1.1 Context – The issue

Today's labour market relies heavily on technology in a multitude of ways and requires skills and competencies that may vary from simply using an online form to apply for work to writing a sophisticated computer program involving virtual environments. With this broad spectrum of workplace demands in mind, we synthesized our research findings to focus on job skills that involve digital systems and tools and on the anticipated changes digital technologies will have on working and learning conditions of Canadians. In the Institute for the Future (2011) report, out of six key drivers that the Institute considers as most relevant to the workforce of the future, at least five relate to technology: (a) collaboration and co-dependence between humans and machines, (b) working with data and patterns, (c) communicating in diverse multimedia forms, (d) tapping into social intelligence, and (e) living in a globally connected and interdependent world. Similarly, the ten skills that the Institute highlights as crucial for the future workforce are all related to technology (e.g., novel and adaptive thinking, virtual collaboration, design mindset).

Recent national media reports have made the case that education needs to shift towards lifelong learning and retraining since Canadians overall have scored low in literacy, numeracy, data/quantitative literacy, and technological skills, thus creating a mismatch with anticipated labour market needs (Maclean's on Campus, 2013). The Canadian Chamber of Commerce predicts that if these trends continue, by 2021, Canada may have a million of unskilled and unemployable workers (CCC, 2012). Counter-measures should focus on (a) youth-at-risk—to minimize production of low-skilled individuals; (b) government incentives—to re-educate the adult population; and (c) redesign of jobs—to increase demands for skilled workers.

1.2 **Implications and Recommendations** – Structured for target audiences

In the preparation of this report, we engaged targeted researchers, stakeholders, and policymakers in a discourse around our synthesis of current research into the digital skills and key competencies needed by workers if they are to succeed in this technology-dependent and rapidly changing world. Below are details of the implications of our findings, structured to involve larger research and practice communities. Many of the implications and recommendations apply to many of the targeted practice communities.

For provincial ministries of education, labour, training, and colleges and universities. Ministries involved in education, professional development, and training should take into account criticisms found in the literature about the current state of e-learning. Scholars have expressed concern that pedagogies for online education may be ineffective because they are not necessarily designed from the perspective of the learner (Laurillard, 2013; Prensky, 2003), and they caution that digital literacy is not simply about skills and competencies but about frame of mind (DeSchryver, Leahy, Koehler, & Wolf, 2013). Digital competence, in this broadest sense, should be embedded in all curricula (Ala-Mutka, Punie, & Redecker, 2008), which would allow these programs to reach even those students who are not comfortable with using ICTs (Attewell, 2001). Individuals born in the Digital Era are not digitally literate by default (Davies, Halford, & Gibbins, 2012), nor should they be considered a homogeneous generation (Jones, Ramanau, Cross, & Healing, 2010). In some cases, it may even be necessary to up-skill students through technology-centered activities or introductory technology courses (Couceiro, Papastergiou, Kordaki, & Veloso, 2013; Wan, 2011).

However, even if students can use technology, this does not necessarily mean that they can learn with it (Laurillard, 2013). Because using technology to learn does not come naturally to everyone, digital skills should not be treated as independent of context (Young, 2012), and students should be

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exposed to educational uses of technology across the curriculum (Collin & Karsenti, 2013). A general digital literacy course can cover not only the use of various technologies but also (a) how they work, (b) how to adjust technology to meet one's needs, (c) how to increase privacy and security protection, (d) the aspects of online etiquette, and (e) where to find more resources and help (Thompson, 2011).

Missing in today's education, however, are the so-called "disruptive pedagogies" (Hedberg, 2011) that can both adapt to continual technological change and involve students as producers of educational experiences (DeSchryver & al., 2013; Lindroth & Bergquist, 2010). Educators should consider using/developing computer games to increase student engagement and motivation (Couceiro & al., 2013) and should implement various Web 2.0 tools (e.g., blogs, Vokis, wikis; Huang & Lin, 2011) that can support student learning through collaboration, co-creation, and exchange of knowledge.

Students should be guided in developing a new vision of educational technology, a vision that does not focus on any particular technologies, but instead helps learners to use the growing spectrum of technological tools creatively and across disciplines (DeSchryver et al., 2013) to achieve their main learning goals (i.e., course content and transferable skills, such as critical thinking, media literacy, and team work; Watson & Pecchioni, 2011). Because simply providing access to technology in schools does not necessarily result in enriched learning (Wiseman & Anderson, 2012), educational institutions should focus on developing a culture where (a) technology is used to enhance student learning, (b) students are included as co-creators of learning opportunities (Lindroth & Bergquist, 2010), and (c) students are encouraged and supported in their creation of virtual networks of people, services, and resources as their own 'personal learning environments' (Thompson, 2011).

All postsecondary institutional leaders should take the initiative to incorporate technology on campus (Young, 2012), taking care that the technology is used across the curriculum and not monopolized by a few disciplines or individuals (Martinovic & Zhang, 2012). To achieve this goal, all course instructors need to be educated in implementing innovative computer technology integration models (i.e., moving beyond a basic use of technology, such as basic Internet browsing and word processing) and dealing with digital distractions (e.g., IM chimes, multiple windows open, flickering lights; Schnellert & Keengwe, 2012).

Secondary schools should have ICT education embedded in the curriculum to ensure that all school students graduate with ICT skills (Mohamed, Judi, Nor, & Yusof, 2012). Moreover, results of the 2011 EU-wide survey of teachers and students by Wastiau et al. (2013) suggest that effective professional development is needed to increase the number of "digitally confident and positive [towards ICT]" teachers (p. 19). This can be done by creating online learning communities, blended learning, and other strategies that model full integration of ICTs to support efficient and effective learning. Wastiau and colleagues found a positive relationship between a digitally supportive school administration, digitally confident and supportive teachers, and digitally confident students, and they recommend broad-based action that involves students as well as schools and their staff. In addition, special attention should be given to students who do not have sufficient computer access at home.

In guiding all students in the purposeful integration of digital technologies into their learning (e.g., through podcasts, simulations, Web 2.0 tools; Ng, 2012), they should be encouraged to acquire a spectrum of literacies (e.g., technological literacy, information literacy, e-etiquette; see also Young, 2012) through engaging in collaborative activities with peers, family, and teachers (Romani, 2009). To inspire students to employ digital skills creatively, assessment should include multimodal media production (Pirbhai-Illich, Turner, & Austin, 2009).

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For federal government departments, such as the Ministry of Industry and the Ministry for Human Resources and Skills Development Canada. Reports from the EU, US, Australia, and New Zealand have suggested that the best return on investment into technology may be achieved within broad, coordinated actions that mobilize government services, businesses, and education to develop the infrastructure to equip citizens with new literacies. To do so, supportive public policies are needed, but so is a desire in users themselves to create their digital identities (including social, professional, and cultural aspects; Simsek & Simsek, 2013) and to become actively involved in the digital citizenship. To obtain 21st century skills, workers will need to adopt a positive attitude towards lifelong learning and the need and ability to adapt to volatile job market conditions (Bevins, Carter, Jones, Moye, & Ritz, 2012; CEDEFOP, 2012). Finegold and Notabartolo (2010) recommend that problem-solving and capacity for change be treated as higher developmental levels in a range of skills, rather than as isolated abilities, while competencies such as cross-cultural fluency, systems thinking, and financial literacy should be highlighted as increasingly important in the global economy.

Government departments should regularly revisit their strategies to foster digital skills (Ala-Mutka, Punie, & Redecker, 2008) and should identify and categorize jobs (even if such jobs do not yet exist) to better inform and advise present and future job-seekers and their families. The federal government should routinely re-evaluate existing job classifications to reflect both new skill requirements and emerging jobs, and then made regular and timely updates to these data.

For Citizenship and Immigration Canada. Online skills are a prerequisite for using online news media and features (Opgenhaffen & d'Haenens, 2012). Although Canada has been very successful so far in attracting immigrants with specific skills, an anticipated worldwide shortage of highly skilled workers, as well as tough competition among the developed nations for such employees, will require creative measures to attract these kinds of immigrant workers. Possible measures include increasing the number of foreign students in targeted, high-tech college and university programs, and opening opportunities for these graduates to work and remain in Canada after they complete their studies (Cheung, Guillemette, & Mobasher-Fard, 2012).

For private-sector industries and businesses, professional organizations, and unions. The technological advancements in mobile technologies (e.g., 4G[1] and LTE) will allow for more and better streaming of videos, multiplayer online gaming, video conferencing, voice-over-Internet services, and other applications involving the movement of large amounts of information (Dulny et al., 2012). These technological advances have already had implications (e.g., increased customer pool, inclusive online service) for e-health, e-learning, e-government, e-commerce, and businesses that build and use networks. Workers should be supported through the creation of interdisciplinary learning paths so that they can advance their technical, societal, and business skills (Ala-Mutka, Punie, & Redecker, 2008). In addition, in conjunction with general digital literacy education for all, focused efforts are needed to provide highly skilled labour within specific areas of endeavour such as VOIP[2], MMOs, and videoconferencing. Finally, postsecondary training in mobile technologies could be enhanced and expanded by the educational institutions closely working with specific industries (e.g., the integrated circuit industry in Taiwan; ECSIP Consortium, 2013).

For provincial ministries such as the MCYS. To prepare youth to become productive adults and to help families access online services and resources, the government must help individuals achieve digital

[1]The fourth generation of mobile phone mobile communication technology standards; Long Term Evolution (LTE) is its first release.
[2] Voice over Internet Protocol (VOIP); Massively Multiplayer Online (games; MMO).

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literacy skills, doing so with the full understanding that acquiring simple, isolated skills is not enough and that meta-skills are necessary to support full digital literacy and digital competency. While our data indicate that adolescents' physical access to ICTs at home and at school has increased significantly over the last ten years, their proficiency in using ICTs skillfully and effectively for learning deserves more attention (Zhong, 2011). Engagement with technology for learning does not come naturally to young people; it is highly contextual (Jones & Healing, 2010) and varies in range (Ng, 2012). Although the so-called Net Gen'ers have grown up with digital technologies, contrary to popular belief, there is little evidence that they are digitally competent (Li & Ranieri, 2010; Davies & al., 2012), and well-designed instructional materials for developing their digital competency are highly recommended (Li & Ranieri, 2010). Young people should be equipped with lifelong learning strategies that include informal learning through social media (Ala-Mutka, Punie, & Redecker, 2008). Youth need to become accustomed to using creative and transdisciplinary cognitive technological tools (DeSchryver et al., 2013) and must develop a positive attitude towards exploiting the capacities of Web 2.0 technology for learning (Huang & Lin, 2011).

For programs such as Making Ontario Accessible (Ministry of Economic Development and Trade). To encourage citizens to use government online self-service solutions (e.g., renewing driver's licence or health card, accessing information on how to open a business), the government should provide more relevant content as well as user-friendly webpages (Andersen, 2007, as cited in Eriksen, 2011). Some ideas from the Digital Roads to Growth report (2010, as cited in Eriksen, 2011) include: (a) launching a citizen-to-citizen educational campaign (where those more digitally literate can help their less skilled friends and family members); (b) establishing a network for seniors and disseminating information about public places (e.g., libraries, seniors' centres) where they can get free help and instruction about technology; and (c) teaching citizens about future required use of digital services and the inconvenience and costs that a lack of better ICT skills will bring. Finally, sufficient investment by government agencies and private organizations in developing the required infrastructures and in inviting commercial activities, as well as a clear government plan to enhance job opportunities, are especially necessary in rural areas (Mohamed et al., 2012).

