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Defining Essential Digital Skills in the Canadian Workplace:

Final Report

"It is not just the ICT sector that needs people with these skills.
Almost every sector of the economy needs workers who have technical and digital skills"
"if we don't have the systems in place to develop ICT skills for the entire economy,
we're putting Canada's long-term prosperity at risk"
The Honourable Diane Finley, Minister of Human Resources and Skills development Canada, 2010

Submitted to:

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ABSTRACT

The purpose of this study was to develop a proposed digital skills framework for generic users of digital technology in the Canadian workplace. The research methods used to achieve this objective consisted of an analytical survey of the literature, and a key informant consultation. Insight gained from the literature review was used to develop a proposed digital skills framework for Canadian workers, which included four clusters: (1) foundational skills; (2) transversal skills; (3) technical digital skills; and (4) digital information processing skills. Key informants representing various economic sectors were requested to validate that framework and the embedded sub-sets of digital skills. Results indicated that the great majority of the key informants rated the proposed digital skills framework as useful and comprehensive. They also rated the digital skills clusters as either extremely important or important. Key informants' rating of the digital skills embedded in the four clusters showed variations in the perceived degree of importance, level of use, and workers' proficiency. The study also examined various procedures and tools in current use for assessing digital skills. Finally, complexity scales for rating workers' digital skills proficiency level were explored. Several recommendations for further research were made.

SEARCH TERMS

Digital skills, digital competence, digital literacy, ICT skills, ICT literacy, e-skills, computer literacy, information literacy, media literacy, technological literacy, literacy.

PROJECT DESCRIPTION

A proposed digital skill framework was developed for Canadian workers by amalgamating various skills concepts identified through a national and international review of literature and research: Digital skills, digital competence, digital literacy, ICT skills, ICT literacy, e-skills, computer literacy, information literacy, media literacy, technological literacy, literacy. The framework includes four skills clusters: (1) foundational skills; (2) transversal skills; (3) technical digital skills; and (4) digital information processing skills, including cognitive and metacognitive skills. Several sub-skills are also embedded within each skill cluster. The digital skills framework was validated by a group of key informants representing various economic sectors. An analytical survey of promising tools and procedures for assessing digital skills was performed and proposals for developing digital skills complexity rating scale were made. This study was funded by HRSDC and conducted by WDM-Consultants.

LIST OF ACRONYMS

UNESCO	United Nations Educational, Scientific and Cultural Organization
HRSDC	Human Resources and Skills Development Canada
ILO	International Labour Organization
OECD	Organization For Economic Cooperation And Development
EU	European Union
ICT	Information and Communication Technology
IT	Information Technology
PIAAC	Programme for the International Assessment for Adult Competencies
TOWES	Test of Workplace Essential Skills
ETS	Educational Testing Service

EXECUTIVE SUMMARY

The purpose of this study was to shed light on digital skill concepts and to develop and validate a digital skills framework for generic users of digital technology in the Canadian workplace. This work was done on behalf of Human Resources and Skills Development Canada (HRSDC), to support current efforts to update the department's Essential Skills Framework. The particular interest that guided this research was to re-examine the existing concept on "computer use" as one of the nine essential skills, to determine its continued relevance and to make the necessary adjustments in order to more fully reflect the changing skills needs of Canada's digital, knowledge-based economy. The goal of this study was achieved through the accomplishment of the following objectives:

- Provide an overview of the literature on essential digital skills (and related concepts), and the link between digital skills and other essential skills;
- Provide practical insights on the current essential digital skills issues and needs in Canada from the perspective of small and medium-sized enterprises (SMEs) based on employers' consultations;
- Propose a framework that describes the field of digital skills and defines the essential digital skills for work in Canada;
- Identify existing tools and procedures for assessing essential digital skills and related concepts; and
- Develop a new complexity-rating scale for digital skills.

The research methods used in this study consisted of an analytical survey of national and international literature, and a key informant consultation. Insight gained from the literature review was used to develop a proposed digital skills framework for Canadian workers. This framework and the digital skills embedded within, were validated by key informants (N=20) representing various sectors of the Canadian economy.

