service technologies they currently use for searching the Web or booking airplane tickets. However, a major paradigm shift will lead those using technology to rethink the services they offer and how they are offered. For example, the emergence of the Mosaic browser in 1995 made it possible to both publish and retrieve information without having an intermediary, and it made it easy for anyone to publish information quickly and at a much reduced cost. This had a huge impact on the world of distance education that until then leaned toward "big mass media" paper publications and television. The "anyone can publish" environment brought on by the Web meant that almost any institution could start offering distance education, which they are doing in ever increasing numbers. By 2005, the integration of mobile telephones with the Internet literally meant that almost anyone, almost anywhere could connect to the world's information systems.

This has been particularly beneficial through democratizing information access in developing countries as they are now able to use mobile phone networks to carry both voice and data information. The ability to "leap-frog" the millions of miles of copper wire and boxes that plug into electrical outlets has enabled emerging and developing countries to partake in the knowledge economy at a faster rate and to partially close the digital divide.

Piña and Rao (2010) argue that cloud computing is creating "new IT [Information Technology]-enabled market constructs" and is having a profound effect on management, particularly in terms of incentive structures and administrative processes. This poses challenges to business transformations from which the adult literacy community and other educational and economic sectors cannot escape. The shift to cloud computing provides an opportunity for adult literacy providers to implement and/or re-structure their online operations and decide what services to offer and how they will be provided. They also have an opportunity to pool their efforts. However, this will not happen automatically. The adult literacy sector in Canada faces endemic regionalization and programming challenges that have little to do with computing, and everything to do with politics, funding, community leadership, and professional collaboration. Community leadership is required to bring the appropriate focus.

Myers and de Broucker (2006) recommended the implementation of a public policy framework for adults that acknowledges the 'right to learn.' This includes financial support, incentives for employers, and more government investment using a "co-ordinated approach to respond to adult learners' needs." Support for cloud computing would go a long way in addressing these recommendations.

An e-learning expert symposium sponsored by Contact North (2010b) identified a number of specific operational and technical challenges, all of which could be viably addressed using cloud computing. These include addressing content quality, learner support, the e-learning compatibility of administrative systems, on-going IT management infrastructures, tools, broadband availability, support services (helpdesk), and the evergreening of IT.

While cloud computing can be used to lower the costs of providing a technological infrastructure for adult literacy there will still be real costs; the economics of cloud provision will need to be defined and fully understood. The cloud investment can only be realized with a sufficient stable funding environment. Building a collaborative community around cloud computing might be a way to bring a large number of educational resources together to develop and sustain a coherent and cost-effective delivery model for adult literacy training that would benefit many. It may also provide the cross-fertilization of ideas and talents to see a new range of literacy services that will help Canadians with low literacy cope with our text-laden society.

"Building a collaborative community around cloud computing might be a way to bring a large number of educational resources together to develop and sustain a coherent and cost-effective delivery model for adult literacy training that would benefit many."

This report is organized around four questions:

1. What is cloud computing and why is it important for adult literacy?
2. What is the current state of adult literacy education in Canada and is a cohesive community possible?
3. What is the current use of information technologies to support adult literacy?
4. What might a cloud computing strategy for adult literacy look like and what are the challenges to realize such a vision?

The changes cloud computing brings may provide unprecedented opportunity to revolutionize the way in which we offer adult literacy training. It may enable new literacy services that can hasten the integration of adults with low literacy into mainstream society. It may enable them to fully participate in the workforce, in lifelong learning, and in their communities. The cloud could facilitate the alignment of institutional processes and thereby enable the reduction of system complexity. Still, there are legitimate reasons for institutional or organizational differences: size, programming, structure, and the operational mandate all provide significant reasons for differentiation. The main benefits for an initial adult education

cloud lie in the lower layers of the IT stack where infrastructure and platform provision best accommodate scalability. However, areas of significant gain can still be realized at the application level with, for example, email, as examined above, Learning Management Systems, Content Management Systems, and Web Conferencing Systems. These would represent the initial applications that would formulate a common cloud provision.

Annex A contains an annotated bibliography related to cloud computing and adult literacy.

What is cloud computing and why is it important for Adult Literacy?

"Cloud computing is a nebulous term" (Anon.)

Wikipedia notes the cloud concept originated among telephone networks and that "The first scholarly use of the term cloud computing was in a 1997 lecture by Ramnath Chellappa." That said, according to Pingdom (2009):

The term "cloud computing" was launched into the mainstream in 2006 when Eric Schmidt, CEO of Google, used the term when describing Google's own services during a search engine conference: It starts with the premise that the data services and architecture should be on servers.
We call it cloud computing – they should be in a "cloud" somewhere.

The National Institute of Standards and Technology (NIST) defines the term as follows:

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell & Grance, 2009).

In common usage cloud computing has grown to mean Internet access to large scale computing facilities provided by others. There are a few key concepts:

Economies of Scale

The cost of providing ICT has become a growing concern for many organizations. For example a large university with tens of thousands of students might be spending over $500,000 each year just for the infrastructure (servers, software, storage, staff, and communications) to provide email. Cloud providers typically locate their computing facilities near power sources so the electricity is "greener" and cheaper since less power is wasted in transmission. Their large facilities are more robust and require fewer staff per email account to maintain than small facilities. They also have a business model that exchanges free email as a way of building their customer base. For example, Google has a huge email facility that provides millions of Gmail accounts for free and can readily accommodate a few hundred thousand more. Google Apps for Education is offering free university-branded email and other applications like document sharing and file storage to entice universities to make the switch to "greener" and "cheaper" cloud computing services. Free Gmail accounts have paid off by paving the way to long-term corporate accounts for a variety of services. Microsoft and Amazon (and others) are also offering cloud services on a large scale.

ICT in most organizations is normally considered to be a capital cost and all expenditures must be funded from operating revenues. This makes effective planning of ICT infrastructure a very tenuous enterprise, with plans rendered unsustainable as budgets fluctuate with operating requirements that vary greatly depending on external funding. The ICT conundrum is analogous to erecting a building and receiving funding for the initial construction, but with no guarantee that sustainable funding for the ongoing building maintenance will be provided. Yet for the building to be occupied it still needs utilities like heating and electricity and other maintenance services – sometimes minimally – but fully when there is a lot of human activity. The effect of capital costs without operating funds is sub-optimal at best and chaotic and error prone at worst. Unfortunately, this is how all too many adult literacy initiatives are funded with up front funding that is not sustained. The development of an adult literacy cloud can be used to help reduce this funding sustainability gap and allow more effective planning and provision of services. This is not a simple task, however, and will require significant and involved collaboration across the adult education sector, yet institutions and organizations appear to have few viable alternatives. A freely accessible adult learning cloud computing environment or medley of environments could provide significant financial savings for learners, employers and adult learning organizations and institutions while at the same time forming the basis for coordinated approaches to learning delivery provincially or even nationally.

"The development of an adult literacy cloud can be used to help reduce this funding sustainability gap and allow more effective planning and provision of services."

Virtualization

Today's computers are very fast, powerful, and capable of serving several users at the same time. Each user is given a share of the computer's time and resources and several "virtual" computing sessions can be run at the same time. The computers are so fast that the typical user does not even notice that they are sharing a computer. Every job that accesses the cloud through the Internet is assigned to the next available virtual space – often on a different physical computer than the last virtual session. The cloud management software looks after the job allocations, constantly shifting usage to optimize the use of several computers connected together in the cloud. Fewer computers are needed in the workplace than in the current desktop environment where each user has their own personal computer.

Device Independence

Since the data processing is done "in the cloud," the user no longer needs a powerful (nor expensive) desktop computer. Smaller and cheaper workstations, "notebook" computers, and mobile devices like tablet computers or even smartphones can connect to the cloud via the Internet. The cloud will be able to reformat output to suit the user's device – perhaps reading out loud to a mobile phone rather than sending text to its small screen (Chen, Liu, Han, & Xu, 2010). Moreover, users can alternate devices and access their applications and content independently from wherever they are located using any Internet capable device.

Elasticity

With desktop computing, each user is limited to the resource (processing, memory, and data storage) available in their personal computer. With cloud computing users can request as much computing power as they need. For example, Roth (2010) discusses how he recently used a cloud computing facility to find a missing security code by testing every possible combination until he found the one that fit. With a desktop computer this might have taken years, but by programming a cloud to run hundreds of virtual copies of his program at the same time, the missing code was found in minutes, at a cost of about $2. Cloud resources are said to be "elastic" – they can expand or contract to the amount of computing power needed at any given time. This means very powerful analyses can be conducted more readily than would be feasible on a desktop computer. Keahey et al. (2008) note how several scientists can schedule use of a shared cloud, and that open source cloud software makes it possible to quickly create new cloud installations. Of course, licensing approaches will need to be more flexible for this to be advantageous. A more flexible, pay-as-you-go approach will need to be integrated into licensing structures.

Cloud Service Models

Cloud services typically fall into one of three technical/marketing categories: Infrastructure as a Service (IaaS) where the expert user implements their own software to optimize use of the computing facility, Platform as a Service (PaaS) where the client customizes their application to run inside the cloud management software, and Software as a Service (SaaS), like Gmail, where the user simply uses the software provided. This flexible approach means that an organization with special needs and the appropriate technical skills can build their own computing solution while customization and the use of generic software can meet most users' requirements. As a rough analogy, if IaaS were renting a car at the airport, then PaaS would

be hailing a taxi, and SaaS would be taking the bus. The service models provide options to suit user independence, expertise, budget, and technical needs. Different services will have different benefits; the uptake rate will be influenced by the applicability within organizations. The models will need to evolve with requirements of the adult literacy provider and their needs for the cloud; executing working cloud models, and ensuring satisfactory quality of service are essential.

Concerns Over Cloud Computing

The major concern is about **security**. Since cloud computers are accessed over the Internet it is difficult to know where a virtual job will actually be processed (i.e. where the computer is physically located). Data may easily cross international boundaries and suddenly be open to legal inspection in other countries, which would be a concern. For example, Canadian data that is supposed to be protected under Protection of Privacy Laws could cross over to the USA and be subject to the Patriot Act, under which the data would be accessible to investigators. Haigh (2010) notes that Microsoft located its European email server farm in Dublin to avoid client concerns that their data would be open to the US government. Private, secure, or mission critical data should not be processed in third party public cloud

computing environments. One alternative is to process secure data in private clouds. For example, Danek (2010) notes that the Canadian government is planning to set up its own secure cloud computing environment that will rationalize the use and cost of government ICT infrastructure across several federal departments.

The second concern is the need for a **fast and reliable Internet connection**. Cloud computing involves rapidly moving the data to be processed elsewhere, and then quickly returning the results. A slow or intermittent Internet connection can interrupt the data flow and separate the user from the virtual machine. (One author of this report had to re-type several paragraphs when a communications interruption disconnected him from the word processing application in a cloud environment.) Cloud computing may initially not be a successful strategy for users in rural and remote areas until they can be assured continuous robust connectivity.

The third concern is about **switching costs**. Legacy applications will need to be incorporated into the cloud environment and incompatibility in design standards can pose significant hurdles and be quite costly when porting them to a cloud platform. Fortunately, as previously mentioned, very few adult literacy organizations have investments in ICT legacy software. On the other hand, the costs of "lock in" cannot be avoided. The tale of the monkey and the coconut suggests you can catch a monkey by chaining a coconut to a tree and boring a hole just large enough for a monkey to reach his hand in and grab a fistful of honeyed rice. The closed fist is too large to go backwards through the hole. For the monkey to be free of the trap, he has to let go of the bait. The costs of "letting go" from a cloud service to return to an internal ICT infrastructure or to another cloud provider may be insurmountable, just as it is difficult for a homeowner to dispute rate hikes by the local electricity provider or buy their energy from another source. It is conceivable that in the future, the "free" Google and Microsoft academic and email services may have to charge for services in order to recover their costs. Institutions that are "locked in" at that point may have to search for new resources or abandon their cloud services. How long the free ride can continue is probably more of a question of market economics than any one company's strategy.