For postsecondary institutions and private and public sector alliances. Postsecondary institutions, especially those oriented towards preparing students for the workforce, should create tight partnerships with the pool of potential employers. This can be accomplished through regular updates on workforce requirements from employers and professional and trade associations, program advisory committees, and focus groups looking at emerging demands and opportunities (Washbon, 2012). In this way, programs offered by educational institutions can be aligned with workplace needs to ensure that graduates are ready for both entry-level employment and ongoing professional development. In fact, all learning organizations—the workplace being considered a learning organization in this context (Romani, 2009)—will have to collaborate, with such collaboration serving two purposes: (a) supporting and sustaining the creation of a labour force that is rich in technology skills and human capital (Bevins et al., 2012), and (b) providing continuous and necessary re-evaluation and promotion of the terms and practices related to e-competencies.

To deal with a lack of motivation in certain segments of the population (e.g., some youth, some elderly or unemployed), promoting the acquisition of e-competence should be supported through informal venues (e.g., through family members or community groups) and personal ICT uses (e.g., through libraries, community centres; by giving incentives to use online services).

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Educational institutions, businesses, and policymakers—in addition to cooperating to promote the development of e-competent students, workers, and in general, all of whom must become capable seekers and users of knowledge in the coming technology-saturated environment (Romani, 2009)—should develop and agree upon an international standardization of e-competencies. The postsecondary institutions should enrich their technology-based courses (e.g., computer science, engineering, visual arts, multimedia) by covering business and communications aspects; in addition, through their industry partners, they should provide valuable internship and co-op opportunities to their students, thereby giving new graduates an increasingly sought-after package of skills that is highly valued by employers (Cheung, Guillemette, & Mobasher-Fard, 2012). See Appendix C for some examples of innovative models for building consortia and partnerships around both the more effective education of a skilled workforce and the coordination of actions and reforms. In the field of science, for example, creating strong scientific clusters in Canada would attract high-tech industries and professionals, as well as balance regional development (ECSIP Consortium, 2013).

For researchers and research funding agencies. Research into ICTs should take into account the importance of context (i.e., school or home) and analyze the quality rather than the quantity of technology use. Activity theory can serve as a theoretical framework for identifying social tensions introduced by technological changes, as well as explaining the connections between different activity systems, the transfer of knowledge between these systems, and the division of responsibilities in a technologically rich society (Engeström, 2008). Of particular interest are studies of the organizational and social changes made by multiple organizations that have linked together through a sustained use of technology. In the knowledge economy, cognitive task analysis (Hoffman & Militello, 2009) can be used for empirical study of workplaces and work patterns to gain an understanding of the level of performance and cognitive skills necessary for working in a given specific context (e.g., agriculture, tourism, logistics). Romani (2009) recommends organizing longitudinal studies to measure the impact of ICTs on learning and on the development of instruments that can measure gains in soft skills (e.g., creativity, innovation, experimentation, problem-solving, collaborative work, critical thinking).

Rawlings (2011) recommends a more participatory research design to understand aspects of exclusion and resistance to technology training among certain groups; user groups such as the unemployed, workers, and community groups would be treated as partners in research and encouraged to contribute to discussions based on their lived experiences about the types of skills they are using or lacking. In addition, systematic studies are recommended to identify what lies behind the different elements of the digital divide and to propose ways out (Li & Ranieri, 2010). Finally, more research and more fine-grained data are needed to properly follow trends, evaluate educational and other changes, determine performance measures, and provide funds to organizations and research groups in a purposeful and fair manner (Cheung, Guillemette, & Mobasher-Fard, 2012).

For all activity systems: Moving from a digital divide to digital inclusion. Increasing ICT competency within population segments with specific needs can be achieved by: (a) providing programs that are customized to match the needs (e.g., one-to-one training as a possibility for older retired people, training programs in youth centres as a possibility for unemployed youth), skill level, and circumstances of the target population; (b) considering the digital divide as a knowledge divide and abstaining from a technocentric approach (Chen & Liu, 2013; Romani, 2009); (c) getting the target groups to buy in by showing them the advantages of obtaining more ICT skills; and (d) cooperating with various liaison groups (e.g., youth, immigrant, women's centre; Bunker, 2010).

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Overcoming limited digital opportunities should be organized as a system-wide action (Bull, Bell, & Kajder, 2003) by: (a) providing open-access resources and free software as well as engaging youth via social media (Brady, 2009); (b) obtaining government funding for the purchase of software licences and/or preferential fees to allow disadvantaged target populations to access the e-learning environment (Chen & Liu, 2013); (c) organizing programs that can reach across cultural and social boundaries (Brunner, Kirschmann, Pumphrey, & Vu, 2009); (d) using language in policy documents that emphasizes social inclusion (rather than using the terms 'divide' or 'Digital Era'; Rekhari, 2009); (e) recognizing access gaps early by paying attention to upgrading technological resources in schools and attending to students' technological needs at home (Li & Ranieri, 2010); and (f) organizing ICT training for those groups that are disadvantaged because of poverty, citizenship, disability, gender, age, or employment status to increase their social inclusion and assist them in ongoing learning and accessing resources (e.g., the EU e-Inclusion planning, Commission of the European Communities, 2007). Currently, digital inequalities go beyond access and manifest themselves in discrepancies in ICT use patterns (Eriksen, 2011); governments at all levels should treat these inequalities as complex and changing, and should regularly update and re-evaluate their perception of the phenomenon.

1.3 **Approach –** Methodology

Our methodology combines qualitative narrative search and a systematic review of findings from prior studies to produce syntheses of research insights, evidence, interpretations, and effective practices, and to identify knowledge gaps related to the two themes identified in the proposal. To synthesize alternative approaches to technological skill development, we relied on both Canadian and international databases (e.g., ERIC), books, reports, and government sources (e.g., Statistics Canada).

The adapted Engeström's (2009) multiple activity systems model conceptualizes our approach (see Figure 1). The model presents different activity systems as interconnected and affected by various technologies that act as disruptors and ask for special consideration. Technology acts as a 'runaway object' because of its ubiquitous and yet, unpredicted effects (e.g., it is constantly evolving and has various forms; it affects ways in which we do things, communicate, and learn; it affects our value systems, social structures, and our behaviour and emotions).

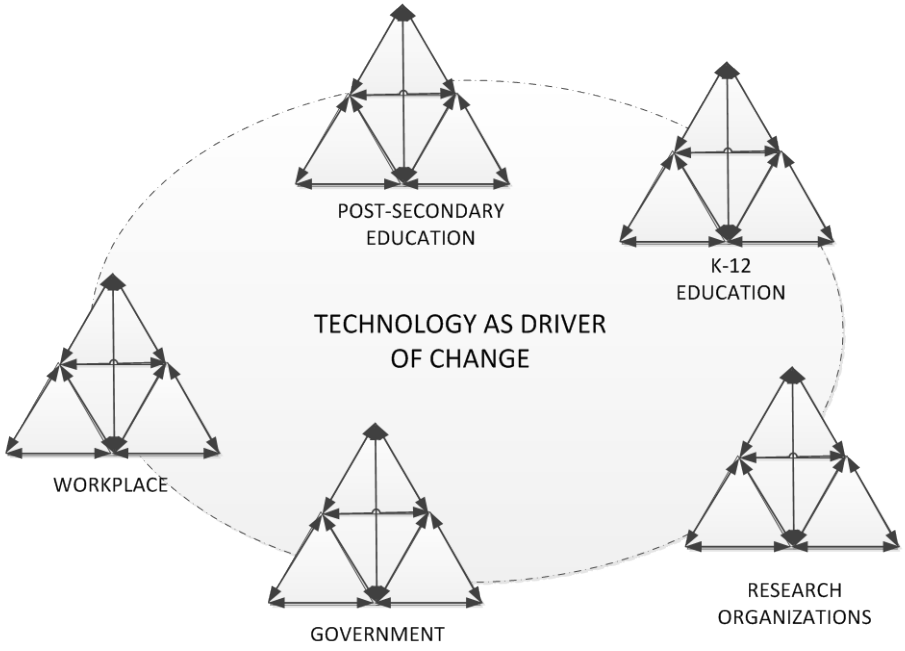
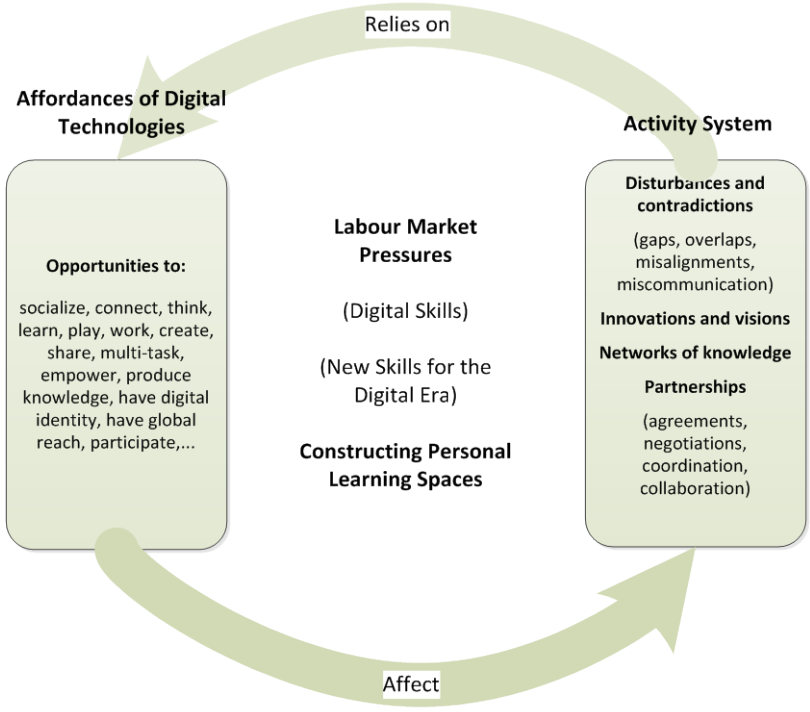


Figure 1. Multiple activity systems related to our report.

According to the Activity Theory (Engeström, 2001; Murphy & Rodriguez-Manzanares, 2008), the main units of analysis are the activity systems, such as education, workplace, etc. These systems interact and have to resolve their internal and external contradictions (e.g., in ways in which the technology is used in everyday life vs. in education or workplace). In each activity system, expansive learning is achieved through technological affordances, e.g., extended connectivity and networks that go beyond one's geographical domain (see Figures 2-3).

The technologies provide then a range of affordances for those who are digitally literate (see Hammond's definition of affordances[3]), however, these purposeful possibilities for action are shaped by one's experience, education, and contextual factors, and because of the fluctuation of technologies that are available in various circumstances, technology may be perceived in inadequate or limited ways. Since affordances are relative to one's goals, it is important to develop positive attitude towards changing living and working conditions, and life-long learning.



A Connectivist perspective of learning in a digital world emerges as response to a view of our society as rapidly changing, complex, connected socially, global, and mediated by increasing advancements in technology which implies that for the learner to be connected to this outside knowledge is more important than his or her existing state of knowing. As a core skill that helps to succeed in such a world the authors define the ability to "see connections between information sources and to maintain that connection to facilitate continual learning" (Duke, Harper, & Johnston, 2013, p. 6).

Figure 2. Pressures for new skills and attitudes of workers, consumers, learners, and citizens in the Digital Era.