Results of the review of literature and research revealed that the ingreasing pre-eminence of China and India in the production of digital technology goods and services is becoming a global concern, especially at time when the digital economy appears to be the single most promising means to ease OECD countries out of the recession and create jobs to curve rising unemployment. Not surprisingly, almost all developed countries have implemented, or are in the process of implementing a digital economic strategy. There is a general agreement among world economists, that a digitally-skilled workforce is a pre-requisite for benefiting from the opportunities offered by the digital economy. A consensus is also emerging that prosperity from the digital economy will not only depend on specialists and advanced users of digital technology, but also on the contribution of all workers in general. However, research indicated that many workers in several OECD countries lack the basic digital skills readiness to effectively and efficiently contribute to the digital economy. Therefore there is an increased interest to ascertain that all workers possess the essential digital skills necessary to operate digital systems and tools for performing everyday job tasks. Digital skills development is currently the number one economic recovery policy in the great majority (15) of OECD Member States, and it also ranks number 6 in their long term economic policies. In addition to the interest in digital skills for economic gains, most countries' digital economic strategy also promotes digital skills development as a means to achieve social cohesion and inclusion.

With increased demands from the digital and information economy for processing large amount of information effectively and efficiently, people have gradually realized that working with digital systems and tools to perform most job tasks involve complex cognitive and metacognitive skills, over and above the basic ICT skills necessary for operating a computer. Concerns about the digital divide are now shifting to the digital-skills divide and to the cognitive skills divide. In spite of the widespread interest in digital skill, it is still an underdeveloped and under conceptualized concept which need the illumination of sound research.

Several countries have developed their national digital skills framework. An analytical survey of these digital skills frameworks revealed that in general the frameworks have essentially two overarching areas of emphasis: (1) technical digital skills; (2) and fluency in processing information. The most comprehensive and well-structured frameworks share some common skills concepts, notably: (1) Information literacy; (2) Digital technical skills; (3) Foundational skills; and (4) Cross-cutting or "transversal" skills. Therefore, the proposed Canadian digital skills framework was developed using these skills concepts. Various layers of sub-skills identified in the literature were also embedded within each digital skills concept.

The digital skills framework along with its sub-sets of embedded skills were validated by a group of key informants (N=20) representing various sectors of the Canadian economy. Results of the validation revealed that 80% or more of the key informants perceived that framework was useful and comprehensive. They also felt that all the digital skills clusters (foundational skills, transversal skills, use of digital systems and tools, applying security measures, and information processing skills) embedded in the framework were relevant, accurate and clearly defined. Approximately two-thirds of key informants rated several of the layers of skills included in each cluster as important: (1) use of digital systems and tools (10 out of 20 skills); (2) use of software applications (6 out of 19 skills); (3) application of security measures in digital environments (17 out of 21 skills); and (4) processing of digital information 24 out of 43 skills). Key informants' rating of the frequency of use of these skills at the workplace showed wide variation in the level of use across these various digital skills. The same observations were made with regard to perception of workers' proficiency in performing these skills. Key informants' ratings of all the skills embedded in the four digital skills clusters (use of digital systems and tools; use of software applications; application of security measures in digital environments; and processing of digital information) suggested that, to various degrees, all these skills legitimately belong to the digital framework. Key informants inputs suggested that Canadian workers are frequently applying important digital skills for which they may not be adequately proficient.

There are various approaches that can be used for assessing digital skills. However, in selecting one approach over another, consideration should be given to sustainability and conformity to evaluation standards. The European/International Computer Driving License (E/ICDL) is a European Union success story and a best practice with regards to the standardization, assessment and certification of digital skills.

Considering that several skills concepts converge to form digital skills, the HRSDC computer use complexity rating scale may not be appropriate for leveling technical digital skills and information processing skills. New complexity rating scales should be developed and validated for each digital skills cluster.

The following conclusions were reached. Digital skills are essential survival skills for the 21st century. A general consensus has emerged that digital skill is not merely about operating digital systems and tools, but that the concept involves more complex cognitive and metacognitive skills for processing different types of information quickly, effectively and efficiently. As a result, policy targeted to access and equity in digital technology cannot be limited to physical access, but must also focus on intellectual access. There is therefore an important need to ensure that all Canadians have the necessary cognitive literacy skills so that they can contribute to, and benefit from the digital economy. The proposed digital skills framework developed in this study was perceived to be relevant and useful by key informants. Canadian workers are frequently using the great majority of the skills embedded within the framework. However, there are also indications that proficiency levels may be lower than what they should be.