The fourth concern is **hype**. Katz, Goldstein & Yanosky (2009) note that cloud computing seems to have caught the attention of almost every technology journalist to the point where it might be oversold. While the cloud has arrived for common services like email, for many other services the transition may take much longer.* Much technical and policy work remains to be done by the adult literacy community to determine which applications can go to the cloud and which require a more conservative approach. Expectations will need to be adjusted to reflect realistic and achievable applications.

Summary

Cloud computing changes the efficiencies and economics of providing ICT services. Large cloud "utilities" are being developed that will make it cost-effective to move many if not most ICT services "to the cloud"; the nature of the services provided can be negotiated with the cloud provider. Virtualization will enable several computing jobs (like word processing or email

users) to run on a single computer, while elasticity makes it possible to have huge amounts of computing resources instantly available to meet demands for intensive data processing. Cloud computing is evolving rapidly and new methods to ensure effective management and security will emerge. Currently most applications of cloud computing are in administration and research applications, but the ability to build and share powerful new processes will rapidly expand the variety of services available. This is where the greatest potential might be for adult learning and literacy training.

"The ability to build and share powerful new processes will rapidly expand the variety of cloud computing services available. This is where the greatest potential might be for adult learning and literacy training."

Katz, Goldstein & Yanosky (2009) provide the following list of the benefits of a cloud computing approach:

- driving down the capital costs of IT in higher education;
- facilitating the transparent matching of IT demand, costs, and funding;
- scaling IT;
- fostering further IT standardization;
- accelerating time to market by reducing IT supply bottlenecks;
- countering or channelling the ad hoc consumerization of enterprise IT services;
- increase access to scarce IT talent;
- countering a pathway to a five-9s and 24 x 7 x 365 environment;
- enabling the sourcing of cycles and storage powered by renewable energy; and
- improved interoperability between disjointed technologies between and within institutions as they conform to cloud service protocols.

These benefits can explain the growing interest in cloud computing among a wide variety of organizations, institutions, and businesses around the world. Access to IT support is especially important for small community-based organizations; continued funding for IT support and hardware/software upgrading could be provided more easily using a cloud

approach. Figure 1 shows the exponential growth in the number of Google searches using the term “cloud computing.”

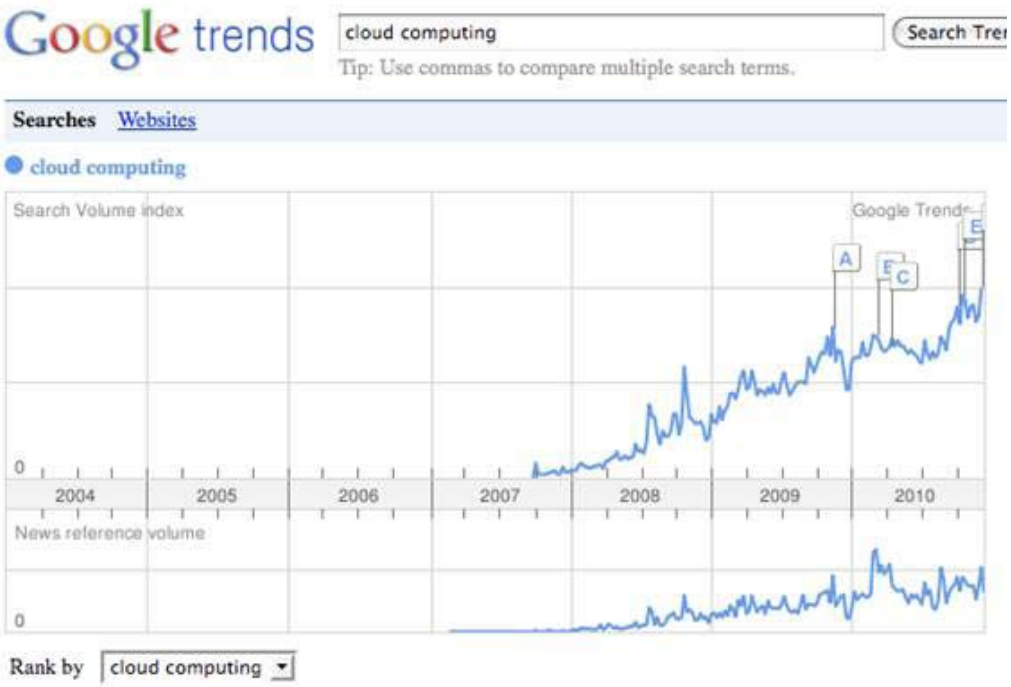

Figure 1. Google Trend plot of the term “cloud computing” taken 16 December 2010. The top line shows the exponential growth in the relative number of Google searches.

What is the current state of Adult Literacy Education in Canada and is a cohesive community approach possible?

It is beyond the scope of this report to completely portray the current state of adult literacy in Canada. The annotated bibliography in Annex A flags a few of the excellent studies and literature reviews already published on this topic by researchers and government organizations. Their portrayal is consistent with the The Organisation for Economic Co-operation and Development (OECD) (2002) Thematic Report on Adult Learning: Canada is a vast country and despite a wide variety of regional and federal programs that contribute to adult literacy, there remains a shortage of programs especially in rural and remote areas. There is a general need for additional programming for adults, particularly for Aboriginal peoples and for the working poor. The thematic report also expresses concern that the lack of a coordinated federal-provincial policy on adult literacy makes it difficult to resolve many issues, such that:

- the special needs of adults are generally neglected;
- there is no sense of a coherent system of adult education; and
- adult education is vulnerable to instability in government (OECD, 2002, p. 42-43).

The lack of coordination originates with Canada's Constitution that clearly makes education a responsibility of the provinces while giving the federal government responsibility for training, for Aboriginal peoples and for immigration. These areas of overlap have led to standing differences in opinion and service deficits. The provincial responsibilities also lead to different approaches and organizational types. In some regions it is community groups that deliver the bulk of adult literacy education; in other areas this is left to community colleges or partnerships of both. Funding comes from a mix of federal employment initiatives and provincial education programs. The funding is usually short term, and literacy providers spend a good deal of their time applying for the next grant or writing reports. The lack of a long term funding strategy makes it difficult to sustain programs and staff (Movement for Canadian Literacy, 2007). Adult Basic Education (ABE) has been described as "the poorest cousin of the education system" (Horsman & Woodrow, 2009).

Just as the mechanisms for adult literacy education and training vary from province to province, so do the demographics of need. While there are regional differences, there are three main target audiences for adult literacy services in Canada:

- Canadians from rural and remote areas where access to education is limited (including a large number of people of Aboriginal ancestry);

- school leavers who fail to complete high school due to a complex array of reasons and become trapped in the “working poor” layer of the economy; and
- new Canadians – immigrants from around the world who are generally literate in their own language.

Although education is a provincial responsibility in Canada, the federal government has responsibilities for immigrants and for Aboriginal peoples. This mixed funding model often makes it unclear as to which level of government should take the lead. Federal funding is generally targeted to assist new Canadians to become functional in one or the other of the official languages, and there is a pattern of successful economic integration particularly by the second family generation in urban areas. On the other hand, OECD (2002) identifies Aboriginals and the working poor as the two populations least served by adult education programs. Many Aboriginals grow up in isolated areas and learn English from parents for whom English was a second language imperfectly learned in federally-funded residential schools. Many of the current generation also often fail to master their own native language and are caught between two cultures. The increasing urbanization of the Aboriginal population brings many within reach of targeted literacy programs. A number of e-learning approaches are being initiated to reach those in remote areas; however, low literate adults in isolated communities are among those with the least access to Internet connectivity and computers.

Some 20% of Canadians form “the working poor” and earn less than one-third of the median wage (OECD, 2002). Many of them are also in rural and remote areas and traditionally earned their living in the primary resources and agriculture sectors. With the decline of the resource economy, many lack sufficient education to access re-training for other jobs. Others simply cannot access existing daytime literacy programs because of commitments to work or family care.

While a lot of people are falling through the cracks, some adult education practices are making significant inroads. Prior Learning Assessment and Recognition (PLAR) enables individuals to get recognition for life experiences and skills, and the resulting academic credits make academic credentials accessible. In BC, considerable work has also taken place in “laddering” or transferring credits earned in college or trades as entry paths into higher education. In Alberta and the Northwest Territories, the Alberta-North consortium of higher education institutions and community organizations provides technology access and educational support in 87 remote communities. This conduit enables a large number of learners to become the first in their family to earn a degree. Unfortunately, these practices build upon a foundation of literacy and numeracy skills that may be difficult to achieve.

Despite the low level of federal-provincial co-ordination, the adult literacy community has organized itself into regional and national networks to exchange information and educational resources. Of particular note is the National Adult Literacy Database (**www.nald.ca/**) that maintains a repository of up-to-date research and AlphaPlus (**www.alphaplus.ca**) that shares digital technology learning resources. The Canadian Literacy and Learning Network (www.literacy.ca) provides a forum for all of the regional literacy networks across Canada. Similar organizations such as the Fédération canadienne pour l’alphabétisation en français (www.fcaf.net) exist in Francophone Canada.

Adult literacy deficits are not unique to Canada, but are also found in Australia and the USA, large developed countries with remote areas populated by resource workers and indigenous peoples. Literature from these countries reveals many of the same issues and offers relevant approaches to providing adult literacy education. Ideally, it would seem the place to prevent adult literacy problems is in primary school education. However, literacy education starts in the home and the influences of early community literacy are well documented (Fleer & Raban, 2005).

What is the current use of Information and Communication Technologies to support Adult Literacy?

Although technology evolves rapidly, there are currently four basic patterns of using technology for literacy education:

1. Learners receive individualized computer-based lessons from CD-ROMs or via websites. The Web delivery is becoming more practical as it resolves the software distribution issues and learners can maintain records of their progress, however, in areas with poor Internet access it may be more practical to transfer the lessons to a CD-ROM or DVD. Drill and practice sessions are particularly effective for initial skills and knowledge including phonetics, building vocabulary, improving spelling, and learning grammar. Audio-visual materials, such as podcasts, can also help create a contextual awareness of language conventions. Literacy might borrow techniques from a number of very effective second language learning websites such as japanesepod101.com that match services to the motivation and budget of the learner. Free materials are very useful but study texts, drills, and maintenance of a vocabulary portfolio require a subscription. Tutor-mediated online conversation sessions are available for an additional fee. An unexpected boon has been the wealth of free informal learning materials available in video format on sites such as YouTube.

2. Online courses or workshops can be used to offer higher-order learning activities such as reading and discussing articles from newspapers with other learners in a text or voice chat. Cohort-paced online courses enrol learners in a group so they move through the learning activities about the same time and speed. The cohort reduces the feeling of isolation, learners can interact to discuss the course content and to give each other support. A course facilitator, instructor or tutor helps the group move through the materials in a timely fashion and provides answers to questions that may arise. Cohort-paced courses typically have lower drop-out rates than independent courses or self-study materials. In some instances cohorts may involve synchronous computer conferencing, however, the scheduling of such events can be complicated and they can make it difficult for learners who have other obligations like childcare, shift work, or travel. Some community learning centres are also equipped with broadband videoconference facilities that make it possible to bring small groups of learners together for work or study sessions, although the main use to date appears to be for the professional development of the tutors rather than for literacy instruction (iCCAN, 2010).