[3]An affordance is the perception of a possibility of action (in the broad sense of thought as well as physical activity) provided by properties of, in this case, the computer plus software. These possibilities are shaped by past experience and context, and may be conceptually sophisticated and may need to be signposted by peers and teachers. However, they may, drawing on intuition and deduction from user accounts, be 'perceived directly', and perception of actions can precede internal mental ordering. Perceptions of affordances can, and do, become habitual. Affordances arise because of real physical and symbolic properties of objects. Affordances provide both opportunities and constraints. Affordances are always relative to something and, in the context of ICT, relative to desirable goals or strategies for teaching and learning. Affordances are often sequential and nested in time. (Hammond, 2009)

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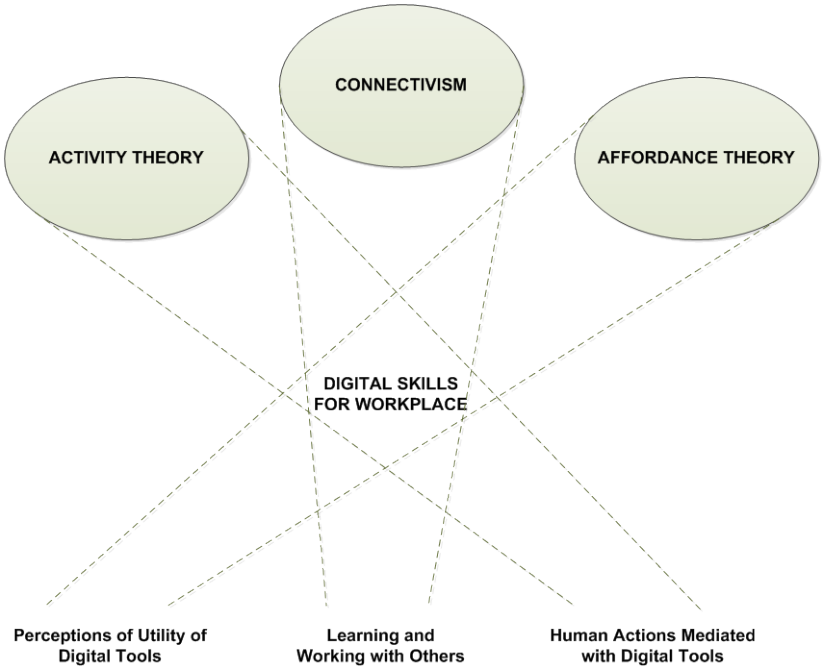

According to this view, knowledge is distributed across the Web and people's engagement with distributed knowledge constitutes learning (Kop, 2011). Today's students may use these technologies to "form their own information networks, including learning communities in which students participate in the knowledge creation process, rather than merely consuming information" (Dunaway, 2011, p. 675).

Figure 3. Theoretical lenses used in this report: Activity theory, affordance theory, and connectivism.

More specifically, Downes (2009, as cited in Kop, 2011) claimed that "people can create and use their own personal learning environment (PLE) and network to find information, make connections with knowledgeable others of their choice" (Kop, 2011, Connectivism), and in order to advance their learning, they become actively engaged in four major types of activity:

1) Aggregation—access to and collection of a wide variety of resources to read, watch, or play;

2) Relation—after reading, watching, or listening to some content, the learner might reflect and relate it to what he or she already knows or to earlier experiences;

3) Creation—after this reflection and sense-making process, learners might create something of their own using any service on the Internet;

4) Sharing—learners might share their work with others on the network.

Participation in activities is therefore seen to be vital to learning. In order to enhance learning in such environments, Armatas (2013) suggests providing learners with diverse information sources, access to collaborative Web 2.0 tools and promoting creation of learning networks. Equipped with the ICT affordances, individuals create their own networks of people and their own personal learning spaces, where they can connect with others, satisfy their interests, find information they need, be creative, and contribute their intellectual assets to the network. Some personal qualities are useful, such as self-determination and critical thinking, as well as self-direction and continued presence in the network (Downes, 2009).

1.4 Results – Outcomes of research and how they support the implications

Changes in one's lifestyle arising from advancements in digital technologies and from the propagation of these technologies into all aspects of human activity are profound (see Figure 4). The introduction of Web 2.0 has made available a variety of online collaborative and interactive tools that allow the user to generate, make changes to, and share content easily and in real time (Solomon & Schrum, 2007; Wilson

et al., 2011). With the provision of less costly and more sophisticated technology (e.g., larger bandwidth, superior hardware, cheaper memory), video started dominating the Web, thus opening up new opportunities for global collaboration (Anderson, 2010). Web 2.0 provides online tools for sharing (e.g., communal bookmarking, photo/video sharing, social networking, writers' workshops/fanfiction), tools for thinking (e.g., blogs, podcasts, online discussion forums), and tools for co-creating (e.g., wikis/collaborative file creation, mashups/collective media creation, collaborative social change communities; Dede, 2009). In Simsek and Simsek's (2013) interpretation, Web 2.0 combines the features of a library, a marketplace, "a hypertext jigsaw puzzle of interconnected micro content" (p.134), a communication network, and a playground. Such possibilities for action present technological affordances that are shaped by the user's experience and education, as well as by contextual factors.

Because the availability and use of these technologies can vary widely, digital technology itself may be perceived by some in inadequate or limited ways (e.g., only as a source of entertainment; Wijekumar, Meyer, Wagoner, & Ferguson, 2006). However, open-mindedness plus adaptability and the desire to learn are crucial personal qualities for functioning under today's variable and changing living and working conditions.

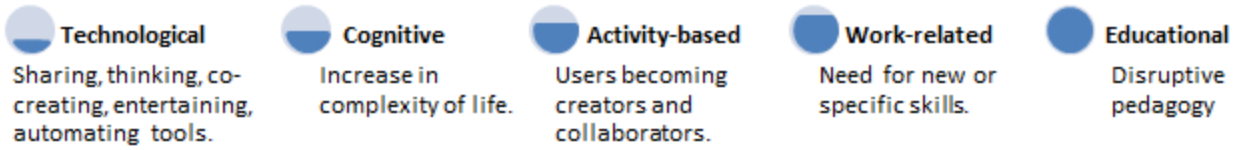

Figure 4. Changes experienced in one's lifetime as a consequence of technological advancements.

In addition to an improved basic quality of life, human cognitive development can also be enhanced through more complex living conditions that are saturated with information, multimedia, and technology (Martinez, 2007; Neisser et al., 1996). With the propagation of new technological tools, new literacies have emerged, and people have stopped being solely on the receiving end of the dissemination of information (i.e., collecting and searching for information); instead, they have started taking an active role as creators, designers, and collaborators, thus blurring the distinctions between programmers and users, producers and consumers, writers and readers (Kress, 2010).

These changes have affected both business processes and employers' expectations. Workplace tasks have become more complex and reliant on cognition, rather than on physical labour, thus bringing to the fore the importance of understanding the complex sociotechnical environment where people and technology cohabit (Hoffman & Militello, 2009). With many routine jobs now being done either solely by computers or with their help, workers are increasingly required to deal with nonroutine tasks and to engage in expert thinking (e.g., pattern-matching, problem-solving) as they handle vast amounts of information and engage in complex communication, often at distance and under unpredictable conditions (Dede, 2010; Levy & Munane, 2004). Indeed, most of the employers in the Louise (2011) study stated that in the next five years, critical thinking as well as problem-solving and information technology skills will increase in importance; at the same time, however, fewer than half of the respondents felt that the current crop of four-year university graduates excelled in information technology.

The problem here is that the more intelligent and helpful technology becomes, the more difficulty its users have in understanding what and why it does what it does. In effect, people can become 'de-skilled' and may thus have more difficulty developing their knowledge and abilities

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(Hoffman & Militello, 2009). All of these changes are challenging educators and trainers to develop and implement pedagogies to advance 21st century skills.

Technology has generated learning opportunities that are less demarcated than before (e.g., formal/informal, school/home) as well as educational scenarios that are multifaceted (e.g., face-to-face/distant, collaborative, multidisciplinary, self-directed, open). Wiseman and Anderson (2012) caution that ICTs in instructional practice are only at the entry level; it seems that equipping educational institutions with computer resources does not automatically translate into advanced learning and knowledge. A "disruptive pedagogy" (Hedberg, 2011, p. 1) is now needed, which will help students become active participants, not just in their own learning but in creating knowledge. Since new generations of students are becoming increasingly accustomed to reading from the screen and in independently and intentionally using digital tools and functions (e.g., hypertext, multimodality; see Kress, 2010), educational institutions need to adapt to these new trends, not only to bridge the gap between formal and informal learning practices but also to demonstrate that they value both old and new ways of knowing.

However, educators are faced with a dilemma: Is technology detracting from the learning process by being too entertaining, too game-like? Wijekumar et al. (2006) examined the online learning experiences of 77 undergraduate and graduate students in Australia, most of whom had extensive computer experience. The students' learning and recall were influenced by multi-tasking and frequent distractions (e.g., having a number of programs and windows open concurrently on the computer, engaging in multiple chats at once, having instant messaging chimes on). These students perceived computers as tools for communication with friends and colleagues, as sources of fun and games, and as a means for completing homework. From the students' point of view, they were using computers appropriately, but the researchers have called for urgent action to change the youths' perception of technology from the playing to the learning affordance.

In the workplace, another paradox has been noted that also speaks to this mismatch in the perception of digital technology. Having more advanced and automated systems in a workplace does not mean that the human operator is absolved of the need for skilled decision-making and troubleshooting; even when technology is introduced to reduce the tedium of the job task, the worker still needs to monitor the automated process. This also means that more resources (i.e., time, money) need to be invested in the operator's training in three areas: (a) crisis-resolution skills (e.g., when the machine fails or performs contrary to expectations), (b) engagement with the task even when the task is repetitive and boring, and (c) development of the right attitude to delineate human and technology roles and relations (i.e., to view the workplace as a system that unites humans and machines—where neither of the two has by default an inferior role, but they work as a team; Hoffman & Militello, 2009).

3.4.1 Technology as a driving force for change in both educational and work practices.

Recent projections have recognized Information and Communication Technology (ICT; e.g., computers, smart phones, tablets, Internet) as a major driver of change in both education and work. We found a number of terms relating to skills in technology use, the most common of which being 'digital literacy' and 'digital competency' (for detailed survey of the terms and their historical development, see Appendix D). In our synthesis, we will use the term 'digital literacy' (as given, for example, in Tuckett, 1989; Lanham, 1995; Nicholas & Williams, 1998; International ICT Literacy Panel, 2002; Meyers, Erickson, & Small, 2013). The Canadian Chamber of Commerce (CCC, 2012) report, which was based on an extensive series of Canada-wide consultation meetings with CCC network members, stated that ICT improves productivity on one hand, but on the other, it intensifies skill-based inequalities in the

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workforce. Moreover, while some ICTs may help decrease operational costs by improving workplace efficiency, other ICTs may require substantial investments in infrastructure, reorganization, and/or training, thus limiting their desirability (PROGRESS, 2009).

According to the Organisation for Economic Co-operation and Development (OECD, 2009), ICT has shifted its role from being solely a driver of innovation to being also an enabler of innovation. New technologies on their own are not enough to bring about economic advancement; they increasingly need to be complemented by new business models and novel approaches to working. Two examples of how ICT has enabled innovation are (a) the merger of three universities in Finland to provide for multidisciplinary research and education in technology, business, and design studies, and (b) the formation of a joint privately and publicly funded multidisciplinary institute in Sweden that combines research in technology, business, and human behaviour to inform the local mobile phone industry.

Overall, the use of digital technology can have conflicting effects, from easing problems with future labour shortages to requiring new organizational structures and business models (e.g., team-based, multi-disciplinary; PROGRESS, 2009) to magnifying "contradictions between exchange value and use value, between private ownership and public good, between proprietary and freely accessible or open forms of knowledge and production" (Engeström, 2009, p. 310). Governments around the world are currently engaged in attempting to predict changes that may be induced by digital media, e-learning, e-health, wireless technology, and financial services (Information and Communications Technology Council, Research, n.d.). New professional graduate degrees are being developed to produce "T-shaped professionals," individuals with a combination of disciplinary depth and a breadth of workplace skills (National Research Council, 2008; as given in Finegold & Notabartolo, 2010). While Finegold and Notabartolo cite statistics that show how more advanced technological skills allow individuals to earn more and find a job sooner, some other scholars (e.g., Rawlings, 2011) caution that having only basic or inadequate ICT training can further propagate inequalities between individuals and that ICT should not automatically be equated with opportunities for workers' upward mobility.

To sum up, nowadays (a) more jobs require advanced ICT skills; (b) more jobs that previously required no or little ICT skills now rely on them, at least at the basic level; and (c) technology is also changing at an increasingly rapid pace. Individuals need to adapt to these social and economic changes by learning new skills and constantly upgrading older ones (i.e., moving from basic levels to more advanced ones).