Recommendations made for further research include: launching a campaign for promoting the digital skills framework among key stakeholders; conducting further validation of the digital skills framework and the digital skills complexity rating scale; updating the Essential Skills occupational profiles to reflect the digital skills concept and scale;

investigating the cognitive and metacognitive skills which support the acquisition and efficient practice of digital skills; conduct research to inform cognitive skills augmentation in order to bridge emerging cognitive skills divide; and developing a standard to facilitate digital skills development and assessment.

KEY FINDINGS

Digital skills development is currently the number one economic recovery policy in the great majority (15) of OECD Member States, and it also ranks number 6 in their long term economic policies. Additionally, due to the increased demands from the knowledge-based economy for processing large amount of information effectively and efficiently, people have gradually realized that working with digital systems and tools to perform most job tasks involve complex cognitive and metacognitive skills, over and above the basic ICT skills for operating computers. An analytical and international survey of literature and research indicated that several countries have developed a national framework to facilitate digital skills development, assessment and certification in educational, training and workplace contexts. Examination of a cross-section of these frameworks revealed that most well-structured frameworks share some common skills concepts, notably: (1) Information literacy; (2) Digital technical skills; (3) Foundational skills; and (4) Cross-cutting or "transversal" skills.

The validation of the proposed Canadian digital skills framework developed during this study revealed that 80% or more of the key informants perceived that the framework was useful and comprehensive. They also felt that all the digital skills clusters (foundational skills, transversal skills, use of digital systems and tools, applying security measures, and informational processing skills) embedded in the framework were relevant, accurate and clearly defined. Approximately two-third of key informants rated several of the layers of skills included in each cluster as important: (1) use of digital systems and tools (10 out of 20 skills); (2) use of software applications (6 out of 19 skills); (3) application of security measures in digital environments (17 out of 21 skills); and (4) processing of digital information 24 out 43 skills). Key informants' rating of the frequency of use of these skills at the workplace showed wide variation in the level of use across these various digital skills. The same observations were made with regard to workers' proficiency in performing these skills. Key informants' ratings of all the skills embedded in the four digital skills clusters (use of digital systems and tools; use of software applications; application of security measures in digital environments; and processing of digital information) suggested that, to various degrees, all these skills legitimately belong to the digital framework. Key informants inputs suggested that Canadian workers are frequently applying important digital skills for which they may not be adequately proficient.

There are various approaches that can be used for assessing digital skills. However, in selecting one approach over another, consideration should be given to sustainability and conformity to evaluation standards. The European/International Computer Driving License (E/CDL) is a European Union success story and a best practice with regards to the standardization, assessment and certification of digital skills. It should be noted however, that the main emphasis of the assessment is on digital technical skills.

Considering that several skills concepts converge to form digital skills, the HRSDC computer use complexity rating scale may not be appropriate for leveling technical digital skills and information processing skills. New complexity rating scales should be developed and validated for each digital skills cluster.

INTRODUCTION

Small and medium-sized enterprises (SMEs) employing fewer than 500 employees represent close to 97 per cent of registered businesses and employ approximately 55 percent of Canada's labour force (The Conference Board of Canada, 2009). The competitiveness and productivity of SMEs can be attributed to synergistic effects of four types of capitals: natural resources, technology, human capital and social capital. Human capital is perceived as the most important of the four in the global knowledge-based economy (Gray, 2002). Based on renewed interest in the human capital theory, there is now a general consensus that a well-educated workforce is the key to competitiveness and prosperity (Saunders, 2009). The conclusion reached by the G20 leaders during the Toronto Summit was that a skilled workforce is essential to ensure a strong, sustainable and balanced growth (Government of Canada, 2010a), and they have therefore made a pledge to support robust training strategies (International Labour Office, 2010).

Before the economic down turn Canada was experiencing a steady economic growth that expanded the size of the labour force, increased the participation rate and reduced unemployment rates to 30-year lows (Expert Panel on Older Workers, 2008). Canada's economic success can be attributed to resilience in making timely and strategic large-scale economic and industrial restructuring in order to cope with increased global competition, technological advancement, trade liberalization, large fluctuations in the value of the Canadian dollar and energy costs, global economic recession, international outsourcing, offshoring of jobs; plant closing, workplace restructuring, production cutbacks, and shifting global consumer demand patterns (HRSDC, 1999), (OECD, 2005).