3. Web searches, email, conferencing, writing, blogging, and digital media projects are authentic everyday communications activities that provide rich opportunities for literacy instruction. This type of support is best provided in (or from) a learning centre where a staff member can be available to assist learners with the technology and with their literacy tasks. The completed artifacts can be copied into an e-portfolio to promote reflection on progress over time. There is no reason why the instructional support could not be given at a distance. This would benefit transient literacy learners – especially if they could access their personal files from any Internet connection.

4. Another area is the use of assistive technologies, for example, software that can help the learner by reading electronic text files out loud, or providing online dictionaries and other reference materials. Some assistive software that patches onto Office software and reads text as it is composed has been particularly useful for English language learners and learners with dyslexia (Kurzweil Educational Systems, 2005). Assistive software will become portable and personal as the number of smartphones that link to the Internet increases and a wide variety of assistive applications emerge for that platform.

Despite this enormous potential, technology has not built a strong following among literacy providers. Holun & Gahala (2001) note that technology has a reputation as a "moving target" – by the time a serious intervention can be developed and evaluated, the technology has moved along. Another reason is the lack of technology accessible to literacy learners and the relatively low number of studies examining the use of technology for literacy training. Finally Fahy & Twiss (2010) note that while adult literacy educators are beginning to use technology for their personal communications and professional development, few have adopted technology into their teaching practices. A greater use and benefit of instructional technology can be achieved if technology enhanced learning is made accessible in a cloud computing environment that encourages localization and sharing across the wider community.

What might a cloud computing strategy for Adult Literacy look like and what are the challenges to realize such a vision?

Whenever a new technology is implemented there is a tendency to first think of it and use it in terms of whatever it replaced, similar to the way automobiles were first thought of as horseless carriages. Gradually, as technology improves, it finds acceptance and stimulates new ideas and new ways of using it, much the way mobile phones merged with personal digital assistants (PDA) to become smartphones that can access the Internet. Cloud computing is not simply an extension of the Internet, it represents a convergence of Web services provision with high performance computing, delivered on-demand over broadband networks.

Although the initial entry point of cloud computing into the education sector is the outsourcing of email and collaboration software, we are beginning to see ubiquitous access to an unprecedented variety of on-demand computing services. These services require tremendous processing power for short instances, which is enough power to instantly convert a tourist's digital snapshot of a street sign into text, to translate the text to the target language, and to return an audio message to the user, perhaps with an accompanying map

and directions back to the hotel. Such appliances are already being used and can be adapted for a wide variety of literacy applications.

However, augmenting knowledge is not the same as amplifying human learning. While we still do not fully understand how people learn best, we do know many useful ways in which technology can support learning and support the performance of daily tasks. Unfortunately, such promising practices are currently scattered and not collected together into a cohesive framework. For this we need community building and agreements to make it possible to cut and paste instructional ideas and resources from one computing environment into another. Cloud computing can serve to provide a ubiquitous platform to make such techniques coalesce into a common infrastructure for adult literacy.

"We need community building and agreements to make it possible to cut and paste instructional ideas and resources from one computing environment into another. Cloud computing can serve to provide a ubiquitous platform to make such techniques coalesce into a common infrastructure for adult literacy."

The following sections imagine a progression of cloud computing applications from simple (what we are doing now) to complex (what we might do in the future). We pass through our current state of online applications (or apps) that provide personal computing support and community collaborations, to the power that comes from being able to track language acquisition and analyze one's performance to prescribe appropriate learning methods and appropriate instructional resources for literacy training. As we may also see the rise of contextualized reading devices that will help everyone decipher text back into the spoken words it represents, the latest level are applications that make low literacy no more an impairment than an astigmatism for those wearing corrective eyeglasses. There are two paths to ending low literacy, and while educators might persevere in efforts to train low literate adults, perhaps the real power of cloud computing will be in developing methods and devices that make the stigma irrelevant.

1. Provision of Personal Computing

Free provision of application services means anyone who can get on the Internet can have basic word processing, spreadsheets, and email. Gmail, for example, also provides personal file storage and some collaboration tools. Free cloud access is important for literacy learners as it provides an easier computing environment to learn in, as low text literacy rates go hand in hand with low computer literacy. Free access provides an Internet identity and a continuing address for the homeless and for low income earners forced to move on a frequent basis.

Moreover, with the appearance of more inexpensive notebook computers, tablets, and smartphones, the cost of each access point is lowered and thus the costs of setting up public service and education Internet access facilities is decreasing rapidly. Everyone can afford these cheap devices and with an expansion of free public Wi-Fi, they will have continuing access to the Internet and to the cloud.

The mobile phone market has grown to the point where there are now more mobile phones than personal computers. Each year, more of these are smartphones capable of computing, displaying text, images, and video, as well as accessing the Internet. These devices are capable of connecting to and through the cloud computing systems. With widespread coverage and a growing installed base of users, wireless networks have the potential for supporting a variety of new on-demand data-processing services. Mobile technology providers are quick to encourage growth in the number of "apps" by providing efficient online marketplaces such as the Apple Store or Android Market for developers to sell their products or provide them free of charge. Unfortunately, Canada still has one of the most expensive bandwidth costs for wireless access over the cellular telephone networks, so market growth of smartphones will likely be slower for lower income individuals and for those in rural areas where many low literate adults reside and where free Wi-Fi service is uncommon (Kamener & Anghel, 2010).

The hardware/software paradigm suggests that anything that could be done in hardware should be replicable by software. This is becoming true for low-cost assistive technologies such as screen readers-talking typewriters that can now be configured on the small touch

screen of the smartphone. Wearable and implantable technologies are also emerging, with the potential of being connected to an omnipresent cloud that monitors one's personal health and safety. The matrix of possibilities is so vast that it might be harder to guess when these trends will appear than what will appear. Cloud computing makes it possible to augment the processing power of personal technologies in unprecedented ways.

The world of adult literacy education still awaits a substantial adoption of these emerging technologies. For example, a recent compilation of promising practices for online literacy training (Best et al, 2009) paints a world heavy in text interactions and professorial facilitation. While literacy is important for scholarly activity, smart devices may soon help discretely accommodate limited language users by reading aloud, or prompting contextually appropriate actions.

2. Shared Community Resources

Google Docs was originally conceived as a shared space for collaboration in creating and revising documents. This application has the potential for supporting shared professional development, and educational resources (computer teaching, coaching). The shared cloud platform also offers greater opportunities for community and work collaborations (Miller, 2008). An advantage of cloud computing in education noted by the Seattle Project is that students learning programming were no longer disadvantaged by age differences in their workstations (although they might be affected by differences in bandwidth), and that shared resources could be available among all the educators involved (Cappos, Beschastnikh, Krishnamurthy, et al, 2009).

"Since clouds have a potentially unbounded elasticity, it is possible that millions of users can be interacting at once, giving rise to spontaneous communities and interactions."

Since clouds have a potentially unbounded elasticity, it is possible that millions of users can be interacting at once, giving rise to spontaneous communities and interactions. In a social networking environment there is potential for communities of literacy learners to grow, and for literacy providers to develop and test shared resources and enable volunteers working from home. The resulting statistics can also greatly facilitate the ability to evaluate the usage and effectiveness of any materials provided. This is possible now under Web service models, but with a cloud there is the potential to have more interchanges of experiences, techniques, content, and learning applications. This amplifies the need for policy directions supporting openness in terms of intellectual exchanges among professionals, release of information using

open licenses and open educational or learning application development as open source. If millions of computer users are connected to the same cloud, essentially they could all access services using the shared network. (Facebook already operates a large monolithic cloud that has millions of concurrent users.) This common platform increases the potential for new types of resources that might be cooperatively developed and shared including localized lexicons, information overlays to provide directions or assist adult learning, and employer-specific job training materials.

Programmers in a cloud's user population could contribute in developing or customizing the software and services, much as they do in creating open source software. Sharing of applications will accelerate the development and spread of new functions the way creative commons licensing has accelerated the spread of content and lessons as open educational resources (OERs).

Another possibility is the "crowdsourcing" of volunteer literacy coaches and translators. In the "real world" EnglishTown (www.PuebloIngles.com) is a Spanish training organization that offers free board and room to hundreds of Anglophones each summer who are willing to spend a week or more tutoring Spaniards in the English language. Lucifer Chu has also demonstrated crowdsourcing of 20,000 volunteers for the translation of Massachusetts Institute of Technology Open Courseware into Chinese (RTI, 2010). Using the cloud to build a social network for the adult literacy community, providers can similarly harness the power of volunteers across Canada to support learners and build a useful collection of artifacts and exercises. The United Nations has created an international network of online volunteers who aid in course development, translation, programming, advice and support (**www.onlinevolunteering.org/**). This type of service for developing countries can be duplicated in Canada to take advantage of the growing number of educated retirees who wish to volunteer their time to support adult literacy initiatives.

"Using the cloud to build a social network for the adult literacy community, providers can similarly harness the power of volunteers across Canada to support learners and build a useful collection of artifacts and exercises."

A pan-Canadian literacy cloud, combined with accessible and inclusive repositories of OERs that can be used, reused, mixed and remixed, and localized for specific populations would also be of immense help in augmenting the capacity of the diverse adult literacy organizations across the country.

3. Persistent Personal Storage – Augmenting Cognition

In addition to massive computing power, cloud computer farms also offer rapidly accessible and massive file storage. Cloud-based personal portfolios could readily be used to track the acquisition and use of learning content by learners, and allow the storage of learning artifacts captured on pocket cameras or mobile phones. These ideas exist in some custom server applications, but the reality is that the cloud will make them faster, with more memory, and more accessible from almost anywhere that bandwidth is sufficient and affordable. Local organizations or employers could create verbal lexicons. Today, GPS-equipped smartphones can serve as just in time training aids – for example, Øhrstrøm (2010) has demonstrated the use of smartphones in Norway as procedural aids for autistic teenagers. Routine tasks such as taking a bus are presented as a series of location-triggered action prompts that the child can refer to as required. This allows the autistic child freedom to travel in a relatively large geographic area while having the security of a smartphone equipped with a repertoire of situational procedures.

4. Analytics and Personalization

Analytics refers to a wide range of data-processing methods that uses data from a wide range of sources to make inferential decisions about a situation and recommend a path of action. At the low end are a wide variety of computer based learning tutorials, some of which have been linked to course management systems to keep track of student progress. Performance tracking involves the collection of data about an individual's progress through a set of online learning activities. By tracking the speed and outcomes of learning activities, an individual's performance can be compared to aggregate histories of a large number of learners moving through the same courses. The resulting analysis can lead to pattern matching and identification of persistent learner errors and personal characteristics (such as speed of cognitive processing) that could forecast learner outcomes, or be used to prescribe remedial exercises.

These computational methods are used to track credit card purchases and identify activities that are uncharacteristic of the cardholder's previous purchasing patterns, potentially indicating inappropriate use. The emerging research in this area involves tracking data and providing analytics to suggest optimal learning paths based on learners' preferences and observed performance.

The elasticity of cloud computing is ideal for this kind of large-scale instantaneous analysis. Not all the data needs to be gathered automatically. Teachers at the Open High School of Utah track student progress by making notes in a Client Relationship Management (CRM) system. As teachers interact with students, they make notes of progress and problems, and the system prompts the teacher whenever a student falls behind or fails to keep in touch. If installed in a cloud computer, such a tracking system could help teachers everywhere monitor the progress of learners and provide the social contact and personalization that is so important for learner engagement and retention.