How is technology changing educational practices? There is constant pressure from the job market on educational institutions to provide graduates with adequate work-related skills, including skills in the use of technology. In addition, education is becoming increasingly driven by the principles of inclusion and globalization, both of which emphasize the need for education at a distance (Martin, 2005) and for the skilled use of new digital technologies. Huang and Lin (2011) describe changes in learning a foreign language through the integration of Web 2.0 technologies with a traditional lecture-based university setting. In their study, blogs offered a form- and meaning-focused writing exercise, Vokis increased opportunities for oral practice and meta-linguistic awareness, and wikis pulled the learners together in a collaborative writing project.

New haptic technologies, too, can provide for a multisensory experience that is both innovative and challenging. In the UK, the hapTEL project posited that dentists could be trained to operate in a simulated 3D environment instead of simply observing others working on patients. As part of the hapTEL project (Gillen & Barton, 2010), dentistry students were asked to interpret 3D on-screen images and digital sounds, and to use haptics and foot controls to learn and hone their clinical skills. However, the

researchers discovered that both the students and their professors found it challenging to seamlessly adopt these new ways of learning, primarily because

> … digital literacies are not independent of other literacies ... [T]here is a relationship between traditional literacy (the ability to read and write text), numeracy (the ability to manipulate and interpret numbers), mechanical skills (the ability to handle and understand various mechanical devices) and digital literacies, in the sense of the ability to use and understand a range of IT hardware, software, new forms of representations, and the interface between them, and most importantly, connecting and linking all of these literacies to meet the changing educational needs and practices. (Gillen & Barton, 2010, p. 16)

Critics claim that while Web 2.0 is a reality, Education 2.0 is an aspiration (Noss, 2008). According to Ipsos MORI (2008), universities are not currently perceived as leaders in developing and/or implementing new pedagogies. Instead of training students and staff simply in how to use learning management systems or other technological tools, universities need to start utilizing "online frameworks for collaborative, learner-led work … and new conventions for learning through digital media" (p. 42), and to prepare their students to use the new range of skills required for such learning. It would thus be prudent to work on developing digital literacies in a contextual way, enabling both students and instructors to gain and implement technological skills relevant to their life, work, or education. Moreover, since one can nowadays study at distance and combine leisure with learning, the distinction between home and school activities is blurring. In essence, students engaged in the new literacy practices (e.g., writing multimodal and collective online compositions, incorporating unconventional visual elements in their comments and blog entries, using 3D simulations online, engaging in multiplayer games) inhabit the informal learning ecology (Barron, 2006) as much as they do the formal traditional one.

According to Gillen and Barton (2010), creativity, collaboration, and criticality are at the core of digital literacies associated with both informal and educational practices. Although collaboration is valued in both worlds, it may be of a different nature in each. In formal schooling, collaboration is often organized and controlled by the instructor, and assessment is mainly individualized, while in informal practices, knowledge-sharing is viewed as a communal process rather than as an individual product (Martinovic & Magliaro, 2007), and the assessment is based on contribution to the group.

One relatively recent idea that has challenged established practices in higher education has been to make available on the Web, free of charge, the complete teaching materials from virtually all of the courses taught at MIT (MIT OpenCourseWare). Vest (2006) termed this exercise in intellectual generosity "an exercise in openness, a catalyst for change, and an adventure" (p. 13), and it has opened the door for other novel types of free online education for the masses: Massive Open Online Courses (MOOCs).

Kop, Fournier, and Sui Fai (2011) discuss the conflict between the MOOC-distributed learning model—with its open, emergent, and hectic online interaction—and the rigidly organized social structure of formal education—with its prescriptive, standardized, and fixed schedules, curricula, organization, and assessment. This conflict between learning in everyday life and learning at university will have to be resolved if we are to take advantage of what the emerging technologies have to offer to higher education. MOOCs offer ways of making connections between different professions (e.g., enrollment in one MOOC included teachers, researchers, managers, mentors, engineers, facilitators, trainers, and university professors) and providing new opportunities for participatory learning, shared knowledge, and distributed cognition.

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How is technology changing work practices? With the increasingly rapid rate of technological innovation and business restructuring, the ability of individuals to adapt, be flexible, innovate, and contribute to the production of new knowledge within the workplace is a highly sought-after virtue (Finegold & Notabartolo, 2010). Technology is "transformative in changing core occupational practices" (Washbon, 2012, p. 44) to the extent that skills now required by the labour market are becoming similar to those gained in postsecondary programs, even in jobs for which, until recently, a high school diploma would have been sufficient. Washbon suggests offering flexible modes of learning that either include or are solely based on distance learning for those employees who need up-skilling. Such programs can incorporate technological innovations, such as interactive television, videoconferencing, video-based delivery, and online learning, as well as accelerated, self-paced, or weekend learning options.

Beverly Bunker (2010) has described various initiatives taken by different countries aimed at enhancing the accessibility and usability of ICTs as well as improving the digital competencies of their workforces. While these programs resulted in increased ICT skills within the target populations, the benefits were not instantaneous, nor did the productivity rate among workers increase automatically with government investment in ICT products and services. It appeared that the best success rate might lie within broad, coordinated actions that could mobilize government services, businesses, infrastructure, and education. In fact, rather than being used to replace routine jobs, Bunker reported, the ICTs became drivers of innovation, in effect re-engineering business processes.

3.4.2 What balance or combination of transferable and specific skills should be emphasized in the education of a future workforce for it to be digitally literate?

Worker mobility, mobile technology, and outsourcing have already enabled broader access to potential employees. European forecasters (CEDEFOP [European Centre for the Development of Vocational Training], 2012) have predicted a decline in manual and routine jobs (i.e., jobs easily replaced by technology or organizational change; Wilson, 2012) and a concomitant increase in highly skilled jobs, over-qualification of people who must try to stay competitive in threatened economies, and a further polarization of the workforce towards a top-heavy/bottom-heavy job skill and wage spectrum. Future workers will need to be adaptable lifelong learners (CEDEFOP, 2012; The Institute for the Future, 2011), as even the most formerly unskilled occupations will require a combination of transferable and specific skills, including personal, technological, and analytical (e.g., independent problem-solving, organization, communication, planning) skills.

Young (2012) argues that employers value employees with good communication skills and will look in the future for those who can present their ideas visually as well as orally and in writing. It seems that every success-oriented 21st century society will need citizens who are creative and innovative contributors to the co-production, co-sharing, and co-using of knowledge in the increasingly complex digital environment. It is now widely recognized (e.g., Government of Canada, 2010; OECD, 2010; United Nations, 2009) that digital literacy—that is, the ability to (a) use digital technology and the Internet; (b) gather, manage, and evaluate information; (c) create documents in multiple media forms; and (d) communicate at distance—is a milestone in creating a knowledge-based society (California Emerging Technology Fund, 2008; CCC, 2012). Digital literacies (e.g., digital, media, information technology literacies; Bawden, 2008; Newman, 2008) have become almost a prerequisite for creativity, innovation, and entrepreneurship—all irreplaceable attributes of the 21st century citizen (Beetham, McGill, & Littlejohn, 2009).

The Programme for the International Assessment of Adult Competencies (PIAAC) survey was conducted in 2011 by the OECD (2013) to assess working-age adults' ability to apply technology in

workplace and social situations. The survey results provide an insight into the status of both the information-processing skills (e.g., the ability to solve problems in situations where technology is required or helpful as well as the ability to evaluate the relevance and credibility of information) and the generic skills (e.g., the ability to work and communicate with others, to plan and organize one's time, and to make inferences) of the target population. This performance-based assessment presents Canadians as generally well-educated, with above-average (among the OECD nations) proficiency in problem-solving in technology-rich environments. Canada is among the nations with both the largest percentage of adults scoring at Level 3 (7.1%) and conversely, the largest percentage of adults scoring below Level 1 (14.8%), with a below-average mean score in numeracy and the highest net difference in literacy between high- and low-educated adults. It is of special concern that inactive young people in Canada (i.e., youth who are not employed or enrolled in school or training) are six times more likely to score at literacy Level 2 or below.

A more recent CEDEFOP (2013) forecast extends to 2025 and foresees that the demand for high-level qualifications will speed up. Regardless of whether the market scores low, medium, or high (i.e., pessimistic, baseline, or optimistic), all three conditions suggest skill and labour market scenarios that are predicated on an increase in people holding high-level qualifications (i.e., at least 40% of 30- to 34-year-olds will complete tertiary-level education by 2020, and fewer than 10% will leave education and training early), which may ultimately mean that job seekers may be overqualified in future. The EU forecasters caution that the workforce of the future needs to prepare for jobs that are "not easily replaced by technology, organisational change, or outsourcing … —jobs requiring people to think, communicate, organise and decide" (CEDEFOP, 2013, p. 2). The required workforce skills include critical thinking and problem-solving, teamwork and collaboration, technology use, and life skills such as self-directed and lifelong learning (Australian Blueprint for Career Development, 2003; Partnership for 21st Century Skills, 2006). Lifelong learning will be necessary for adapting to continuously changing market demands (Bevins et al., 2012) and could be provided through distance education, although both students and instructors would need to be skilled in using digital tools to act in effect as an e-learning community (Martin, 2005).

While there is general agreement that modern society requires its citizens to be digitally literate, different research groups conceptualize digital literacy differently. Fred Garnett (2010) has suggested that we shy away from the 'deficit model' of digital literacy and incorporate a more inclusive model, which would be oriented towards 'digital inclusion.' Garnett described the TLRP-TEL[4] project, which views digital literacy as "an enabling skill allowing for a broader range of learning interactions, using a greater range of tools, which then offers the possibility of a wider range of traceable meanings to be made in society" (p. 23).

After comparing and contrasting different frameworks for 21st century skills, Dede (2010) concluded that several national and international (e.g., the American Association of Colleges and Universities [AACU], 2007; Educational Testing Service [ETS], 2007; International Society for Technology in Education [ISTE], 2007; Metiri Group & NCREL[5], 2003; OECD, 2005) frameworks are essentially in accord with each other, although they may emphasize different areas (e.g., ISTE and ETS lean more towards technical skills versus the digital literacy skills emphasized by Metiri Group & NCREL).

[4]Technology Enhanced Learning (TEL) programme is the fifth phase of the UK Teaching and Learning Research Programme (TLRP) which began in 2000.

[5]North Central Regional Educational Laboratory (NCREL), a member of the Regional Educational Laboratory Network (i.e., Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin) that specialized in technology, was in operation until 2005.

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Accordingly, digital and media literacy is being increasingly understood as a collection of life skills that are necessary for full participation in media-saturated, information-rich societies (Beetham et al., 2009; Hobbs, 2010; Hobbs & Jensen, 2009). Those who face obstacles to the development and/or exercise of their digital and media literacy skills are the victims of the phenomenon named 'the digital divide.' The concerns expressed in a Danish doctoral study by Eriksen (2011) pertain to a number of reasons for the digital divide: (a) The digital divide is a complex phenomenon that is mostly related to socioeconomic status and age. (b) The elderly and the unemployed lack both opportunity and stimuli that exist for individuals in the workforce. (c) Young people, too, who are usually heavy users of technology, do not use certain digital services (e.g., e-government), probably because they lack interest in such services.

To overcome the digital divide, all factors should be considered, including lack of interest (among youth) as well as lack of opportunity, lack of motivation, or fear of technology (among the elderly and unemployed). Indeed, even though young people are born in a technology-saturated world, transferring or translating their presumed ICT skills into employability skills is not a sure thing (de Hoyos et al., 2013); hence, de Hoyos and colleagues suggest that youth be provided with career guidance in conjunction with developing their digital skills. For older people and for immigrants, it is crucial that the government provide them with access, training, and support to encourage them to engage with technology. Taking a holistic approach to integrating into the digital economy is more beneficial than focusing on acquiring specific ICT skills; such skills are certainly necessary, but they are most useful in conjunction with other social skills, qualities, and behaviours (de Hoyos et al., 2013; Romani, 2009).