Now that Canada has weathered the worst of the economic crisis, the country must propel itself back on the trajectory to economic prosperity. The Government of Canada has recognized that the pathway to growth and prosperity must be in strategic alignment with the emerging paradigm shift of the global economy in which the control of knowledge is the competitive advantage and human resources and technical infrastructure are the main assets. Canada's success in becoming the most innovative, competitive, productive and prosperous nation resides in the ability to fully harness and exploit digital technologies, and we need: "a digitally skilled workforce to take advantage of the opportunities these technologies provide" (The Honourable Tony Clement, Minister of Industry, 2010, p. 1)[1]. It is also becoming increasing apparent that: "It is not just the ICT sector that needs people with these skills. Almost every sector of the economy needs workers who have technical and digital skills" (The Honourable Diane Finley Minister of Human Resources and Skills development Canada, 2010)[2]

Three landmark events were the precursors of the digital economy: (1) the invention of the microprocessor in 1971; (2) the introduction of the IBM personal computer (PC) in 1981; and (3) the commercialization of the Internet in 1994. The microprocessor switched the world from analog to digital mode. The term digital economy emerged from the observation that technological revolution has facilitated production of information goods, which can be digitized. Digital skills therefore are the competencies required for using digital systems and tools for producing these goods (van Baalen & Maratis, 2001). The technology revolution makes knowledge a competitive resource. Knowledge is not only beneficial to the well-being of the worker, but is also viewed as a major competitive advantage for a company and a key element to ensure the country's national prosperity and social development. Technology is said to be the driver of this new economy, but workers knowledge and skills are its fuels (Moe & Blodget, 2000).

Countries that were early adopters of the digital economic paradigm are already benefiting from the effects. According to a recent OECD report China has become the largest exporters of ICT goods, while India is now the

[1] Speaking Notes of a speech given by The Honourable Tony Clement in his capacity as Ministry of Industry at the Canadian Chapter of the International Institute of Communications' conference on November 22, 2011 in Ottawa: *An interim report on the digital economy and telecom strategy*. Retrieved from: http://www.ic.gc.ca/eic/site/ic1.nsf/eng/06098.html.

[2] Speaking Notes of a speech given by The Honourable Diane Finley in her capacity as Minister of Human Resources and Skills development Canada at the Canadian Chapter of the International Institute of Communications' conference on November 23, 2010 in Ottawa: *Connections, Content and Consumers: Towards a National Digital Strategy for Canada.* Retrieved from: http://news.gc.ca/web/article-eng.do?nid=576909.

largest exporter of ICT infrastructure and services (OECD, 2010)[3]. The e-skills UK Sector Skills Council noted that: "Digital technology is the single biggest lever for productivity and competitiveness across every sector of the economy" (e-skills UK Sector Council, 2009a, p. 5). Employers' survey conducted by the e-skills UK Sector Skills Council indicated that the great majority (77%) of workers were using digital technology to perform their everyday job tasks. This explains why these employers also reported that almost all (92%) new employees being hired must have at least some basic level of digital technology skills (e-skills UK Sector Council, ibid). It is anticipated that technology will be a key driver for job creation in western countries.

The imperative for Canada to embrace the digital economy was stated in the Speech from the Throne on March 3, 2010, and concrete action to create a national digital economic strategy was launched in May 2010 by a broad consultation of Canadians. The consultation paper on a Digital Economy Strategy for Canada defined digital technologies as: "tools, capacities or knowledge assets that can be embedded in business processes, products and services to help firms and individuals in all sectors of the economy become more productive, innovative and competitive" (Government of Canada, 2010b, p. 11). To be merely in possession of technical infrastructure (hardware and software) is by no means sufficient to provide a comparative advantage and to become competitive and succeed in the digital economy. Having a workforce that can lever these key assets effectively and efficiently is essential (Subramanian, 2005). Although Canada has a world-class education and training system, the economic prosperity which is helping Canadians to sustain a high standard of living may be at risk from poor adaptability of the workforce to new technology. The digital strategy consultation paper revealed that a substantial proportion of Canadian workers (40 percent) lack the basic literacy skills necessary to support the adoption of technology and effectively contribute to our growth in productivity and competitiveness in world trades (Government of Canada, 2010b). This skills gap can have serious implications for the Canadian economy: "if we don't have the systems in place to develop ICT skills for the entire economy, we're putting Canada's long-term prosperity at risk" (The Honourable Diane Finley Minister of Human Resources and Skills development Canada, 2010, p. 1).[4] Review of international trends also indicated that digital skills are now essential to support participation, inclusion, and innovation in a knowledge economy (Media Awareness Network, 2010).