Cloud computing already supports a wide range of virtual worlds and online multi-player games; teenagers spend innumerable hours on their X-BOXes, PlayStations and other gaming systems, using avatars to form teams for virtual assaults on military targets in cyberspace. Today's games are highly collaborative and interactive. Players can communicate with each other using headsets or text and they learn how to form groups to cooperatively develop strategies and solutions in team based game environments. While much learning takes place with these games, it has little intentional learning related to the skills of reading, writing, and arithmetic. Educational games come across as being rather dull in comparison; imagine the gains that could be made if content and applications enabling literacy learning were embedded in such massively subscribed cloud-based edutainment systems.

5. Policy Issues

Policy and control issues are crucial. The provincial/federal issues are a major cause of fragmentation across the country. This and other issues, such as regulatory compliance to ensure security, enable audits and preserve privacy represent significant barriers to the adoption of cloud computing in adult literacy circles. Although a common platform affords easier collaboration, it also increases security risks. Cloud computing will require new schemes to preserve privacy and gain the trust of the users, while developing measures to boost the security of publicly accessible systems that may come under attack.

6. Moving Beyond Text – Is Literacy Obsolete?

Early digital computers had to be programmed using binary code, and only in the 1970's did we see higher-level computer languages that allowed programmers to specify directions in English-like text commands. Today many computers (like those used in a car's navigation system) can be directly interfaced by voice commands. Indeed, smartphones equipped with cameras can easily read bar codes and retrieve related messages from the Internet, including short video clips or other situation-relevant material. With enhanced processing, text analysis can be made available to scan and interpret text, not just into English, but through other Web services like Google Translate, into the target language of choice. For the large number of new Canadians who struggle in ABE classes, this form of literacy appliance can be an excellent assistive technology. Voice to text, and text to voice, French to English, or Chinese or any other language, we are approaching the era where the universal translator, once the stuff of science fiction, (like the Babel Fish translator in the Hitchhiker's Guide to the Galaxy) is becoming a reality.

Universal literacy is a fairly modern concept that came along with the industrial revolution and the need to have a literate population to work and communicate in the era of the post office. Before literacy, specialists called "scribes" were called upon to write and read letters dictated by the non-literate members of their community. Perhaps voice and video over Internet and mobile phones have flattened the need for this type of training, and with electronic book readers, the non-literate have gained access to copious amounts of text information. In parts of Africa, the tribal drums have given way to solar powered FM radio transmitters and mobile phones – neither of which rely on the heavy burden of text that extracts so many years of anguish on the dyslexic population and others that have the misfortune of reading difficulties. In the near future, speech-to-text and text-to-speech applications will help to level the playing field for those with learning difficulties or who have not had the advantage of a good school in early life. While text literacy might not become obsolete, it may, like Latin, become less important as new technologies emerge (Nadin, 2001). Nonetheless, computer literacy and access to computing resources will continue to increase in importance and will grow as a critical component in the curriculum of adult education.

Conclusion – The impact of cloud computing on Adult Literacy

This report provides a first look at rapidly emerging technology and an attempt to gauge its potential impact for the world of Adult Learning and Literacy. Let us review some basic notions:

First of all, “cloud computing” is a movement toward purchasing utility computing provide by large “server farms” located next to “green energy” sources and connected to the Internet by low-power high bandwidth fiber optics. Cloud computing will provide the computing infrastructure for many small, medium, and large organizations that can no longer cost-effectively provision their own in-house IT systems. The first of these commercial systems have already been launched by companies like Amazon, Google, and Microsoft, with many more being planned. Cloud computing facilities are also being used for research and for government services. Some clouds are public and can be used by anyone; others are private and tightly secured to protect the privacy of the information contained. Both Microsoft and Google are giving away cloud computing capacity to educational organizations to run custom email and other documentation sharing services. This appeals to universities because student email alone is costing them hundreds of thousands of dollars each year.

Thus, a first step toward use of cloud computing by an adult literacy community could be to recommend to learners, adult educators, and program administrators about the **use of the free services** available or make special email arrangements with a cloud provider if a branded email address is preferred. It would be ideal if a significant number of adult literacy providers in Canada could collaborate on this approach, because then the same cloud provider could host a common suite of specialized services of benefit to learners with literacy difficulties in all areas of Canada. It would also make it easier to co-develop and share other services in the future. Every adult literacy learner would benefit by having free email and free access to these services, and the adult literacy community could benefit by using the data collected to refine software and determine new services that might be useful. This could all be achieved without losing traditional organizational or institutional email identities or “logo brands.” Probably, it would take more time to negotiate the collaboration agreement among the literacy providers than to implement the technical service, so this would require vision and leadership to pave the way. The emergence of a consolidated collaborative cyber community for adult literacy would show the way to future collaborations in literacy training software, literacy appliance software, instructor professional development, and research. It would also be possible for an adult literacy learner to have continuity of email and literacy support if they moved from one community to another.

“Every Adult Literacy learner would benefit by having free email and free access to these services, and the Adult Literacy community could benefit by using the data collected to refine software and determine new services that might be useful.”

The second important notion is that cloud computing is **elastic** and provides computing power on demand. Just as cyber security codes can be quickly solved by tasking a thousand virtual machines to work for two minutes, powerful learning analytic software could help track and coach literacy learners in a just in time analysis of their needs. This is not “ready to go”,

but it is within the realm of current knowledge and systems. However, the knowledge and routines are scattered in pockets. Identifying requirements and unifying the system to do this should be the second step.

Assuming that a literacy cloud community could be coordinated, once the basic parameters are known, many of the lessons can be assembled from OER repositories and documented; others might be created or mixed through the "wisdom of crowds" wherein tasks are distributed among the many community literacy volunteers and researchers. Collaborative research projects could be sought after to create the analytic software to track and coach individuals as individuals who are working towards common goals.*

Thirdly, in order to take full advantage of the affordances enabled by cloud computing, the adult learning community needs to support the development, adaptation, assembly, and dissemination of OERs. With proprietary content and applications, the burden of requesting permission and/or having to pay again and again and again as the materials are used and re-used in different formats significantly negates the advantages of the cloud. Users need to have free reign to mix and remix the content and adapt it for voice and video as appropriate for their learners. The cloud can provide learners and their organizations with access to the growing number of free **open education resources** as well as open source applications supporting social interaction, publishing, collaborating, editing, content creation, computing, etc. (Bittman, 2008).

"In order to take full advantage of the affordances enabled by cloud computing, the adult learning community needs to support the development, adaptation, assembly, and dissemination of open educational resources."

The fourth notion is that literacy training needs to be augmented with literacy appliance software that provides just in time assistance to low literacy Canadians. The range of software includes text-to-voice, voice-to-text, bar code reading, and language translation. Much of these services exist as **Web services**, but they need to be harnessed and brought together in a suite of applications accessible and usable by low literate adults. Cloud computing can both provide a collaborative portal for these services as well as the high power computing necessary to extract text or shapes from pictures and generate the appropriate response including related information that might be available. While literacy would be ideal, such applications may make it possible for low literate adults to participate more inclusively in everyday life.

Fifth, cloud computing and the Internet are available through an increasing number of mobile devices. In fact, more adult literacy learners have mobile phones than have personal computers and mobile tablets are becoming increasingly more popular and are beginning to augment and even replace laptops and netbooks. Thus, mobile devices as a delivery platform should be given priority for research and technical development – over printed texts and personal computers. These mobile devices represent the state-of-the-art, where the adult learners go, and are becoming the platform of choice for accessing a wide range of services including training through **mobile learning**.

Finally and most significantly is the reality that it is becoming impossible to conceive a modern definition of literacy that excludes ICT literacy. The growing importance of the Internet and networking skills for adults must be recognized. A 21st century literacy is not possible without the skills for accessing and using the Internet. The cloud can be the doorway to these skills.

"A 21st century literacy is not possible without the skills for accessing and using the Internet."

Cloud computing is at our doorstep, but it will take time to implement all of the above ideas. Some of these ideas face technical barriers, others face political barriers, and some are distant ideas in need of more research. However, they do provide a unified vision of what is possible, if the Adult Literacy community can collaborate together for mutual benefit. Then all literacy providers and the Adult Literacy learners will surely benefit from the synergies that

emerge. Canada is large and vast and as such, the literacy movement needs to coordinate its efforts in a way that retains and reinforces the local roots and human face. Cloud computing provides an affordable opportunity to plan a new future together.

Annex A: References

This literature review looked at three core topics:

- Cloud computing: what it is, how it works, why it is important for education, and might be important for literacy education;
- Adult literacy education: what research has been conducted, what are the methodologies of training, and who is providing instruction in Canada; and
- Technology based literacy education: A 21st century literacy is not possible without the skills for accessing and using the Internet to identify examples of promising practices that might be ported to a cloud environment.

This bibliography is by no means exhaustive but it provides a representative flavour of the literature in these areas.

The academic literature on cloud computing was found to be extremely technical and thus secondary sources from magazines, recent technical presentations and blogs were found to be more accessible in explaining the concepts and the implications for educational computing. Google Trends showed that searches for cloud computing have risen exponentially since 2007, indeed many search engine links to “cloud computing” revealed papers and publications that had used the term in their title, but provided little integration or contribution to the technology or its use. These name-dropping papers were removed from the links below, save for the Anderson (2010) blog which provides an example of this hyperbolic enthusiasm.

In the area of adult education and adult literacy education there is a wealth of reports that review the state of the research (Kuidner, 2002) and practice (Myers & de Brouker, 2006). In Canada, adult education and literacy have been reported on extensively, with several agencies commissioning various reports e.g. Statistics Canada (2001), OECD (2002), Canada Council on Learning (2010), so many indeed that Crooks et al (2008) complained that applying for funds and filling in the reports was detracting educators from the actual provision of services. ABE in Canada appears as a community of well-meaning government agencies and non-profit organizations cheering on a large number of equally well meaning but

under-funded professionals and volunteers with a huge number of short-sighted, short-term, small-budget, cross-purpose, cross-jurisdictional programs (OECD, 2002). Characterized as the "poor cousin" of the education sector (Horsman & Woodrow, 2006; Movement for Canadian Literacy, 2007), ABE and the need for adult literacy programs reflect a long chain of circumstances that begin in homes and communities before children enter school, and the inability of schools to remediate. Moayeri (2009) provides a devastating glimpse of the results of Canada's residential school policy on First Nations people. Chovanec & Lange (2010) provide detailed needs assessment for adult literacy in the City of Edmonton. Fleer & Raban (2005) provide a review of literature on early childhood factors affecting literacy, Anstrom & Richardson (2007) provide practical suggestions for teachers of adolescents, and Tayman et al (2009) noted a longitudinal study in which 70% of children with reading disabilities (RDs) in Grade 3 had RDs as adults.

There lies persistent hope in the growing networking and collaboration among adult literacy providers, and in the possibilities that technology may help close the gap, not just in sharing information among providers, but also in direct instruction to learners. While Best et al (2009), Contact North (2010a and 2010b), and Goforth (2004) provide an optimistic view of the emerging role of technology, Fahy & Twiss (2009) and Langille (2004) note pragmatically that instructors are slow to incorporate technology into traditional teaching practices. An earlier study by Kurz (2000) suggested that the access to technology barrier was slowly giving way as public access computers became available. A literature review by Folinsbee (2008) notes we are making progress and slowly accumulating best practices for the online engagement of a difficult to reach audience.