3.4.3 How should postsecondary education accommodate the changes noted among the young and support both the incorporation of youth into the workforce and the development of basic 21st century skills?

Romani (2009) analyzed the outcome of the use of digital technologies in primary and lower secondary education among youth who would be entering postsecondary education and/or joining the labour force within the next decade. His major findings were that despite substantial investment into incorporating ICTs in schools, the evidence was lacking that (a) access to ICTs in schools ensures their use, and (b) both access to and use of ICTs automatically guarantees increased academic achievement of students. To shift the focus from tool (i.e., technology) to knowledge, Romani has suggested the term 'e-competent user,' which refers to a person who is able to complement their ICT skills with other proficiencies and knowledge necessary for both their social and professional life. Among other recommendations, the author calls for (a) co-ordination between policymakers, educators, and employers to better evaluate the impact on education of various societal investments into technology, (b) enhanced assessment practices and tools appropriate for measuring new skills, and (c) involvement of instructors and students in consultations around their ICT use and needs.

To identify the factors that affect undergraduate students' decision to use technology for learning, Lai, Wang, and Lei (2012) conducted a study at a large comprehensive research university in Hong Kong. The researchers identified three factors — (a) educational compatibility (i.e., self-perceived compatibility of the technology with one's learning style), (b) facilitating conditions (i.e., self-perceived availability of support in the student's environment that would encourage and facilitate adoption of the technology), and (c) encouragement from faculty and peers for technology use — as the most significant in determining whether the student will be comfortable using technology for learning. These findings corroborate a study by Lumpkin (2012) who found that in the process of selection and implementation of technologies for university teaching and learning, the feelings, attitudes, and beliefs of faculty

members had to be taken into account. Oftentimes, a trigger (e.g., a crisis, a challenge) would initially force the university into the process of innovation, but proper training of the faculty members, consideration of how they perceived of the utility of using technology for learning, and recognition of the early adopters of technology among them were then needed to help sustain the process of change.

Concurrent with the advancement of computer technologies as learning tools, educators are expected to develop pedagogies (e.g., lifelong, learner-centred, and self-directed learning) to address new societal demands and rapidly changing student expectations (Koper, 2004). An important body of literature analyzed these expectations in terms of the concept that the so-called Net Generation identifies new generations of learners as autodidactic and visual learners. While doing schoolwork, for instance, they perform several tasks simultaneously, shifting their attention from one project to another; they prefer receiving information quickly, are adept at processing it rapidly, prefer multitasking and nonlinear access to information, have a low tolerance for lectures, prefer active rather than passive learning; they are kinesthetic, experiential, hands-on learners who must be engaged with first-person learning, games, simulations, and roleplaying (Junco & Mastrodicasa, 2007; Oblinger & Oblinger, 2005; Tapscott, 2009). These learners rely on ICT to access information and to interact socially and professionally (Veen & Vrakking, 2006; Pletka, 2007), and they value freedom, scrutiny, integrity, customization, collaboration, entertainment, speed, and innovation (Tapscott, 2009).

Meanwhile, educators wonder whether young people entering university will turn the social networks they are actively engaged in into a tool for knowledge exchange or sharing. While studying the use of StudiVZ (a German analog of Facebook), Wodzicki, Schwämmlein, and Moskaliuk (2012) did not find much evidence of study-related knowledge exchange among students, although they allowed that communication on StudiVZ did promote students' social inclusion, indirectly contributing to their studies. And a multiyear study by Ipsos MORI (2008) found that UK students did not expect that their ICT skills would be challenged in university unless they were taking courses in ICT. Students resented using social networking sites in their coursework because they did not consider social media to have any part in formal education: "Use of social networks … can be appropriate, but does not feel right when led by the teacher" (p. 36), they argued.

Framing any generation (e.g., Net-Gen'ers, Millenials) as homogeneous means that stereotyping occurs, But multiple factors must be taken into account, such as age, gender, and sociocultural background, when looking into how ICTs are used and the changes such technology can bring into people's lives (Martinovic, Freiman, & Karadag, 2011). A study of a large sample (*n* = 931) of 18- to 26-year-old students attending one Flemish university analyzed their self-reported digital skills in terms of their use of online news media (Opgenhaffen & d'Haenens, 2012). After finding that college students in general did not use online news media intensively and that only a minority even used the advanced online news features, the authors suggested that "the level of digital skills is a better predictor of news media and interactive features use than demographics" (p. 297). Lack of interest in online news, especially if exacerbated by a lack of digital skills, may limit information-processing and civic participation of some higher-education students.

In an Australian study of second-year university students, mostly pre-service teachers enrolled in the 'Introduction to eLearning' course (Ng, 2012), the majority of the participants had access to mobile phones, laptops, and the Internet, and considered themselves proficient in using word processing software for writing but not proficient in webpage design, photo editing, and movie-making software. Moreover, the majority of the students were not hands-on users of many technologies that could be considered 'educational,' such as Prezi (presentation software), VoiceThread (social media), Hot

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Potatoes (quiz creation), Dropbox (file storage), SurveyMonkey (survey/quiz creation), and Interactive White Board; nor were they familiar with the concepts of WebQuest, ePortfolio, cloud computing, digital story, and podcast. In effect, the students overall were more users than creators of Web content.

Jones and Healing (2010) refute the strict cause-and-effect approach as well as the generational discrimination (i.e., the views found in Net Generation and Digital Native literature) that distinguish those born in the era of digital technology (1982 and later; Berk, 2010) from everybody else. In fact, their mixed-methods study of first-year university students in the UK provides a different view: Digital skills did not come naturally to the young people they studied; instead, they were induced to learn these skills by provisions in their school environment and their course requirements. Although most students felt at least moderately confident in using presentation software and online library resources, more than one third of them did not feel confident in using the university virtual learning environments and in participating in blogs and wikis. The authors concluded that while technology affected the students, it did not define them as a cohort; in short, familiarity with technology was not enough to produce skilled use of that technology. To better understand young people as active agents engaged with technology, we should look beyond the motives and motivation of individuals and instead examine aspects of the social system that enforce physical, economic, and moral sanctions.

While students are becoming increasingly comfortable using ICTs for administrative purposes (e.g., enrolling, paying for services, finding library resources; Ipsos MORI, 2008), universities should be aware that students need more training in the use of ICTs for learning both academic subjects and enhanced techniques for validating online resources used in research; however, they should not discriminate against students who need this extra training as opposed to those students who do not.

Ala-Mutka et al. (2008) emphasize the importance of understanding privacy and security challenges as well as the ethical and legal aspects of ICT use, and have proposed developing a critical stance in creating and using digital content in an educational context (e.g., not revealing sensitive information on social networking sites; using online resources responsibly). The authors have recommended (a) embedding digital skills widely at all levels and in all curricula, (b) supporting and upgrading digital competency through lifelong learning, and (c) using emerging online communities to encourage students to informally brush up on their technological skills. Although strategies for achieving digital skills should be constantly revisited, starting early is crucial, as is supporting students in striving beyond achieving only basic user skills. The cross-disciplinary perspectives and collaboration skills gained through embedding technology in all courses can help students follow “interdisciplinary learning paths (technical + societal + business)” (p. 6).

There is further evidence that digital literacy in all students does not occur automatically. While examining students’ perceptions of their online learning experience at one Ontario college, Schneider (2010) found that a significant minority of students not only did not possess sophisticated information technology skills but, in some cases, had only minimal skill in manipulating technology-based tools and applications (10%–30% of students reported having little or no skill in assessing the credibility of online information, searching the Internet effectively and efficiently, and/or using the college’s library website). The students preferred taking courses that had at least some face-to-face component and complained that some instructors either did not use the learning management system effectively or avoided using it at all.

Therefore, learning how to use technology should not be left to chance events; technology should be introduced not only as a tool for learning but also as an object of learning itself (Collin & Karsenti, 2013). For example, during their first semester in an undergraduate program at the University

of Thessaly (Greece), all students are required to take a course titled 'Computers,' which is intended to raise their digital literacy level and to promote "the acquisition of essential learning competencies, such as logical and critical thinking, reasoning ability as well as problem-solving skills" (Couceiro et al., 2013, p. 534). Through this course, students can develop more sophisticated language and ideas about the basic functions of computers.

At the same time, other studies, like the one conducted by Young (2012), suggest that technology skills are not and should not be thought of as independent skills to be taught in a 'technology' course. For instance, Bevins et al. (2012) note that "educational institutions must work in collaboration with a private sector to combine efforts in building a skilled, knowledge-based labor force that is second to none—in terms of both technology and human capital" (p. 9). Zinsor (2012) shares a vision of a curriculum model for educating future citizens that starts with a foundation of academics (contextual mathematics and science), vocational skills, and technological literacy, alongside process skills, which include systems thinking and problem-solving.

DeSchryver et al. (2013) have provided a practical example of how postsecondary education can prepare pre-service teachers to cope with technological change and to creatively utilize technology in their future teaching profession. They suggest that adaptability to continuously changing technologies and the development of a creative mindset can be achieved by: (a) not focusing on specific technologies, but instead, actively promoting a technology-agnostic approach; (b) providing pre-service teachers with creative and transdisciplinary cognitive tools with which to build new habits of mind (i.e., to start considering themselves as designers and innovators) for teaching and learning; (c) helping pre-service teachers to transition from being consumers of educational technology to being producers of educational experiences; and (d) encouraging pre-service teachers to replace a traditional teaching philosophy with a vision for educational technology. The authors noted that many future teachers have a traditional concept of what it means to be creative and thus do not appreciate the creative mindset necessary to construct their own solutions; they have difficulty in understanding the existence of a mindset grounded in the idea that no single technology is adequate, but that new tools will emerge regularly that will be conducive to certain and specific creative thinking skills.

Watson and Pecchioni (2011) have described how they used the creation of documentaries as a teaching tool in a senior-level college course in health communication. The authors' goal was to use what Hedberg (2011) has called "disruptive pedagogy" to make the course truly learner-centred and the students co-creators of knowledge. The students created documentaries on health-related topics of their choice, incorporating information from the Internet, popular magazines, and research journals, as well as using interview excerpts and material from popular culture sources. The instructors observed not only a higher level of engagement among the students compared to before they became involved in the production of the documentaries, but also an increase in motivation and collaboration among them. Watson and Pecchioni (2011) concluded that having students produce digital media motivated them to learn in a way that other more traditional ways could not. There were several challenges the instructors faced — (a) finding ways to scale down the complexity of technology use, (b) proposing tasks that would capture the students' interest and allow for creativity, and (c) providing enough time for the students to do the actual production work — so that the course content and transferable skills (e.g., critical thinking skills, media literacy, group collaboration) could continue to be the main learning goals.

Garcia (2009) conducted a four-year postgraduate research study to better understand the development of communication, networking, and collaboration skills among online course facilitators in three universities in the Manchester, UK, city region. Garcia posited that developing connectivity skills

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are part of one's strategies for lifelong learning and may increase one's social capital in any electronic-mediated interaction. Using a grounded study approach, she proposed a personal knowledge path for developing these skills, consisting of four consecutive stages: first, creative lifelong learning (which is people-oriented), second, environment adaptation (which is technology-oriented), third, a systemic view (which is technology-oriented), and finally, community membership (which is people-oriented). The facilitators progressed through these different stages, fluctuating in their people-orientation versus technology-orientation, discovering affordances of online technology, and developing a more flexible approach to facilitating learning.