The OECD Information Technology Outlook 2010 indicates ICT skills development is the number one economic recovery policy in the great majority (15) of OECD Member States, and ICT skills development also ranks number 6 in long term economic policies (OECD, 2010). The International Labour Conference of 2008 also concluded that skills development will be essential to address the opportunities and challenges and meet new demands of changing economies and new technologies in the context of globalization (International Labour Organization, 2008); and that a highly skilled workforce: "fuels innovation, productivity, increase in enterprise development, technological change, investment, diversification of the economy, and competitiveness that are needed to sustain and accelerate the creation of more and better jobs in the context of Decent Work Agenda, and improve social cohesion" (p.1-2).

While fully embracing training as a key driver for growth and development, the International Labour Conference Report nonetheless, cautioned against disjointed and uncoordinated skills development initiatives. According to this report, skills development initiatives must form an integral part of the national economic development strategy alongside of labour market policy, trade investment policy, macroeconomic policy, and technology policy (Figure 1). The ILO recommendation for collecting and disseminating information on current and future skills requirements and skills supply is also of relevance to this project.

[3] The OECD Information Technology Outlook of 2010 provides detailed analysis of issues and trends regarding the globalization of ICTs in national economies, and discusses recent market dynamics related to the shift in the production of ICT good and services to non-OECD countries, such as China and India. (OECD, 2010).

[4] Speaking Notes of a speech given by The Honourable Diane Finley in her capacity as Minister of Human Resources and Skills development Canada at the Canadian Chapter of the International Institute of Communications' conference on November 23, 2010 in Ottawa: Connections, Content and Consumers: Towards a National Digital Strategy for Canada. Retrieved from: http://news.gc.ca/web/article-eng.do?nid=576909.

Results of this study will undoubtedly be of significant importance to the elaboration of Canada's digital economy strategy. Additionally, review of the submissions made to the recent Government of Canada digital strategy consultation, revealed strong stakeholders support for digital skills research and development. This support is exemplified by the recommendation made by Dr. Elaine Soetaert, on behalf of the NorQuest College in Alberta:

> *"As the Conference Board of Canada developed the "employability skills" that drove curriculum development and learning in PSIs [post-secondary institutions] over the past 20 years, we now need a similar document which outlines the critical skills to be developed by Canadians to enable their engagement in the digital economy and knowledge society. What are the benchmarks for digital skills? Such a government developed and endorsed document would provide the evidence that PSIs need to create institutional outcomes based on those identified skills"* (Soetaert, 2010).

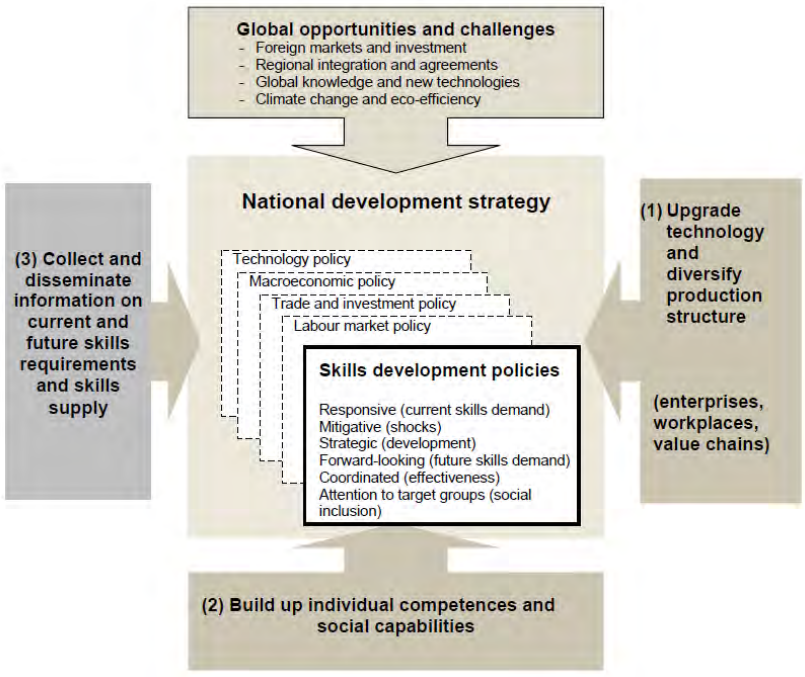


Figure 1, Skills development strategy for productivity, employment and sustainable development. Source: (International Labour Organization, 2008, p. 11).