Other than using Google Docs or Google Apps, no use of cloud computing was found specific to the area of adult literacy. However, the use of computer learning for remedial English and second language learning is extensive and goes back over 30 years. Indeed, one author's first publication in 1980 was about setting up such a system (Kenner and Richards, 1980). One difficulty of computer teaching systems is that the technology tends to change faster than the applications can be developed, tested and distributed. Perhaps cloud computing can assist by providing a common and stable environment in which to consolidate efforts of the larger community.

Annotated bibliography

- Anderson, G. A. (2010). Why cloud computing provides flexibility for online learning in higher education. Helium Blog posting. Retrieved November 22, 2010, from **http://www.helium.com/items/1928759-why-cloud-computing-provides-flexibility-for-online-learning-in-higher-education**
  Actually despite its title, the article reads like a technology propaganda sheet citing one virtualization case study and does not provide any specifics about the advantages.

- Anstrom, K. & Richardson, T. (2007). What Content-Area Teachers Should Know About Adolescent Literacy. (Monograph) Jessup, MD: National Institute for Literacy. Retrieved November 28, 2010, from **http://lincs.ed.gov/publications/pdf/adolescent_literacy07.pdf**
  This is a practical guide for teachers to the difficulties adolescents can have with literacy tasks, and provides strategies that teachers can directly use in structuring lessons and providing direct guidance to promote the development of literacy, and to assist low literacy students with content tasks that require literacy skills.
  The report provides a good overview of alphabetics, phonemic awareness, morphology, fluency, vocabulary, text comprehension, and writing strategies (including pre-writing and post-writing strategies).

- Bittman, T. (2008, November 26). Cloud Computing and K-12 Education. (Blog posting). retrieved from **http://blogs.gartner.com/thomas_bittman/2008/11/26/cloud-computing-and-k-12-education/"http://blogs.gartner.com/thomas_bittman/2008/11/26/cloud-computing-and-k-12-education/**
  Cloud computing is coming faster than schools can plan for it. Its lower costs will make computing available everywhere (e.g. in the preschool) and it will help with growing content from constructive creation and collaboration.

- Best, L., Kaattari, J., Morgan, D., Trottier, V. & Twis, D. (2009). Bridging Distance: Promising practices in online learning in the Canadian literacy community. (Monograph). Retrieved December 8, 2010, from **http://www.nald.ca/gettingonline/goresources/bridgingdistance/bridgingdistance.pdf"http://www.nald.ca/gettingonline/goresources/bridgingdistance/bridgingdistance.pdf**

This resource guide provides information about being an online learner, how to facilitate online instruction, developing online content, and using technology. [While the guide is very thorough, it is surprising that the methods are drawn from adult education and instructional design but are not particularly adapted to the needs of the literacy learner. For example, the guide is very text heavy and the reading level of the chapter on being an online learner is probably too high for most literacy learners. Perhaps the effort might have been better spent talking about recruiting, reassuring and tailoring the online experience to the needs of the online learners. Contrast this with the list of specific ways in which technology can be used that is provided by Anstrom & Richardson.]

- Blokdijk, G. & Menken, I. (2009). Cloud Computing - The Complete Cornerstone Guide to the Cloud Computing Best Practices: Concepts, Terms, and Techniques for Successfully Planning, Implementing and Managing Enterprise IT Cloud Computing Technology (2nd ed.). Brisbane: Emereo Pty Ltd. Retrieved December 21, 2010, from **http://www.ebooksx.com/Cloud-Computing-The-Complete-Cornerstone-Guide-to-Cloud-Computing-Best-Practices-Concepts-Terms-and-Techniques_312071.html**
  This is a quick primer on cloud computing including terminology, benefits and drawbacks, and legal implications. It includes case studies and technical details.
  "The major benefit of cloud computing is that the average user does not require a powerful computer to handle complex database indexing tasks." (p 10.)

- Canadian Council on Learning (2010). State of Learning in Canada: A Year in Review. (Monograph). Ottawa: Canadian Council on Learning. Retrieved October 18, 2010 from **http://www.ccl-cca.ca/CCL/Reports/StateofLearning/index.html"http://www.ccl-cca.ca/CCL/Reports/StateofLearning/index.html.**
  This publication provides an up-to-date overview of all learning sectors in Canada, including Adult Learning and Literacy. Of particular note is the section on Aboriginal learning. Extensive bibliography of about 50 reports.

- Cappos, J., Beschastnikh, I., Krishnamurthy, A., & Anderson, T. (2009). Seattle: a platform for educational cloud computing [Electronic Version]. ACM SIGCSE Bulletin, 41(1). Retrieved December 17, 2010, from **http://portal.acm.org/citation.cfm?id=1508905"http://portal.acm.org/citation.cfm?id=1508905**
  This technical paper presents a free, educational research platform called Seattle that is community-driven, a common denominator for diverse platform types, and is broadly deployed. The advantages for teaching computer programming are a uniform platform for student code, and a sharing of resources for educators. The platform can be run from cell phones and PDAs thus increasing access for learners.

- Cayirci, E., Rong, C., Huiskamp, W., & Verkoelen, C. (2009). Snow Leopard Cloud: A Multi-national Education Training and Experimentation Cloud and its Security Challenges. In M. E. Jaatun, G. Zhao & C. Rong (Eds.) Cloud Computing: Proceedings of the First International Conference, CloudCom 2009. pp. 57-68. Beijing.
  This paper describes the architecture for a NATO training infrastructure based on cloud computing to support multiple scenario simulations. It is mainly focused on security lessons learned in building standards and recommendations for a secure educational cloud. [This paper has been included because it likely depicts the current upper-end of use of flexible computer power in a training setting.]

- Chen, X., Liu, J., Han, J., & Xu, H. (2010). Primary exploration of mobile learning mode under a cloud computing environment. Paper presented at the International Conference on E-Health Networking, Digital Ecosystems and Technologies (EDT), 2010 Shenzhen, China. Retrieved December 28, 2010, from **http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5496435"http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5496435**
  This article compares traditional models of mobile learning with models that make use of cloud computing.

- Chovanec, D. & Lange, E. (2010). Learning needs assessment for low-income adult populations. (Report to City of Edmonton.) Retrieved December 20, 2010, from **http://www.ecala.org/LinkClick.aspx?link=2009+ECALA+Files%2FLearning+Needs+Assessment+2009.pdf&tabid=36&mid=371**
  This needs assessment combined interviews with low income adults (n=39), agencies (n=32), and a street survey (n=105) to create a profile of educational gaps, trends and barriers for accessing learning in the City of Edmonton.
  2002 & 2005 OECD report on Canada "suggests an overemphasis on employment, unreasonable funding cycles and funding cuts that undermine provision of essential skills for vulnerable groups."
  Findings from the participants: 1. Low-income is only one of many factors including, life circumstances and social situation, gender, race, and other forms of discrimination,
  2. Low-income adults are wounded learners filed by a system focused on efficiency, uniformity, discipline, and regulation, 3. Low-income learners have career goals and broad learning interests, 4. Low-income adults are enmeshed in a Web of intersecting barriers (dispositional, situations, and institutional), 5. Widening pedagogical sites and practices enhances successful learning experiences.
  Report concludes that community-based organizations are success-enabling points but they need additional, sustained funding as "legitimate but non-institutional providers." Educational providers need to build relationships with ethno-cultural and Aboriginal communities.

- Radio Taiwan International [RTI] (2010). Newsmakers: Lucifer Chu. RTI+Plus blogpost **http://blog.rti.org.tw/english/2010/10/03/newsmakers-lucifer-chu/"http://blog.rti.org.tw/english/2010/10/03/newsmakers-lucifer-chu/.**

- Contact North. (2010a). Fast Forward: How emerging technologies are transforming education and training. Retrieved December 9, 2010, from **http://www.contactnorth.ca/publications**
  This challenge paper outlines five major changes that relate to a) the nature of digital devices [ubiquitous, smarter, smaller, and inter-operating], b) the nature of the Web will be semantically enriched, more personal and connecting to more powerful services such as artificial intelligence, c) artificial intelligence will make advances in reasoning, natural language processing, and machine learning, d) the users will change from the current text generation to the socially-networked media homozappiens, e) e-learning will continue to grow and e-learning platforms will enable smarter, faster creation of courses that connect to mobile devices. The way knowledge and skills are delivered will change radically with high fidelity simulations and visualizations becoming commonplace. Construction of personal knowledge networks will replace information delivery. Learning will be on-demand and situated in authentic settings (e.g. supermarkets).
  Challenges for educators will include managing innovation costs, shifting roles for learners and instructors, and reducing technology barriers.

- Contact North. (2010b). The future of e-learning: Realities, myths, challenges and opportunities. Retrieved from **http://www.contactnorth.ca/publications"http://www.contactnorth.ca/publications**
  This report addresses questions on the realities of e-learning today and the challenges, opportunities, and myths in e-learning.

- Crooks, S., Davies, P., Gardner, A., Grieve, K., Mollins, T., Niks. M., Tannenbaum, J. & Wright, B. (2008) Connecting the Dots: Accountability in Adult Literacy: Voices from the field. The Centre for Literacy [SIC] of Quebec. Retrieved October 25, 2010 from **http://www.literacyandaccountability.ca/File/03_CTD_Field_report_Oct_2008.pdf"http://www.literacyandaccountability.ca/File/03_CTD_Field_report_Oct_2008.pdf**
  "They interviewed 136 informants, providers and funders, to learn about the state of accountability practices in every province and territory... This report synthesizes and analyzes the data from the field review and includes recommendations made by interviewees."
  In a nutshell, the report paints a picture of adult literacy in Canada as a patchwork of mostly soft-funded activities carried out by a wide variety of colleges, schools, and community agencies. An inordinate amount of staff time is taken up applying for funds, gathering data, and completing reports for funds received. Funds are received from multiple agencies and through different government programs and the programs are increasingly pressed to do more and more reporting for what seems like less and less money. With soft funding it is hard to recruit and maintain staff. Quite often per capital funding does not recognize the cost of delivery to rural populations or counseling marginalized people. Consistent multi-year funding is needed. [In one sense it is nice that there are so many programs, but they are all pulling on different priorities. With such a mishmash of players it will be difficult to have a single accountability framework in Canada.

- Croll, C. & McEvoy, N. (2010). Canadian Cloud Roadmap: Part I. Defining the cloud space. (Joyent A/V PowerPoint Presentation) Retrieved November 23, 2010, from **http://www.joyent.com/resources/webinars/?mkt_tok=3RkMMJWWfF9wsRoku67KZKXonjHpfsX86u0vXqGg38431UFwdcjKPmjr1YEHRdQhcOuuEwcWGog8ygNBH%2B6B#canadian-roadmaps**
  "Cloud computing is a nebulous term" (Croll) pun nebulous has had prior use
  Part I (Croll) Presentation is probably the best (clearest) overview of technical and business definitions of cloud computing.
  Part II (McEvoy) Provides an in-depth analysis of the Canadian government's cloud strategy (see Danek, 2010)
  Discussion covers legal issues mostly regarding internationalization: where data must be maintained, Patriot Act, Freedom of Information and Protection of Privacy Act, and data-security. "Cloud computing may be like airlines - every country has its major airline yet here are hubs for interchange. There are also private planes and special planes, but most people use the public infrastructure."

- Cross, J. (2007). Informal Learning: Rediscovering the natural pathways that inspire innovation and performance: Pfeiffer: Wiley & Sons.
  This is a book about knowledge workers, twenty-first century business and informal learning.