Couceiro et al. (2013) have suggested that the use of innovative learning methods, such as educational games, might be more appealing for the current generation of learners, whose very way of thinking, learning, and processing information has been changed by technology. Their concern has been that some disciplines, such as physical education and sports science, are disadvantaged because of a lack of ICT resources, the general misconception being that such resources are not as needed in these disciplines as they are in some other areas. A similar observation was made by Martinovic and Zhang (2012), who noted that both in schools and in teacher education programs, technology is often monopolized by mathematics and science instructors. When technology is scarce, it is natural that it is made available first to those who are most inclined to use it; however, such a practice emphasizes the dichotomy between disciplines that are considered technology-friendly and those that are not. Martinovic and Zhang call for reversing the compartmentalization by subject or department of already-limited ICT resources and for maximizing the impact and reach of computer technologies in an integrated fashion across all subjects and disciplines.

To investigate the informal aspects of learning with new technologies, Thompson (2011) conducted an exploratory qualitative study into the use of online communities to support so-called work–learning. Unlike more formal online spaces for distance learning (e.g., online courses organized by some educational institution), most online communities described by the study participants (self-employed workers) appeared to support a variety of functions, serving as learning spaces, business tools, and/or support mechanisms, as well as forms of entertainment or diversion. Most participants commented that participating in these online spaces helped them feel less isolated, gave them opportunities to help others, and/or provided a sounding board to see if what they were thinking was on track. At the same time, the study revealed numerous challenges to the users of these online spaces: protecting privacy, managing reputation, figuring out where to go, assessing relevancy and credibility of people and resources, protecting intellectual property, and acting as both worker and learner in the same space. Thus, the findings highlighted the complexity of the concept of 'online community' and the fluid and sometimes contradictory use of these spaces for work-related learning. At the same time, the study has indicated that a more personal learning environment might better support sustainable work–learning practices through a network of targeted people, services, and resources.

Learning through computer networks and exploring the possibility that taking an online course could provide students with lifelong learning skills were the subjects of Morrison's (2010) small-scale study of undergraduate students who had previously had an online learning experience. The findings revealed the students' conservative understanding of learning in computer networks, so it appears that students need to be educated about the role that technology can play in learning so that they can use online networks in novel ways (and beyond requirements of a formal course). Morrison's research also suggests that students need to consider learning as continuous participation and creation, this view being well aligned with the notion that computer networks provide an ideal environment for lifelong learning through connections with other users.

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Using a laptop in class can enhance the potential for learning from lectures, but it can also increase the risk of digital distractions. Based on a four-year in-depth ethnographic study at Swedish IT-university (including 1200 hours of field observations plus data from interviews with students and instructors), Lindroth and Bergquist (2010) portrayed a typical 'laptoper[6]' and proposed that "it is not the case that the laptop either supports learning or disturbs it, it may support learning at different levels" (p. 313). To this end, they advised instructors to involve students in the course design process and to minimize any classroom distractions they had control over, such as noisy fans and blinking lights. The students, on the other hand, were advised to develop their digital competencies by (a) creating a culture of learning with explicit rules of appropriate and responsible behaviour, (b) controlling for distractions during the lecture, and (c) learning to use various Web 2.0 tools (e.g., wikis, mind-mapping software, online forums).

A study conducted by Bennett et al. (2012) among students from three universities in Australia confirmed the potential learning benefits from the effective use of Web 2.0, particularly through student content-creation and content-sharing. The activities involved student-generated digital photo archives in chemistry, biology, and environmental education classes (organized as a collaborative work, with varied success and some technological and organizational issues). Other activities involved using blogging in journalism and education classes and using wikis in psychology class, although students did not always see the connection to the curriculum and did not collaborate efficiently during the online writing activities. The cases reported by the authors suggested that the students were not familiar with Web 2.0 tools and that there was an inherent misalignment between the Web 2.0 concept and traditional educational practices. The students looked to traditional norms that included individual assessment and clear relationship between the assignment and learning outcomes, while the novel Web 2.0 activities emphasized voluntary contribution and group work. The results from this study reinforce the notion that while Web 2.0 is a reality, Education 2.0 is an aspiration (Noss, 2008) and highlight the importance of convincing students (and educators) that competencies related to the effective use of Web 2.0—lifelong learning in collaboration with others, creativity, and adaptability—are very much the competencies required by 21st century employers. Those who fail to develop such competencies may very well diminish their chances for success in the Digital Era, and thus join the groups that genuinely lack opportunities due to the digital divide.

3.4.4 Exemplary participatory activities and alternative solutions in cases where access is limited.

As pointed out by Chen and Wellman (2003), the digital divide has multiple faces and thus should be termed "digital divides" (p. 3). To properly address these divides, several aspects of access to technology should be considered: physical access, financial access, cognitive access, content access, and political access (Wilson & Wilson, 2000). Cuneo (2002) lists 12 aspects of the digital divide: demographics (e.g., computer to person ratio), age, gender, geography (i.e., where one lives, infrastructure), the individual's disposition to ICT (e.g., fear, lack of confidence), form of learning (e.g., traditional, online), disabilities (e.g., physical), and economic, social, labour-related, cultural, and political factors. The author posits that "education is at the heart of the Internet and the Digital Divide because of the importance to society of transmitting information and knowledge" (p. 25). Van Dijk (2006), for his part, summed up his review of studies conducted between 2000 and 2005 on the digital divide by arguing that in developing

[6]Lindroth and Bergquist (2010) refer to "the student and a laptop as laptoper and [to the] associated activities as laptoping" (p. 311). By so doing they emphasize mediation between the subject of activity (i.e., the student) and a tool (i.e., technology).

countries, physical access seems not to be an issue, while in terms of "digital skills and the use of applications, the divide persists or widens" (p. 221).

Zhong (2011) analyzed two sets of PISA (Program for International Student Assessment) data: one from 2003 that comprised 3503 schools and 61,781 adolescents (on average 16 years old, with an almost equal split between boys and girls), and the other from 2006, with 3949 schools and 87,562 adolescents with demographics similar to the first cohort. The author noted a generally negative relationship between the ICT penetration rate in a country and that country's adolescents' self-reported digital skills. He also noted that as the students' access to ICTs (both at home and in school) increased over time, their reliance on school ICT facilities decreased. In fact, in countries with high ICT penetration rates, Zhong found that students generally tended to have more advanced and accessible ICTs at home than in school.

Several studies have provided us with examples showing that availability of digital technologies per se does not necessarily promote fairness and digital equality between individuals, groups, and societies. For example, Boyd (2007) argued that Facebook members, the so-called "hegemonic teens," represented primarily the middle and upper-middle class, whereas MySpace members, the so-called "subaltern teens," came from mixed-class or lower-class backgrounds (p. 41).

It is also worth noting that minority groups and indigenous peoples in Canada still use the Internet primarily for community building and for access to alternative viewpoints that may not have found a place in mainstream media (Budka, Bell, & Fiser, 2009), and this may exacerbate their self-exclusion from the mainstream societies in which they reside (Landzelius, 2002). At the same time, when used for "an exchange of culture, creativity, and experience between non-Indigenous and Indigenous young people" (Rekhari, 2009, p. 179), online space can provide opportunities for self-determination and empowerment of young Aboriginal people (Singleton, Rola-Rubzen, Muir, Muir, & McGreggor, 2009).

Other groups that may need special attention and help to become fully integrated in a digital world are the elderly, who are often reluctant to use social networks for learning and self-expression for fear of security threats (Martin, 2007), and women.

Including the elderly. The elderly would not seem to be considered an important target population in terms of developing the digital skills of a country's workforce, but national statistics in Canada, US, and the EU warn that the developed world's population is aging and that the expertise of the elderly should not be undervalued. Retirees may serve as excellent and dedicated consultants and mentors, and keeping them in touch with the newly employed, start-up businesses, or educational institutions can have multiple benefits (Farhan, 2012). Martin (2007) found that helping the elderly attain digital literacy addresses three major social challenges: (a) empowering senior citizens by presenting them as productive and independent citizens; (b) easing seniors' economic needs; and (c) narrowing a generation gap widened by the proliferation of technology among the young. Martin referred to organizations such as the UK's University of the Third Age, as well as public libraries and other public spaces with access to digital technology, which can provide informal learning opportunities and special courses for the elderly that support their digital literacy development in a small-class environment.

De Koning and Gelderblom (2006; as given in Bunker, 2010) studied ways in which older workers in the printing and wholesale trades used ICT and the problems they had with its use. The older workers were able to compensate to some extent for their lack of skill with ICT through their knowledge and experience within the industry. The authors also suggested that learning ability is related more to

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formal-education level than to age and that the investment in training older workers could well pay off for their company because such employees would be less likely to quit.

Bunker (2010) details the advantages to organizations in undertaking programs to develop ICT competencies in older workers, including: (a) standardizing skills and reducing calls to the IT department, (b) increasing efficiency so that more time can be dedicated to critical tasks, (c) improving life skills beyond the skills needed for the job, (d) increasing motivation among workers, and (e) retaining more workers after in-house retraining.

Including women. Recently, Kuo, Tseng, Lin, and Tang (2013) reported the results of the longitudinal intervention, Taiwan Women Up (TWU), aimed at improving the digital literacy of middle-aged and older females in Taiwan. In only four years, more than 5500 females had completed the TWU training. For this study, Kuo et al. surveyed 133 females who were taking the TWU classes and found that about 80% of them had computers at home that they never or rarely used. The authors found that with sufficient social support, female learners can manage to build up their computer self-efficacy, persevere with ICT learning, and enhance their subjective well-being. In fact, the study reported that ICT utilization already plays an important role in the well-being of middle-aged and older women just starting to learn and use these technologies. These women valued social connections and relationships and cared for each other, and thus were motivated to gain ICT skills that have helped them to connect with others over the Internet and to extend their personal networks into cyberspace, a sure method for sustaining their ICT usage and improving their sense of well-being.

Working with contingent/temporary workers—primarily immigrant women—in Toronto, Rawlings (2011) discovered that the ICT training these women had previously been given did not meet their expectations. The women still felt socially excluded as low-paid contingent workers and "as inferior persons within their own homes" (p. 97). Rawlings proposed methods for organizing alternative training of vulnerable groups: that is, training that would listen to their voices and help them work towards enhancing their social capital. She further recommended that (a) the curriculum of such programs be holistic, incorporating elements of social awareness and EAL (English as Additional Language) education; (b) the teachers be culturally sensitive; and (c) that drop-in centres be made available for those who might require further support.

Including rural populations. Many authors have stressed the urgent need for a comprehensive government technology policy aimed at narrowing the digital divide in its various incarnations (e.g., the rural–urban knowledge divide). Chen and Liu (2013) pointed to both the rural–urban gap and the imbalance in allocation of educational resources as two of the major contributors to the digital divide. Their study found that limited access to digital teaching materials and online learning due to licence restrictions, copyright issues, and the high cost of information sources negatively affected small, often rural and remote communities. They have proposed a policy with two overarching goals: (a) to authorize teachers to use copyrighted material for pedagogical purposes; and (b) to provide financial help from the government to rural students and residents to help them in obtaining access to licensed digital resources.

Including prison inmates. The availability of digital technology has affected educational outreach to traditionally hard-to-reach populations. The British government's Department for Business, Innovation & Skills (BIS) reported plans to establish a virtual educational campus across the British prison system (BIS, 2011). An agreement was brokered between several British government bodies (i.e., BIS, the Ministry of Justice, and the Minister of State for Further Education, Skills and Lifelong Learning) to engage businesses, career advisers, and training providers to work together to help increase inmates'

employability upon their release from prison. Online education would enhance the skills of inmates, better match them to labour market needs, and increase their prospects of finding and holding a job, thus enhancing their chances of reintegrating into society. Using technology to learn was seen as an essential strategy for ex-offenders who could, after their release, continue to use the virtual campus through simple Web access. Post-release engagement with ICT through updating online resumes would allow and encourage offenders to continue to hone the skills and employment activity they started to develop while in custody. Particular attention would be paid to the needs of women, inmates close to finishing their sentence, and young offenders transferring to adult detention.