The purpose of this study was to develop a more complete understanding of the essential digital skills required of workers in the context of the Canadian workplace. This goal was achieved through the accomplishment of the following objectives (HRSDC, 2010a):

- Provide an overview of the literature on essential digital skills (and related concepts), and the link between digital skills and other essential skills;
- Provide practical insights on the current essential digital skills issues and needs in Canada from the perspective of small and medium-sized enterprises (SMEs) based on employers' consultations;
- Propose a framework that describes the field of digital skills and defines the essential digital skills for work in Canada;
- Identify existing tools and procedures for assessing essential digital skills and related concepts; and
- Develop a new complexity-rating scale for digital skills.

METHODOLOGY

This study was structured into two distinct research stages, namely: (1) a review of literature and research and (2) key informants' consultation. Following is a brief description of each.

Stage I consisted of a review of pertinent Canadian and international literature across relevant disciplines, focusing on digital skills (and related concepts) required by workers to function in the labour market of today and in the knowledge economy generally. The literature and research publications reviewed were carefully selected in order to address the research objectives and answer the research questions formulated by HRSDC.

Relevant materials (government documents, research reports, technical reports, journal articles and other published materials) were accessed from specialized databases, the Internet and library facilities using key words searches. Because of the exploratory nature of this study the search was not restricted only to primary empirical research but also included practitioners' opinions, policy reports, and scholarly academic reviews.

Stage II consisted of an online consultation of Small and Medium-sized Enterprises (SMEs) (N = 20) drawn from various industry sectors across the country to validate the proposed Canadian Digital Skills Framework, its digital skills concepts and their definitions, and the skills components associated with these concepts. The survey questionnaire consisted of the following sections:

- Section 1 Assessment of the relevance, accuracy and clarity of the proposed Canadian Digital Skills Framework, its skills concepts and their definition;
- Section 2 Validation of the digital skills included in the proposed Canadian Digital Skills Framework in terms of their perceived degree of importance, frequency of use and workers' proficiency level;

Open-ended questions were also included in the survey to provide in depth qualitative insights about industry's perspective on digital skills in the Canadian workforce.

LITERATURE REVIEW

The first section of the literature review intended to provide a better understanding of the digital skills concept and its definitions as well as to ascertain the sub-set of skills which constitute its attributes. The second part of the review consists of an analytical survey of frameworks developed for operationalizing workers' skills related to the use of digital systems and tools, which can inform the development of a digital skills framework for Canadian workers.

Although digital literacy has been viewed as important since 1960, it is still an underdeveloped and under-conceptualized concept and its theorization still needs the illumination of sound research. This need has also been voiced by others: "the discourse on this important subject has been practice-oriented, and lacks a sound integrative framework and theoretical foundation" (Aviram & Eshet-Alkalai, 2006, p. 1). As a result there is an absence of a precise and generally accepted definition of the term.

Evolution of digital literacy

As digital technology becomes ubiquitous, workers will increasingly need an appropriate set of digital skills to access and process information using digital systems and tools. These skills will become as important as the ability to drive a car (Bawden, 2001). The prevalence of digital technology which gave people access to a vast amount of largely