- Culp, K. M., Honey, M., & Mandinach, E. (2003). A retrospective on twenty years of Education Technology Policy. (monograph) Washington, DC: U.S. Department of Education, Office of Educational Technology.
  http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.170.3777&rep=rep1&type=pdf
  This interesting review of 28 reports recommending investment in education technology over a 20 year period. Three key recurrent themes are that: technology is a tool to address challenges in teaching in learning, technology is a change agent, and technology is a force for economic competitiveness. The key difficulty in implementing technologies are: technologies are multiple and complex; technologies evolve rapidly, faster than schools can change practices or purchasing plans; local, state and federal budgets are in a state of flux making sustained investment difficult; and public perceptions of the role of technologies in K-12 continue to evolve. Further, the researchers' visions of technology creating inquiring and collaborative environments seldom materializes as most teachers use the technology for presentations, for Internet searches, and for classroom management. Report concludes that technology policy needs to align with teacher relevant issues with public concerns, and build on previous successes. "Undoubtedly, technology shapes, often in unanticipated ways, how we live and work as well as how we educate our children." Now is the time to plan the next 20 years. Extensive bibliography.

- Danek, J. (2010). Government of Canada Cloud Computing: Information Technology Shared Services (ITSS) Roadmap. (PowerPoint presentation). Retrieved November 23, 2010, from **http://isacc.ca/isacc/_doc/ArchivedPlenary/ISACC-10-43305.pdf"http://isacc.ca/isacc/_doc/ArchivedPlenary/ISACC-10-43305.pdf**

These presentation slides outline the Canadian Government's plans for a mix of private and public cloud infrastructures to satisfy its IT requirement. The main concern over cloud computing is security; the main expectation of return is better quality of service at a lower overall IT cost.

- Delic, K. A. & Walker, M. A. (2008). Emergence of the academic computing clouds. [Electronic Version]. Ubiquity, 9. Retrieved December 21, 2010, from **http://delivery.acm.org/10.1145/1420000/1414664/v9i31_delic.html?key1=1414664&key2=7954574721&coll=GUIDE&dl=GUIDE&CFID=91510199&CFTOKEN=64217970**
  This paper outlines the architecture, technologies and standards of academic computational grids with examples. Then the architectural lines of cloud computing are used to show the design and technology and indicate some future challenges.

- Fahy, P. J. & Twiss, D. (2010). Adult literacy practitioners' uses of and experiences with online technologies for professional development. J. Applied Research on Learning 3(2) 1-18. Retrieved November 22, 2010, from **http://www.ccl-cca.ca/pdfs/JARL/Jarl-Vol3Article2.pdf"www.ccl-cca.ca/pdfs/JARL/Jarl-Vol3Article2.pdf**
  Survey of Canadian adult literacy educators (n=86) about their use of technology for distance professional development reveals that despite cost-saving and convenience, many of the literacy educators are relatively new to technology and technical problems have negatively affected attitudes. Many found the transactional distance too great and that distance was a poor substitute for face-to-face settings. Report concludes that proper [quality] guidelines need to be set out for delivery of online PR. [Note: This carries a further implication that unless the educators have great online learning experiences, they will continue to be loath to implement online courses for the learners they tutor.]

- Fleer, M. & Raban, B. (2005) Literacy and numeracy that counts from birth to five years: a review of the literature. (Report to DEST Australia). Retrieved November 22, 2010, from **http://www.deewr.gov.au/Earlychildhood/Resources/Documents/LiteratureReview.pdf"http://www.deewr.gov.au/Earlychildhood/Resources/Documents/LiteratureReview.pdf**
  This review of early childhood education literature notes the importance of early childhood experience in promoting readiness for schooling and success in life. In its Australian context, the authors note that children most likely to have literacy and numeracy problems were boys, indigenous, and of lower SES. They noted several studies showing how promoting early literacy activities in the home e.g. parent-child reading interactions, promoted literacy skills. They noted a large disconnect between what happens at home and what happens at school. Also of interest was the current pedagogical shift away from Piagetian "development appropriate practice" to a more socio-cultural pedagogy that situates learning activities in a social context. In the emerging socio-cultural pedagogy teachers mediate learning by way of scaffolding. The learner first sees the skill or knowledge in its social-cultural context, and then internalizes it into their own behaviour. They anticipate that adoption of new pedagogy will be hindered by the average age of teachers and the 25 years since most took their teacher training.

- Folinsbee, S. (2008). Online learning for adults: Factors that contribute to success (A literature review). Sudbury, ON: College Sector Committee for Adult Upgrading. Retrieved December 16, 2010, from **http://www.nald.ca/library/research/csc/litreview/litreview.pdf"http://www.nald.ca/library/research/csc/litreview/litreview.pdf**
  Interesting literature review that tried to focus on online and adult education retention but found few studies that widened the scope to look at online retention in general. ABE adult learners often have difficulties with access to technology, familiarity with computers, and reading and writing skills. Successful online learners characterized by elf-direction and motivation, self-discipline, ability to communicate in writing, assertiveness, ability to stay on task, meet requirements of the program, have problem solving and critical thinking abilities, comfortable with computers, access to technology. Retention of online ABE learners related to strong orientation programs and having a good relationship with the instructor. Motivational appeal of online is low. Successful interventions for an online masters program with high drop-outs included: small class sizes, clear expectations of requirements, monitoring online behaviour and providing feedback, technical orientations and on-going support. Content was structured to go from easy to complex, and concrete to abstract. Academic readiness was assessed to ensure material was at the right level, and instructors could tailor examples to learners' backgrounds. Clear weekly goals, evaluation info, guidance and weekly feedback from instructors, student collaboration activities. Over 3 years the 44% retention grew to 56% to 78% and then 85%. Key appears to be good organization, social inclusion and frequent guidance from the instructor. Report concludes with several recommendations including that on-going program evaluation is needed to address barriers, improve retention, and improve the quality of the programs and support services.

- Goforth, D. (2004). Reaching the People Who Need It the Most: e-PD Reading and Response. (Pilot Project Summary Report). Sudbury: Goforth Consulting. Retrieved October 25, 2010, from **http://www.collegeupgradingon.ca/projrprt/reaching/reaching.pdf"http://www.collegeupgradingon.ca/projrprt/reaching/reaching.pdf**
  Documents a pilot test to use e-learning methods to build a professional learning community of literacy providers.

- Haigh, G. (2010). Baby Steps into the Cloud: ICT as a service for education. (Corporate brochure). Reading, UK: Microsoft Corporation. Retrieved, December 14, 2010, from **http://blogs.msdn.com/b/ukschools/archive/2010/12/07/microsoft-education-white-paper-baby-steps-into-the-cloud.aspx"http://blogs.msdn.com/b/ukschools/archive/2010/12/07/microsoft-education-white-paper-baby-steps-into-the-cloud.aspx**
  Initially we resisted including this white paper as it seemed more marketing than technical exploration, however it does present the Microsoft perspective in the UK and is accessible to a less technical audience. The key content is that Microsoft is aggressively providing free email services to European universities, and they have placed their server farm in Dublin to avoid concerns over the USA Patriot Act.

- Holum, A. & Gahala, J. (2001) Critical issue: Using technology to enhance literacy instruction. (Web posting) North Central Regional Educational Laboratory. Retrieved December 1, 2010, from **http://www.ncrel.org/sdrs/areas/issues/content/cntareas/reading/li300.htm"http://www.ncrel.org/sdrs/areas/issues/content/cntareas/reading/li300.htm**

- Horsman, J., & Woodrow, H. (Eds.) (2006). Focused on Practice: A Framework for Adult Literacy Research in Canada. St. John's: Harrish Press. Retrieved October 25, 2010, from **http://www2.literacy.bc.ca/focused_on_practice/focused_on_practice.pdf"http://www2.literacy.bc.ca/focused_on_practice/focused_on_practice.pdf**
  "Field researchers for the project discovered that the difficulties of doing research in practice are symptomatic of the realities of the field. Adult literacy and basic upgrading suffers from a lack of recognition, minimal professional development opportunities, and insufficient funding supports."
  Adult literacy is characterized as the "poor cousin" underfunded in provincial education and lacking a consistent national strategy. Part of the policy problem is seen to be that while literacy training might help the individuals and their families, they do not return huge economic benefits for the governments' investments.
  A profile along with bibliography is presented for each region in Canada. Across Canada adult literacy is a complex mixture of target groups (primarily Aboriginals, dropouts, immigrants) in urban and remote/rural settings and institution and community-based programs. Consistency and adequacy of funding and staffing is common.

- Innovative Communities Connecting and Networking [iCCAN] (2010). Literacy tutor training pilot program a first in Alberta. iCCAN Connected. Winter. Retrieved December 24, 2010, from **http://www.iccan.ca/newsletters/119-winter-2010-newsletter"http://www.iccan.ca/newsletters/119-winter-2010-newsletter**

- Johnson, L., Smith, R., Levine, A. & Haywood, K. (2010). 2010 Horizon Report: K-12 Edition. Austin Texas: New Media Consortium. Retrieved November 22, 2010, from **http://www.nmc.org/pdf/2010-Horizon-Report.pdf"http://www.nmc.org/pdf/2010-Horizon-Report.pdf**
  Hewlett Foundation sponsored report that forecasts technology trends likely to have an impact on learning, teaching, research and creative expression. Five key trends are:
  1. Technology is increasingly a means for empowering students, a method for communication and socializing, and a ubiquitous part of their lives. 2. Technology profoundly affects the way we work, collaborate, communicate and succeed. 3. The perceived value of innovation and creativity is increasing. 4. There is increasing interest in just-in-time, alternate, or non-formal education 5. The way we think of learning environments is changing. Key challenges are: Digital media literacy continues to rise in importance as a key skill, Students are different but the educational practice and materials are changing slowly, Many policy makers and

educators believe that reform is needed but there is little agreement as to what a new model of education might look like, A key challenge is the fundamental structure of the K-12 education establishment, Many activities related to learning take place outside the classroom but these are undervalued. Technologies to watch: NEAR: Cloud computing and Collaborative environments, MEDIUM: Game-based learning, Mobile networks, FAR: Augmented reality, and Flexible displays. Several current examples of cloud computing are provided.
Examples of cloud computing use in education are provided.
A Horizon Report is also published for the higher education sector, but as it lags the K-12 report cloud computing will not appear until the 2011 edition is available. It is interesting to note how quickly an obscure notion can become a trend in technology.

- Kaminer, A., & Anghel, B. (2010, July). Death grip: Caught in a contract and cannot quit? Toronto Sun. Retrieved December 29, 2010, from **http://www.seaboardgroup.com/main/index.php?option=content&task=view&id=825&Itemid=212**
  The writers argue that wireless providers in Canada have taken contracts too far, being too long, complicated and strict, and the termination fees are exorbitant. They claim that in Canada the contract terms of wireless licences are among the longest in the world with enormous costs tied to the contract terms with Draconian penalties.

- Katz, R. (Ed., 2009). The Tower and the Cloud: Higher Education in the Age of Cloud Computing. Retrieved from **http://www.educause.edu/thetowerandthecloud"http://www.educause.edu/thetowerandthecloud**
  This volume examines IT in education including access to high-speed networks, social computing approaches, open standards and content and the emergence of the cloud for industrial-scale computing.

- Katz, R., Goldstein, P. J., & Yanosky, R. (2009). Demystifying cloud computing for Higher Education. ECAR Research Bulletin, 19. Retrieved December 20, 2010, from **http://www.educause.edu/ecar"http://www.educause.edu/ecar**
  This paper summarizes a synthesis of insights from industry and university IT leaders on a framework for cloud computing, and potential emergent roles for public and private clouds.
  "Great promise/great hype." While cloud computing is coming, there is too much hype – there remains a lot to be learned about how to implement clouds and how to use them from within organizations.
  Policy issues around governance, security, privacy and intellectual property will slow adoption in higher education.
  Computing costs will not disappear; there will still be a role for on-campus IT support and in-house computing services.
  Higher Education computing has a mix of services; some might easily be put on the cloud, others on research clouds, and still others not at all.
  Some campuses or co-operatives of campuses might also be cloud service providers.
  If an IT group fails to lead its campus cloud strategy, it will end up trying to catch up to its consumers.