Increasing access and skills. Some countries, such as Estonia, Finland, France, Greece, and Spain[7] have recognized Internet access as a human right (European Commission, 2012). The latest initiative of the US administration for expanding broadband access in schools nationwide (The White House, 2013) opens opportunities for reaching out to technologically disadvantaged communities, while a model based on 2001–2009 data, developed by Kyriakidou, Michalakelis, and Sphicopoulos (2011), predicts that by 2018, European countries will all have the same percentage of broadband users in their countries. Wireless networks and small affordable computers with operating systems based on open-source software (such as MIT's "$100 laptop" initiative) promise to make computers not only potentially but actually ubiquitous, thus resolving the issue of access—the first digital divide.

Improving the digital literacy competencies of all citizens so that digital technologies are used meaningfully in work, education, and everyday life activities (Collin & Karsenti, 2013) is the crux of addressing the issues of skill—the second digital divide. So-called 'user empowerment' is the first priority of the Strategic Plan i2010 (European Commission, 2010) for facilitating the transition to what the plan refers to as 'eGovernment' service in Europe. This initiative involves (a) a harmonization of eGovernment services among member countries of the EU; (b) more flexible, personalized, and transparent online transactions: and (c) use of Web 2.0 tools to engage businesses, citizens, and community groups in the design and production of public services.

Digital literacy is an essential life skill, and lacking it can not only limit a person's prosperity and integration into society but can also have economic, social, and political consequences for the affected individuals and groups (Commission of the European Communities, 2007). The Commission has developed the 'European i2010 initiative on e-Inclusion - to be part of the information society,' with goals to (a) bridge the digital availability, accessibility, affordability, and ability gaps (e.g., provide affordable, high-speed ICT products; educate the population about information security and privacy protection; increase digital competencies); (b) stimulate and enable inclusive ICT as a viable and thriving business (i.e., develop accessible digital TV and a 'total conversation' approach so that all citizens can use services such as e-health and e-government); and (c) develop and implement coherent and efficient policies and legislation (e.g., providing multilingual and adapted content so that young people at risk of exclusion, migrants, and cultural minorities might be engaged; supporting 'ICT for active ageing' and workplace programs). To improve skills among EU citizens, the Commission supports a number of initiatives, including: (a) 'Get Online Week' and 'e-Skills Week'; (b) announcing a digital champion in each member country; (c) supporting educational initiatives, such as 'Creative Classrooms' and 'Open Educational Resources'; (d) recognizing digital literacy as a priority in the European Social Fund (2014–

[7]The following percentages of the households without Internet access reported lack of digital skills as the main reason: Cyprus (64%), Estonia (66%), Latvia (57%), Portugal (69%), Slovenia (63%), and Slovakia (49%). Between 2006 and 2011, lack of skills as a reason for not having Internet access increased by six percentage points and was the second most important reason after a lack of interest (European Commission, 2012).

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2020); and (e) alerting the population about the employment potential of ICT through the 'Towards a job-rich recovery' (Employment Package) program (European Commission, 2012).

The benefits of addressing the digital needs of different population segments were identified in the EU e-Inclusion planning. Individuals with a low level of education could increase their employability and access to e-learning through increased ICT competency. Older citizens could not only remain at jobs that required new skills and could also benefit from being socially and intellectually more active. The physically impaired could become more employable through ICT training as well as being more socially involved via the digital world. And groups disadvantaged because of poverty, citizenship, gender, or employment status could increase their chances to get a job, continue with learning, access resources, and lower the barriers to inclusion.

Bunker (2010) summarizes several key factors in delivering programs for ICT competency to population segments with specific needs, stating that: (a) programs need to be customized to match needs (e.g., with the retired elderly population, one-to-one training may work best, while with unemployed youth, training programs in youth centres may work best), skill level, and the circumstances of the target population; (b) particular care must be taken to achieve a buy-in from the target group by demonstrating to them the benefits of obtaining more ICT skills; and (c) such initiatives are best done in cooperation with some liaison group (e.g., youth, immigrant, community centre for women). Bunker highlighted the following initiatives as successful:

(1) European or International Computer Drivers Licence (ICDL/ECDL, ECDL Foundation, n.d.) is a digital literacy qualification program offered in 150 countries and in a number of local languages (e.g., in Arabic). The program so far has had over 12 million participants and is the gold standard for digital literacy (e.g., used for up-skilling the South African ex-offenders; a state standard in some Arabic countries; used in Malaysia for training and certifying local SME employees; part of vocational training programs in some Korean universities). To achieve a minimum level of digital literacy and be granted an ECDL/ICDL certificate, modules 2 (Using the Computer and Managing Files), 3 (Word Processing), and 7 (Web Browsing and Communication) are compulsory and any four additional modules may be added. Out of thirteen modules, the first seven are offered in all countries.

(2) In Canada (ICDL Canada, n.d.), the basic ICDL program is called *e-Citizen*, and it develops skills in essential computer and Internet use, including the use of online resources covering news, government, consumer information, travel, education/training, employment, health, and business. For ICDL Core certification, one has to take any four out of seven modules: Concepts of Information Technology, Using the Computer and Managing Files, Word Processing, Spreadsheets, Database, Presentation, and Information and Communications. ICDL Expert/Advanced certification consists of four modules: Advanced Word Processing, Advanced Spreadsheets, Advanced Database, and Advanced Presentation.

(3) The Internet and Computing Core Certification (IC³, Certiport, n.d.) program advertises itself as the "most up-to-date and globally recognized digital literacy certification available," suitable for obtaining "the foundation skills needed to excel in virtually all career fields and academic pursuits requiring computer and Internet applications." The program has three components: Computing Fundamentals (covering the foundations of computing: computer hardware, peripherals, troubleshooting, how software and hardware work together, how an operating system works and how to manage it); Key Applications (covering both common and program-specific aspects of popular word processing, spreadsheet, and presentation applications); and Living Online (covering skills for working in computer networks, including the Internet).

(4) Microsoft's Digital Literacy curriculum (Microsoft, n.d.) offers three levels of courses: the basic-level 'First Course Toward Digital Literacy' (an introduction to using a mouse and a keyboard, the importance of ICT in society); the Standard curriculum consisting of five courses (computer basics, using the Internet, productivity programs, security and privacy, and digital lifestyles), and the Advanced curriculum consisting of four courses (creating an e-mail account, writing a resume, searching the Internet, and social networking).

Critics caution that even existing ICT training programs can further reproduce inequality by providing only basic skills to some socioeconomic groups (Kvasny, 2009). According to Roberts (2004), it is wrong to assume that those who are disadvantaged would stop being such if they were equipped with digital skills for low-paying jobs in the new economy; in this case, despite ICT training, they might well remain without opportunity for upward mobility (Rawlings, 2011). In her analysis of the digital workforce divide, Rodino-Colocino (2006) cautions that one should not think that the "newest technology and acquisition of technical skills provide passage out of low-wage, temporary work" (p. 504). The problem is that "the digital divide exists in the labour market [; it is embedded] in the hiring practices" and it cannot be resolved without "broader social change" (p. 504).

1.5 Additional Resources (For the Target Audiences)

1.5.1 For provincial ministries of education, labour, training, and colleges and universities:

Clement, H. T., & Pannekoek, F. (2010). Athabasca University's Submission to Digital Economy Strategy Consultation Process. Retrieved from http://www.ic.gc.ca/eic/site/028.nsf/eng/00291.html

Bacsich, P., Harrop, H., & Lackovic, N. (2010). Technology Enhanced Learning: addressing the gap between aspiration and implementation: International issues. Coventry: Becta. Retrieved from http://www.scribd.com/doc/39810407/Technology-Enhanced-Learning-addressing-the-gap-between-aspiration-and-implementation-International-issues.

Bakia, M., Murphy, R., Anderson, K., & Trinidad, G. E. (2011). International experiences with technology in education: Final report. Washington, DC: US Department of Education, Office of Educational Technology. Retrieved from http://www2.ed.gov/about/offices/list/os/technology/iete-full-report.doc

Hobbs, R. (2010). Digital and Media Literacy: A Plan of Action. A White Paper on the Digital and Media Literacy Recommendations of the Knight Commission on the Information Needs of Communities in a Democracy (pp. i–xiv;15–67). Retrieved from http://files.eric.ed.gov/fulltext/ED523244.pdf

Margalef G., L., & Pareja R., N. (2008). Innovation, research and professional development in higher education: Learning from our own experience. *Teaching and Teacher Education*, *24*(1), 104–116.

Martin, S., & Vallance, M. (2008). The impact of synchronous inter-networked teacher training in information and communication technology integration. *Computers & Education*, *51*(1), 34–53.

Moyle, K. (2010). Building innovation: Learning with technologies. *Australian Education Review*, *56*. Retrieved from http://research.acer.edu.au/aer/10/

Stepan, A. (2013). Massive Open Online Courses (MOOC) Disruptive Impact on Higher Education. (Unpublished Master's Thesis). Simon Fraser University, Vancouver, BC. Retrieved from http://summit.sfu.ca/system/files/iritems1/13085/EMBA%202013%20Anita%20Stepan.pdf

WorkforceWindsorEssex. (2013). Tech is in our future: Talent for the ICT Sector in Windsor-Essex. Retrieved from http://www.workforcewindsoressex.com/parents_youth/tech-is-in-our-future-talent-for-the-ict-sector-in-windsor-essex/

WorkforceWindsorEssex. (2012). Promising Sectors and Occupations 2012-2015. Retrieved from http://www.workforcewindsoressex.com/parents_youth/promising-sectors-and-occupations-windsor-essex-2012-2015/

1.5.2 For federal government departments, such as the Ministry of Industry and the Ministry for Human Resources and Skills Development Canada:

de Fátima Goulão, M., & Fombona, J. (2012). Digital Literacy and adults learners' perception: The case of a second chance to University. *Procedia - Social and Behavioral Sciences*, *46*(2012), 350–355.

Franco, J. F., & Lopes, R. D. (2009). Three-dimensional digital environments and computer graphics influencing K-12 individuals' digital literacy development and interdisciplinary lifelong learning. Paper Presented at the ACM SIGGRAPH ASIA 2009 Educators Program. December 16–19, 2009. Yokohama, Japan.

Poore, M. (2011). Digital literacy: Human flourishing and collective intelligence in a knowledge society. *Australian Journal of Language & Literacy*, *34*(2), 20–26.

Taylor, A. (2011). Social media as a tool for inclusion. Prepared by Stiles Associates for Human Resources and Skills Development Canada. Retrieved from http://www.homelesshub.ca/ResourceFiles/Taylor_Social%20Media_feb2011%20(1)_1_2.pdf

Voogt, J., & Roblin, N. P. (2010). 21st Century Skills. Discussion paper prepared for Kennisnet. Retrieved from http://encore.oise.utoronto.ca/download/attachments/5374189/Voogt+Robin+21CS+2010.pdf

Williams, M., Hillage, J., Pinto, R., & Garrett, R. (2012). Sector skills insights: Digital and creative. UK Commission for Employment and Skills. Retrieved from http://www.ukces.org.uk/assets/ukces/docs/publications/evidence-report-49-digital.pdf

1.5.3 For the Citizenship and Immigration Canada:

Abel, G.J., Bijak, J., Wiśniowski, A., Findlay, A., & McCollum, D. (2011). Migration and global environmental change: MR8: Model specification and results of Bayesian forecasts of total and environmental immigration to the United Kingdom, 2010–2060. Retrieved from http://www.esrc.ac.uk/my-esrc/grants/RES-625-28-0001/outputs/read/07fdcf7e-2ca7-43c7-8057-3c85ae222866

Busch, T. (2011). Capabilities in, capabilities out: Overcoming digital divides by promoting corporate citizenship and fair ICT. *Ethics and Information Technology*, *13*(4), 339-353.

Ennals, R., Stratton, L., Moujahid, N., & Kovela, S. (2009). Global information technology and global citizenship education. *AI & Society*, *23*(1), 61–68.