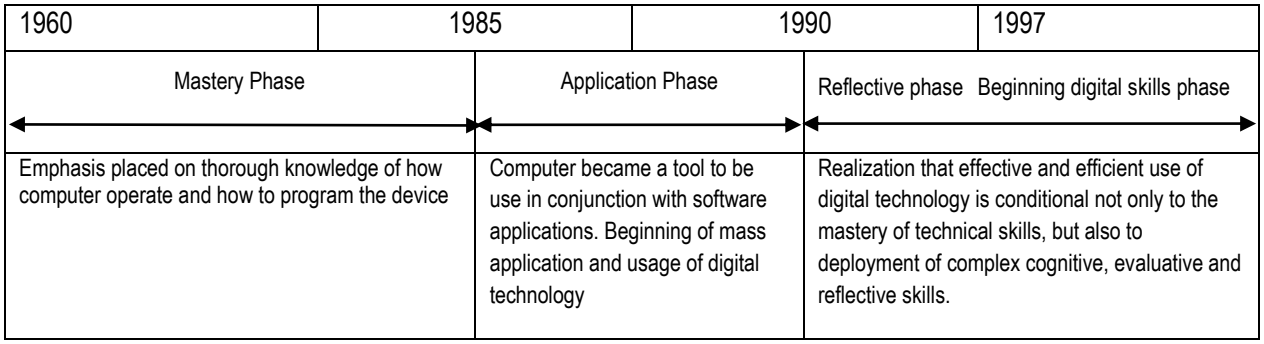
unfiltered information created a need for a set of skills to access, manage, integrate and evaluate information. The increasing use of digital technology to perform routine cognitive and manual tasks caused a fundamental shift in workers roles in the production of goods and services to tasks requiring more complex information processing, critical thinking and decision making that cannot be attributed to computers (Levy & Murnane, 2004). The information literacy concept grew out of this need for processing vast amount of information effectively and efficiently. The review of literature indicated that information literacy has been used in the literature since 1980, and gained widespread acceptance in 1990.

A systematic review of literature, ranging from 1980 to 1998, conducted to identify terminology used for describing the skills needed to use digital systems and tools revealed that the most frequently used term was computer literacy. Several terms are currently being used interchangeably by different authors and audiences (Junge & Hadjivassiliou, 2007) to define these skills although they may take different meanings in different contexts. The most common ones are: IT literacy, ICT literacy, digital literacy, digital competence, ICT fluency, computer literacy, ICT skills, e-Skills, technological literacy, media literacy, information literacy, eliteracy, generic skills, 21st century skills, multiliteracies, and new literacies.

The overlaps between the various literacy concepts can be explained by: "the evolution of literacies from a skills focus through an applications focus towards a concern with critique, reflection, and judgement, and the identification of generic cognitive abilities or processes, or meta-skills." (Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006, p. 253). Others (Jones-Kavalier & Flannigan, 2006) attributed the difference in terminology and the redundancies among the terms and their definitions to the newness of the phenomenon and to the paucity of research in digital literacy.

Digital literacy has evolved from the convergence of several concepts, including library literacy, information literacy and media (Bawden, 2001). Digital literacy also draws its roots from the earlier conception of computer or ICT literacy. Figure 2, shows the major phases of the evolution of digital skills and outlines the emphasis attributed to each phase. Over the years, digital skills have evolved towards greater emphasis on reflective rather than technical competence (Calvani, Fini, & Ranieri, 2008).

Figure 2, Digital skills timeline



Source: Adapted from: (Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006).

The term "digital literacy" has been used as early as 1990, to describe the skills associated in reading and understanding information presented in hypertext or multimedia formats, however, Glister's (1997) is credited with the widespread of use of the term which he described as the:

> ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers. The concept of literacy goes beyond simply being able to read; it has always meant the ability to read with meaning, and to understand. It is the fundamental act of cognition. Digital literacy likewise extends the boundaries of definition. It is cognition of what you see on the computer screen when you use the networked medium. It places demands upon you that were always present, though less visible, in the analog media of newspaper and TV. At the same time, it conjures up a new set of challenges that require you to approach networked computers without preconceptions. Not only must you acquire the skill of finding things, you must also acquire the ability to use these things in your life (Glister, Digital Literacy, 1997, pp. 1-2).

Gilster's also believed that the core skill of digital literacy was the critical thinking which supports the technical competence for using digital systems and tools (Martin & Grudzieck, 2006, p. 254). He also argued that digital literacy has to be seen as "an essential life skill - becoming as necessary as a driver's license" (Bawden, p. 21).

This lack of a consensus regarding the conception and definition of digital literacy is a source of considerable confusion. Some attempts are being made to standardize the definition of digital skills concepts, in the European Union, Australia, New Zealand, the United States and through the UNESCO`s Member states. However, digital skills concepts and their definitions need to remain fluid so that they can be constantly adapted to reflect emerging changes in digital technologies (Markauskaite, 2006). Figure 3, provides a brief review of the definition of the digital skills concepts that were of key interest for the development of a proposed framework for defining digital skills in the Canadian workplace.