- Keahey, K., Figueiredo, R., Fortes, J., Freeman, T., Tsugawa, R. (2008) Science Clouds: Early Experiences in Cloud Computing for Scientific Applications. Cloud Computing and Its Applications 2008 (CCA-08), Chicago, IL. October 2008. Retrieved November 26, 2010, from **http://www.nimbusproject.org/files/Science-Clouds-CCA08.pdf**
  This technical paper describes the Nimbus toolkit, the first cloud system deployed in 2008 at the University of Chicago. The points of interest are its implementation of virtualization, on demand computing, and resource allocation accounting. The authors note the rapid increase of utilization to the point where demand exceeded capacity, and that several other universities soon installed the Nimbus toolkit.

- Kenner, R. & Richards, G. (1980), A home made package for use in the language lab. NALLD Journal, Fall 1980.

- Kondo, D., Javadi, B., Malecot, P., Cappello, F. & Anderson, D. P. (2009). Cost-benefit analysis of Cloud Computing versus desktop grids. In Proceedings of the International Symposium on Parallel & Distributed Processing, 2009. Rome.
  Retrieved December 9, 2010, from
  http://www.chinacloud.cn/upload/2009-04/temp_09042911099702.pdf
  This study looks at the performance trade-offs, the resource requirements/costs and compares the cloud with desktop grids (such as the volunteer computing platform SETI @ home) using performance measurements and the Amazon elastic compute cloud.

- Kuidner, J. (2002). Research-Based Principles for Adult Basic Education Reading Instruction. (monograph) Jessup, MD: National Institute for Literacy. Retrieved November 28, 2010, from **http://lincs.ed.gov/publications/pdf/adult_ed_02.pdf"http://lincs.ed.gov/publications/pdf/adult_ed_02.pdf**
  This review of 70 research reports in ABE reading instruction "represents the best information available about how adults learn to read. It is designed to serve two primary audiences: educators and policy makers who make decisions about the content of ABE reading instruction and researchers eager to identify new avenues of study to add to our understanding of this field." (p viii)
  "Effective reading and reading instruction cannot occur without sufficient motivation. Motivation is one of the topics selected by the Reading Research Working Group for study, along with others that are especially important for adult reading instruction: computer technology, reading assessment, program goals and setting (family literacy, workplace literacy, and general functional literacy), instructional methods (strategies, material, teacher preparation, and the intensity and duration of instruction), and specific characteristics of learners that affect instruction (reading level, whether English is their first language, the existence of a learning disability (LD), and motivation)." (p 2)
  ABE research is limited because of the difficulty in establishing controlled studies. "Emerging principles suggest that reading can improve in ABE settings, that direct or explicit instruction in various components is effective, and that computer-assisted instruction can improve achievement in some aspects of reading." (p 5)

- Kurz, J. L. (2000). Riding the technology wave: Experiences of adult literacy students and teachers in Ontario. (Monograph). Ottawa: Canadian Council on Social Development. Retrieved December 8, 2010, from **http://www.nald.ca/library/research/alphaplus/riding/riding.pdf"http://www.nald.ca/library/research/alphaplus/riding/riding.pdf**
  Survey of adult literacy learners (Anglophones and Francophones) in Ontario reveals computer use slowly growing among literacy learners and literacy educators with email being the most prevalent application followed by word processing. Some 40% have yet to use computers. Low income families least likely to have computers in the home. Most computer access is through schools and libraries. Teachers feel there is a role for computer based instruction and access to resources (e.g. newspapers) online, but lack of updating of hardware and software an ongoing barrier to use. Useful but dated Resource section.

- Kurzweil Educational Systems (2005). Scientifically-Based Research Validating Kurzweil 3000 - An Annotated Review of Research Supporting the Use of Kurzweil 3000 in English Language Learner Classrooms. (Monograph) Retrieved December 30, 2010 from **http://www.kurzweiledu.com/files/K3000%20ELL%20Research.pdf"http://www.kurzweiledu.com/files/K3000 ELL Research.pdf**

- Langille, L. M. (2004). Adult Literacy Educator' Perceptions of Technology Integration. (Masters Thesis, Acadia University) Retrieved November 22, 2010, from **http://www.nald.ca/library/research/adtlitti/adtlitti.pdf"www.nald.ca/library/research/adtlitti/adtlitti.pdf**
  Survey of Atlantic Canada adult literacy educators showed that while most were technology users themselves and said ICT literacy was increasingly important, nearly half did not integrate computers within literacy instruction due to barriers such as a lack of funds, technology, professional development, time, skills, and comfort level. Contains good review of literature on technology use including quote from Keller (2001) "Literacy involves gaining the skills and knowledge to read and interpret the text of the world and to successfully navigate and negotiate its challenges, conflicts, and crises. Literacy is thus a necessary condition to equip people to participate in the local, national, and global economy, culture, and polity. (p.69)"

- Lesieur, B. (2009.). Business Adoption of Cloud Computing. (Wiki posting). Retrieved from **http://www.wikinvest.com/concept/Cloud_Computing"http://www.wikinvest.com/concept/Cloud_Computing**
  Cloud computing is democratizing computing power and traditional IT barriers of cost, time, quality, scale, and geographic location supporting green IT and sustainability. Details some of the expected winners (early innovators of cloud platforms) and losers (traditional data-processing software companies).

- Mell, P., & Grance, T. (2009). The NIST definition of cloud computing. Retrieved from **http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc"http://csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc**
  The NIST IT Laboratory provides a detailed definition of cloud computing.
- Moayeri, M. (2009). Literacy Practice in a Canadian Urban Neighborhood: Two First Nation Mothers. (Working Paper #25). University of British Columbia: Cultural Practices of Literacy Study. Retrieved December 22, 2010, from **http://cpls.educ.ubc.ca/content/pdfs/LiteracyCanadianNeighborhood.pdf"http://cpls.educ.ubc.ca/content/pdfs/LiteracyCanadianNeighborhood.pdf**
  Interesting case study depiction of First Nations literacy development in generation of residential school attendees, and the lasting effects into adulthood. Good introduction to the importance of social and cultural influences in establishing literacy attitudes in the home, and the effects of the disruption of home on Canada's First Nations people.
- Microsoft Corporation (2010). The economics of the cloud. (Corporate White Paper). Retrieved November 22, 2010, from **http://www.microsoft.com/presspass/presskits/cloud/docs/The-Economics-of-the-Cloud.pdf**
  Microsoft establishes basic premises about the inevitable rise of cloud computing due to lower costs and greater concentration of computing power in data centres: supply-side saving, demand-side aggregation, and multi-tenancy efficiency. They point to early building of large data centres that will be more efficient as shared facilities, and avoid the need for start-ups to overbuild their data centres as excess capacity will be available for rental during peak flow periods. Large clouds also have potential to flatten electricity costs subject to daily variation at a single geographic centre. Larger centres with fewer employees and more customer means lower overall costs for data services approaching 80% reduction in total cost of ownership. Clouds offer new concerns in Security and Privacy, Performance, and Data Sovereignty, as organizations must trust external providers. Private clouds are owned by a single entity and public clouds are shared facilities and have the potential to offer more resources, but they bring about greater concerns for security etcetera. Because of the greater number of users and larger facilities, public clouds offer the ten times better savings. Microsoft then positions itself as a trusted provider during this period of IT transition to bring public clouds together to make cloud computing available from "every home, every office and every mobile device."
- Miller, M. (2008). Cloud Computing: Web-Based Applications that Change the Way You Work and Collaborate Online. Pearson. New York.
  A primer on cloud computing that focuses on collaborative work.

- Movement for Canadian Literacy (2007). Environmental Scan: Literacy Work in Canada. Retrieved October 25, 2010, from **http://www.literacy.ca/themes/mcl/projects/enviroscan/enviroscan.pdf"http://www.literacy.ca/themes/mcl/projects/enviroscan/enviroscan.pdf**
  This overview of who is working in adult literacy in Canada reveals the 'poor cousin' of the education industry that is staffed by a great number of volunteers and temporary staff who work for low pay and often no benefits. Conditions are better for college faculty working in the area. The main culprit seems to be the short ad hoc type of funding that is available. As a consequence, few people make literacy training their career, and there is no consistent professional development path for those who are interested. Report also contains a good overview of these issues and extensive references.

- Murphy, M. C., & McClelland, M. (2008). Computer Lab to Go: A "Cloud" Computing Implementation. Retrieved from **http://www.isedj.org/isecon/2008/2343/ISECON.2008.Murphy.pdf"http://www.isedj.org/isecon/2008/2343/ISECON.2008.Murphy.pdf**
  This paper describes a pilot of a virtual computer deployment at North Carolina State University, providing scalable, high performance computing remotely accessing a cloud.

- Myers, K. & de Broucker, P. (2006). Too Many Left Behind: Canada's Adult Education and Training System. (Report for the Canadian Policy Research Network). Retrieved December 20, 2010, from **http://www.cprn.org/documents/43977_en.pdf"http://www.cprn.org/documents/43977_en.pdf**
  "A large proportion of Canada's adult population is not equipped to participate in a knowledge-based society" (p. 2). The authors contend that increasing the skills of those with the least education will lead to increased productivity.
  Each province and territory has its own adult education system. The study authors describe these systems as "complex, fragmented and incomplete." However, they found one unchanging variable across all systems: people without secondary leaving certificates receive the least educational services. Very few supports exist for full-time attendance in adult upgrading programs.

- Nadin, M. (2001). The civilization of illiteracy. [Project Gutenberg electronic text #2481. Originally published Dresden University Press, 1997]. Retrieved December 28, 2010, from **http://digital.library.upenn.edu/webbin/gutbook/lookup?num=2481"http://digital.library.upenn.edu/webbin/gutbook/lookup?num=2481**
  Interesting book about the rise of digital literacies and the need to move away from the traditional view of text literacy and the culture of schools and other vested interests that push it as the only form of intellectual exchange.
  "There was life before literacy and there will be life after it. In fact, it has already begun. Let us not forget that literacy is a relatively late acquisition in human culture. … Improved human interaction, for which new technologies are plentifully available, should be the concrete result of this understanding of the end of the civilization of literacy."

"The literacy-based educational establishment will probably dismiss the proposals set forth as pie-in-the-sky, as futuristic at best. Its representatives will claim that the problem at hand needs solutions, not a futuristic model based on some illusory self- organizing nuclei supported by the economy."

- Naone, E. (2009). Conjuring Clouds: How engineers are making on-demand computing a reality. Technology Review (July/August), Retrieved November 27, 2010, from **http://www.technologyreview.com/computing/22606/?a=f**
  Clear explanation of virtualization: "...the software 'thinks' it has access to a processor, network, and disk drive, just as if it had a real computer all to itself.... Virtualization means that email, Web, or file servers (or anything else) can be conjured up as soon as they're needed; when the need is gone, they can be wiped from existence, freeing the host computer to run a different virtual machine for another user."
  Google exec Vint Cerf states "the ability of virtualization and management software to shift computing capacity from one place to another is one of the things that makes cloud computing so attractive."
  Diagrammatic depiction of 6 layers of cloud computing 1) Hardware - multiple servers in a data centre 2) Virtualization - some clouds use virtualization to instantiate multiple independent server sessions 3) Management - resource allocation and billing based upon usage 4) IaaS - usage of the physical hardware for custom software application, e.g. Amazon's Web Services provides flexible storage for external clients 5) PaaS - use of the operating system and data-base utilities for client specific needs, e.g. Google Apps allows clients to build custom solutions 6) SaaS - the use of cloud software for generic IT applications e.g. Google Docs provides commonly used email, document processing, spreadsheets and storage. With everything run as a service, the customer can negotiate the level of resources and support they need [a bit like renting a car, a car with GPS navigation, or a car with a driver].
  Advantages of cloud computing are it's always on, and can expand to meet peak traffic, but there are still technical challenges in managing resource access especially if the data is modified off-line. As well as public clouds some organizations are setting up private clouds to better meet internal IT requirements.