1.5.4 For the private sector industries and businesses, professional organizations, and unions:

Breen, M. (2010). Digital determinism: Culture industries in the USA-Australia free trade agreement. *New Media & Society*, *12*(4), 657–676.

Franco, J. F., & Lopes, R. D. (2009). Three-dimensional digital environments and computer graphics influencing K-12 individuals' digital literacy development and interdisciplinary lifelong learning, Paper Presented at the ACM SIGGRAPH ASIA 2009 Educators Program. December 16–19, 2009. Yokohama, Japan, 1–8.

Vaz, G. (2012). Integrating vocational education with academic education in Commonwealth open schools. Vancouver, BC: Commonwealth of Learning. Retrieved from http://www.col.org/PublicationDocuments/IntegratingVocationalEducationWithAcademic_COMOSA.pdf

Williams, M., Hillage, J., Pinto, R., Garrett, R. (2012). Sector skills insights: Digital and creative. UK Commission for Employment and Skills. Retrieved from http://www.ukces.org.uk/assets/ukces/docs/publications/evidence-report-49-digital.pdf

1.5.5 For the provincial ministries, such as the MCYS, as well as parent and community groups:

De Abreu, B. (2010). Changing technology = empowering students through media literacy education. *New Horizons in Education*, *58*(3), 26–33.

Ching-Chiu, L., & Bertram, C. B. (2013). Engaging youth in underserved communities through digital-mediated arts learning experiences for community inquiry. *Studies in Art Education*, *54*(4), 335.

Franco, J. F., & Lopes, R. D. (2009). Three-dimensional digital environments and computer graphics influencing K-12 individuals' digital literacy development and interdisciplinary lifelong learning. Paper Presented at the ACM SIGGRAPH ASIA 2009 Educators Program. December 16–19, 2009. Yokohama, Japan, 1–8.

Gormley, K., & McDermott, P. (2013). Integrating the digital literacies into an after-school program: A structural analysis of teachers' lessons. *The Language and Literacy Spectrum*, *23*, 20-33. Retrieved from http://files.eric.ed.gov/fulltext/EJ1005283.pdf

Hobbs, R. (2010). Digital and media literacy: A plan of action. A White Paper on the Digital and Media Literacy Recommendations of the Knight Commission on the Information Needs of Communities in a Democracy (p. i–xiv; p. 15–67). Retrieved from http://files.eric.ed.gov/fulltext/ED523244.pdf

Premier's Technology Council. (2010). A Vision for Education in the 21st Century. Retrieved from http://www.gov.bc.ca/premier/attachments/PTC_vision%20for_education.pdf

Schnellert, G., & Keengwe, J. (2012). Digital technology integration in American public schools. *International Journal of Information and Communication Technology Education*, *8*(1), 36–44.

1.5.6 For the programs, such as Making Ontario Accessible (The Ministry of Economic Development and Trade):

Hsieh, J. J. P., & Rai, A. (2011). Addressing digital inequality for the socioeconomically disadvantaged through government initiatives: Forms of capital that affect ICT utilization. *Information Systems Research*, *22*(2), 233–253.

McPherson, T. (2008). A rule set for the future. *Digital youth, innovation, and the unexpected*. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press.

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education*, *34*, 179–225.

1.5.7 For the postsecondary institutions and private sector-public alliances:

Bacsich, P., Harrop, H., & Lackovic, N. (2010). Technology enhanced learning: Addressing the gap between aspiration and implementation. International issues. Retrieved from http://www.lsri.nottingham.ac.uk/captial/Yr2/SummaryReports/50—D2-international.pdf

Bentley, Y., Selassie, H., & Shegunshi, A. (2012). Design and evaluation of student-focused elearning. *Electronic Journal of e-Learning*, *10*(1), 1–12.

Burgess, M. L., Price, D. P., & Caverly, D. C. (2012). Digital literacies in multiuser virtual environments among college-level developmental readers. *Journal of College Reading and Learning*, *43*(1), 13–30.

Clement, H. T., & Pannekoek, F. (2010). Athabasca University's Submission to Digital Economy Strategy Consultation Process. Retrieved from http://www.ic.gc.ca/eic/site/028.nsf/eng/00291.html

1.5.8 For the researchers and research funding agencies:

Appel, M. (2012). Are heavy users of computer games and social media more computer literate? *Computers & Education*, *59*(4), 1339–1349.

Armellini, A., & Aiyegbayo, O. (2010). Learning design and assessment with e-tivities. *British Journal of Educational Technology*, *41*(6), 922–935.

Bennett, T. L. (2012). 21st century readiness skills for career and technical education. (Order No. 3535733, St. John's University (New York), School of Education and Human Services). ProQuest Dissertations and Theses, 140. Retrieved from http://search.proquest.com/docview/1287039989?accountid=14789.

Canty, D., Seery, N., & Phelan, P. (2012). The validity and value of peer assessment using adaptive comparative judgement in design driven practical education. *International Journal of Technology and Design Education*, *22*(2), 205–226.

King, M. M. (2012). Twenty first century teaching and learning: Are teachers prepared? (College of Saint Elizabeth). ProQuest Dissertations and Theses, 189. Retrieved from http://search.proquest.com/docview/928458354?accountid=14789.

Koh, E., & Lim, J. (2012). Using online collaboration applications for group assignments: The interplay between design and human characteristics. *Computers & Education*, *59*(2), 481–496.

Fetaji, B., & Fetaji, M. (2009). E-learning indicators: a multi-dimensional model for planning and evaluating e-learning software solutions. *Electronic Journal of e-Learning*, *7*(2), 1–28.

Fu, J., & Pow, J. (2011). Fostering digital literacy through web-based collaborative inquiry learning: A case study. *Journal of Information Technology Education*, *10*, 57–71.

McDowell Jr., F. H. (2013). Technology's impact on student engagement in urban schools: Administrators', teachers', and students' perspectives in urban schools. (Unpublished doctoral dissertation). Northeastern University, Boston, Massachusetts. Retrieved from http://hdl.handle.net/2047/d20003034

Moosa, L. (2010). An information technology adoption model for the rural socio-cultural context in developing countries. (Unpublished doctoral dissertation). University of Waterloo, Waterloo, ON.

Pierre, V. D. (2011). A study of the relationship between information literacy, online interactions, students' learning, and success in distance learning courses. (Unpublished doctoral dissertation). Louisiana State University, Baton Rouge, LA.

Vigdor, L. (2010). An intersectional reading of gender & technology. (Unpublished doctoral dissertation). University of Illinois, Urbana-Champaign, IL.

1.5.9 For all activity systems – moving from digital divide to digital inclusion:

Banister, S., & Fischer, J. (2010). Overcoming the digital divide: The story of an urban middle school. *Mid-Western Educational Researcher*, *23*(2), 2–9.

Lasen, M. (2010). Education and career pathways in Information Communication Technology: What are schoolgirls saying?. *Computers & Education*, *54*(4), 1117–1126.

Suarez, L. M. (2012). Influence of technology on the leadership of 21st-century career and technical education administrators. (Unpublished doctoral dissertation). Fordham University, Ann Arbor, MI. Retrieved from http://search.proquest.com/docview/1033501402?accountid=14789

Taylor, A. (2011). Social media as a tool for inclusion. Prepared by Stiles Associates for Human Resources and Skills Development Canada. Retrieved from http://www.homelesshub.ca/ResourceFiles/Taylor_Social%20Media_feb2011%20(1)_1_2.pdf

Wright, D., & Wadhwa, K. (2010). Mainstreaming the e-excluded in Europe: Strategies, good practices and some ethical issues. *Ethics and Information Technology*, *12*(2), 139–156.

1.6 Further Research & Research Gaps

The following gaps were identified in the literature:

1.6.1 *Lack of consensus over terminology.* Researchers from various disciplines have proposed their own terms to address the emerging features of digital technologies. Digital literacy, media literacy, and information technology literacy (Bawden, 2008; Digital Literacy Portal, 2000–2010; Media Awareness Network, 2010; National Educational Technology Plan, 2010; Northwest Territories Literacy Council, 2011; The Partnership for 21st Century Skills, 2009) seem to be the most popular terms currently. While each term represents a distinct concept, they do overlap and are often used interchangeably, which has created terminology overload. In addition, digital skills and digital competency are complex concepts, and there is no agreement as to: (a) what they consist of, (b) whether they should be considered self-contained skills or elements of other 21st century skills (e.g., being a team player, a good communicator, creative, a critical thinker), and (c) how they relate to each other (see Appendix D). Moreover, there exists a range of approaches to the concept of the digital divide, which some understand in the simple, binary sense (haves versus have-nots), while others propose a more complex approach (Eriksen, 2011).

1.6.2 *Gaps in implementation/practice.* Scholars are concerned that current pedagogies are inadequate to fully take advantage of technological affordances and to motivate students to use ICTs for learning. Indeed, pedagogies to promote technology use and to advance student self-direction into the use of digital technology for anything beyond entertainment are lacking (Dede, 2009). Assessing digital literacy is problematic, and there is a need to develop agreed-upon tasks to measure the level of digital literacy a person is at. If digital literacy is not about skills and competencies but instead about frame of mind, a number of questions need to be addressed: (a) how to effectively counteract the 'fun' image of technology that is promoted by the media and entertainment industry; (b) how to incorporate self-directed learning into modern education practices; (c) how to recognize and use informal learning opportunities as contributors to formal education practices; (d) how to coach individuals to take control over their own learning process and to take initiative for learning; and (e) how to educate youth to minimize digital distractions and to increase their meta-cognitive and self-regulative skills. Finally, training programs may be ineffective and may miss the target, giving rise to the following questions about what to do to ensure effective training programs: (a) Where (i.e., schools, workplace, online) are training programs likely to be more effective? (b) To what extent should such programs be government-regulated and/or -supported? (c) Whom should the government fund in terms of training (i.e., individuals who might want to receive such training; institutions receiving funding to offer such training)?

1.6.3 *Gaps in the research.* Finegold and Notabartolo's (2010) literature review suggests that while there is consensus among policymakers and researchers across the OECD on the key 21st century competencies, there is little evidence that these competencies transfer to worker and/or workplace outcomes (probably because of the lack of common standards and agreed-upon tasks to test these competencies). Attwell and Hughes (2010), for their part, point out a disconnect between the large number of studies that describe how young people are using digital technology and the dearth of research on the impact of

such technology on learning. Cook (2009) has suggested that if research studies are to inform practice, they should investigate situations in which e-learning should be used and ways that this could be done effectively. Moreover, more research is needed into the digital divide and ICT training; such studies should reflect the Canadian context and critically examine ways to help excluded or vulnerable population segments to become fully integrated technological citizens (Rawlings, 2011). Finally, data are lacking in the following areas: (a) how employers use technology to recruit and select employees; (b) how specific groups (e.g., the self-employed) keep technologically up-to-date, given their particular circumstances; and (c) to what extent informal activities (e.g., playing video games) transfer into workplace skills (de Hoyos et al., 2013).

1.6.4 *Methodological issues.* Because technology is rapidly changing (which also affects its use and the discourse around it), the relevance of current instruments (e.g., surveys) used in research into technology diminishes over time (Garland & Noyes, 2008). New research instruments will thus need to be developed and some of the old ones updated (Morris, Gullekson, Morse, & Popovich, 2009) or modified, both to address new work processes and to adjust for different terminology and cultural appropriateness (ay Çelik, 2010). Moreover, researchers should ensure that they are making meaningful comparisons in all technology-related research (Cook, 2005). Other issues that require addressing include: (a) the imbalance between the number of descriptive and position articles and the number of articles describing empirical studies (Periathiruvadi & Rinn, 2012); (b) the fact that ICT-related research is of variable quality and impact, with many studies being based on self-reported data and a shortage of studies based on performance data (Attwell & Hughes, 2010); and (c) the lack of clear frameworks that would allow for assessment of learning (Romani, 2009) and for determining how collaborative work in an online environment contributes to core versus specific skills.

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