- Office of Technology Assessment (1993). Adult Learning and New Technologies: Tools for a Lifetime. (monograph). Washington DC: US Government Printing Office. Retrieved October 15, 2010, from **http://www.fas.org/ota/reports/9303.pdf.**
  Perhaps the best retrospective on adult learning, literacy and technology appears in the 1993 Office of Learning Technology Report. This extensive work provides a historical view of literacy and technology in the USA and discusses how notions of literacy and adult learning have changed with the emergence of Information Communications Technologies. For example, in the 1930's three years of primary education were considered sufficient for the average American to be literate. The report discuses the rapid rate of change in a variety of job settings and the need for general education and literacy - particularly technology literacy to keep up with the times. They also discuss the potential role of technology as a vector for literacy training as costs for hardware decrease and technology for development, distribution and delivery of training emerges.

Øhrstrøm, P. (2010, February). Helping autism-diagnosed teenagers navigate and develop socially using e-learning: Some reflections on design and ethics. Paper presented at Arctic Frontiers 2010 – Thematic Conference on Distance Learning. Tromsø,

Paper demonstrated and discussed the use of a smartphone to carry geographical and situational triggered procedural prompts for autistic teenagers. This enabled them to carry out many everyday activities like taking a public bus or preparing for school that would otherwise require an aide.

Organization of Economic Cooperation and Development. (2002). Thematic review on Adult Learning: Canada Country Note. Retrieved December 20, 2010, from **http://www.oecd.org/dataoecd/51/31/1940299.pdf**

Excellent snapshot of Adult Education in Canada – paints a picture of an employment-driven adult education system with high participation (27.7%) among the 25-64 year old population. The notable exception is with ABE (p. 9) where there appears to be a shortage of program space available to meet needs of certain population groups i.e. "to those in need of basic literacy, to Aboriginal groups, and to the working poor."

The Conference Board of Canada notes that employers fail to understand the importance of training. Quebec has a 1% payroll tax on large employers who fail to provide training to employees – the policy works and training is stimulated.

Underserved populations…"several persistent issues prevent adequate programs from being provided. In many of these cases, federal-provincial tension has prevented the development of a clear policy; weak political power of these groups makes it difficult for them to make their voices heard; a lack of consensus on appropriate approaches or models of education creates uncertainty about how best to proceed." (p 17)

Aboriginal people in Canada have the lowest incomes, the highest rates of poverty, the highest rates of dropping out of formal schools (starting around grades 4 and 5), the lowest overall education attainments, and the worst health … "However, here too there has been little sustained effort to grapple with the magnitude of the underlying problem" (p. 20) … Part of the problem in the federal-provincial split. In some areas a part of the problem is a lack of knowledge of both English and their native language. Some discussion of special programs to address education needs of Aboriginal people including special colleges or special programs at community colleges.

"The working poor in Canada need specific forms of adult education but lack access." (p. 24) 20% of workers earn less than 2/3 of the median income. "The need of the working poor for additional education or training is clear. These are individuals who, almost by definition, are stuck in low-skilled, low-wage jobs with few prospects for advancement simply with experience. Therefore they need to develop additional skills, or switch occupations, if they are to escape poverty." (p. 25)

"Throughout Canada, there seems to be relatively little known about the effectiveness of adult education programs." (p. 36) "…the evidence that would convince a skeptic, facilitate the improvement of programs, or enable program developers to choose among alternative approaches is generally missing." (p. 37)

Three consequences of a lack of an adult education policy: 1. The special needs of adults are generally neglected. 2. There is no sense of a coherent system of adult education, and 3. Adult education is vulnerable to instability in government. (p. 42-43). The lack of a coordinated pan-Canadian policy means important adult education issues can not be resolved.

(see list on p. 46)

- Piña, R. A., & Rao, B. (2010, July 18-22). The Emergence and Promise of Cloud Computing for Under-Developed Societies. Paper presented at the PICMET 2010 Proceedings, Phuket, Thailand. Retrieved December 20, 2010, from **http://faculty.poly.edu/~brao/2010.Cloud.PICMET.pdf"http://faculty.poly.edu/~brao/2010.Cloud.PICMET.pdf**
  These authors argue that ICTs have radically altered the dynamics of doing business in modern societies. They point out that for under-developed countries in particular, lack of access is problematic, but it can be alleviated through the increased use of cloud computing. They argue that the cloud "can a) create new IT-enabled market constructs, b) change managerial imperatives, incentive structures and processes, and c) pose challenges to business transformation that may, in turn, affect its rate of adoption."

- Pingdom. (2009, April 7). The origin of 9 popular Web buzzwords. Retrieved November 28, 2010, from **http://royal.pingdom.com/2009/04/07/the-origin-of-9-popular-web-buzzwords/"http://royal.pingdom.com/2009/04/07/the-origin-of-9-popular-web-buzzwords/**

- Powell, J. (2009). Cloud computing – what is it and what does it mean for education? Retrieved from **http://erevolution.jiscinvolve.org/files/2009/07/clouds-johnpowell.pdf"http://erevolution.jiscinvolve.org/files/2009/07/clouds-johnpowell.pdf**
  This paper argues that the capital costs of computing can de done away with if an organization relies on the public cloud, buying virtual server time and storage space on demand.

- Red Hat (2010). Red Hat Cloud Foundations: Cloud 101. Retrieved October 30, 2010, from **http://www.redhat.com/f/pdf/cloud/101_whitepaper.pdf"www.redhat.com/f/pdf/cloud/101_whitepaper.pdf**
  Red Hat is a software vendor that has released this white paper to clarify concepts around cloud computing and the role it sees for its software. Good lucid information without hype.

- Roth, T. (2010). Cracking Passwords in the Cloud: Amazon's new EC2 CPU instances (Web blog of 15 November 2010). Retrieved November 27, 2010, from **http://stacksmashing.net/2010/11/15/cracking-in-the-cloud-amazons-new-ec2-gpu-instances/**
  German self-proclaimed hacker used the Amazon cloud to break SH, an aging password security code, by trying every possible combination until he found the right answer. This is an innovative example of the power of cloud computing since this would have taken an extremely long time to run through all the possible combinations on a single computer. By giving it to the cloud, multiple processors were able to tackle the job in parallel and it was completed in 49 minutes at a cost of about $2.

- SalesForce. (n.d.). What is cloud computing? Retrieved from **http://www.salesforce.com/cloudcomputing/"http://www.salesforce.com/cloudcomputing/** Cloud-based apps can be up and running in a few days; they cost less and are more scalable, secure, and reliable.

- Sclater, Niall. (2010, September). Cloud Computing in Education. (Policy Brief). UNESCO Institute for Information Technologies in Education. Russian Federation. Retrieved December 28, 2010, from **http://iite.unesco.org/files/policy_briefs/Cloud_Computing.pdf"http://iite.unesco.org/files/policy_briefs/Cloud_Computing.pdf**
  The review analyses the benefits and risks for educational institutions.
  There is an examination of the legal and contractual issues and provides guidelines for the selection and deployment of cloud services.
  Policy implications include the changing roles of local computing personnel, data security issues, data ownership, and contractual issues that are best handled by regional or national educational authorities.

- Statistics Canada. (2001). A Report on Adult Education and Training in Canada: Learning a Living. (Report 81-586-XIE). Ottawa: Ministry of Information. Retrieved December 21, 2010, from **http://www.statcan.gc.ca/pub/81-586-x/81-586-x1998001-eng.pdf"http://www.statcan.gc.ca/pub/81-586-x/81-586-x1998001-eng.pdf**
  A review of the state of adult education in Canada. Provides a useful baseline showing which sectors of the population are participating in adult education and that there is a slight decline in participation, but does not break out specific statistics for adult literacy education.

- Taymans, J., Swanson, H. L., Schwarz, R. L., Gregg, N., Hock, M. & Gerber, P. J. (2009). Learning to Achieve: A review of the literature on serving adults with learning disabilities. (monograph) Jessup, MD: National Institute for Literacy. Retrieved November 28, 2010, from **http://lincs.ed.gov/publications/pdf/L2ALiteratureReview09.pdf" http://lincs.ed.gov/publications/pdf/L2ALiteratureReview09.pdf**
  The review covers six topics—assessment, English language learners, accommodations, teaching methods, transition, and impact of learning disabilities.
  Learning disabilities are neurologically based disorders that affect critical learning processes such as reading writing and math skills. Learning disabilities may change as individuals mature, but if they are not adequately addressed they can limit adults' prospects for education, employment and interpersonal relationships.
  Research supports interventions on word skills that directly address deficits in phonological processing and explicit mastery learning. Interventions based on learning styles perceptual and motor training, auditory or visual learners, or coloured lenses etc. continue to be promoted despite the lack of any evidence for efficacy and they are inconsistent with scientific understanding of cognitive processing and brain function.
  Reading disabilities are persistent - in one longitudinal study, 70% of children identified with a

reading disability in Grade 3 had a reading disability as adults.
Extensive discussion of assessment of learning diabilities, Research recommended teaching strategies, Accommodation strategies for testing and instruction.
Note that mobile phones will probably be the platform of choice since more people worldwide have more mobile phones than TVs. Some phones already allow for scanning of documents and text-voice conversion; this will be particularly useful with uptake of e-text and e-books.
Extensive references.
Chapter 5 details evidence-based interventions: Explicit Instruction, use of computer writing tools, note-taking strategies, technology-based interventions can motivate (however specific instruction may be needed for Web use as Web is a literary environment), interactive tutoring,

- Trusting, K. & Barton, D. (2003). Models of adult learning: A literature review. (monograph) London: National Research and Development Centre, Institute of Education. Accessed October 22, 2010, from **http://www.nrdc.org.uk/content.asp?CategoryID=424&ArticleID=380" http://www.nrdc.org.uk/content.asp?CategoryID=424&ArticleID=380**
  The goal of this review of literature was to discriminate between adult learning (andragogy) and children's learning (pedagogy) and the significance of this for adult literacy and numeracy training. Nothing earth shattering here, but a good review of basic theories and the importance of social context for learning. Maybe the main difference in adult learning is the degree of self-determination in setting own goals for learning.

- Vaquero, L. M., Rodero-Merino, L. Caceres, J. & Lindner, M. (2009). A break in the clouds: Towards a cloud definition. Computer Communication Review, 39 (1), 50-55. Retrieved December 9, 2010, from **http://portal.acm.org/citation.cfm?id=1791381.1791384"http://portal.acm.org/citation.cfm?id=1791381.1791384**
  This paper provides 22 definitions of cloud computing. [Didn't we mention "cloud computing was a nebulous term"?]

* As this report was readied for publication, Microsoft launched a television campaign for "the cloud", its new consumer service to "create, connect and share". http://www.microsoft.com/windows/cloud
* Richards first articulated this concept in a 2009 project proposal to Canada's Office for Literacy and Essential Skills entitled the Community Open Literacy Toolkit.

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