Figure 3, Definition of key concepts

Concepts	Definitions	Sources
Literacy	well-versed in a particular subject, lettered, erudite, conversant, informed, widely-read, enlightened or well-grounded	(UNESCO, 2008, p. 53)
Literacy	the knowledge and skills that will enable citizens to function in an increasingly technological world.	(OECD, 2009a, p. 4 Annex B)
Literacy	a person's ability to effectively and creatively use and communicate information	(Jones-Kavalier & Flannigan, 2006, p. 9)
Basic or core literacies	learning how to read, how to write, and how to perform simple numeracy tasks necessary in everyday life.	(UNESCO, 2008, p. 4)
Computer literacy	the efficient ability to know how to use and operate computers as information processing machines. It is one half of the ICT literacies, the other half being Media Literacy.	(UNESCO, 2008, p. 5)
Computer literacy	the set of skills, attitudes and knowledge necessary to understand and operate the basic functions of information and communications technologies, including devices and tools	(UNESCO, 2008, p. 54)
ICT literacy	The Panel identified six processes that they see as critical components of ICT Literacy: … to access, manage, integrate and evaluate information, construct new knowledge and communicate with others ICT focus on new ways of learning, communicating and handling information	(OECD, 2009a, p. 13) (OECD, 2009a, p. 4 Annexe B)
ICT literacy	ICT literacy is the interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in society	(Van Joolingen, 2003, p. 5)
ICT literacy	Include critical cognitive skills such as reading, numeracy, critical	(OECD, 2009a, p. 5 Annexe

Figure 3, Definition of key concepts		
Concepts	**Definitions**	**Sources**
	thinking and problem solving and the integration of those skills with technical skills and knowledge.	B)
Information Literacy	Information Literacy encompasses knowledge of one's information concerns and needs, and the ability to identify, locate, evaluate, organize and effectively create, use and communicate information to address issues or problems at hand; it is a prerequisite for participating effectively in the Information Society, and is part of the basic human right of lifelong learning (Prague Declaration)	(UNESCO, 2003, p. 1); (UNESCO, 2008, p. 63)
Information Literacy	the set of skills, attitudes and knowledge necessary to know when information is needed to help solve a problem or make a decision, how to articulate that information need in searchable terms and language, then search efficiently for the information, retrieve it, interpret and understand it, organize it, evaluate its credibility and authenticity, assess its relevance, communicate it to others if necessary, then utilize it to accomplish bottom-line purposes; Information Literacy is closely allied to **learning to learn**, and to **critical thinking**	(UNESCO, 2008, p. 53)
Information Literacy	Recognizing an information need; Identifying what information will fulfill the need; Constructing strategies for locating information; Locating and accessing the information sought; Comparing and evaluating information obtained from different sources; Organizing, applying and communicating information; Synthesizing and building upon information)	(Martin & Grudziecki, 2006, p. 251)
Information Literacy	A mean to empower people in all walks of life to seek, evaluate, use and create information effectively to achieve their personal, social, occupational and educational goals.	(UNESCO, 2008, p. 65)
Digital competence	the confident and critical use of Information Society Technologies for work, leisure and communication … consisting of knowledge, skills and attitudes. … The terms 'competence' and 'key competence' are preferred to 'basic skills' which was considered too restrictive as it was generally taken to refer to basic literacy and numeracy and to what are known variously as 'survival' or 'life' skills. 'Competence' is considered to refer to a combination of skills, knowledge, aptitudes and attitudes, and to include the disposition to learn in addition to know-how.	(Martin & Grudziecki, 2006, p. 256)
Digital competence	An underpinning element in digital literacy… Digital literacy involves the successful usage of digital competence within life situations	(Martin & Grudziecki, 2006, p. 256)
Digital Literacy	Is the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers	(Gilster, 1997, p. 1)
Digital Literacy	The skills required to achieve digital competence, the confident and critical use of ICT for work, leisure, learning and communication	(European Ministerial e-Inclusion Conference, 2008 , p. 4)
Digital Literacy	the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers. The concept of literacy goes beyond simply being able to read; it has always meant the ability to read with meaning, and to understand. It is the fundamental act of cognition. Digital literacy likewise extends the boundaries of definition.	(Gilster, 1997, pp. 1, 2)
Digital Literacy	According to Gilster (1997) … digital literacy is about mastering ideas, not keystrokes … It is cognition of what you see on the computer screen when you use a network medium… Not only must you acquire the skill of finding things, you must also acquire the ability to use these things in your life. …	(Bawden, 2001, p. 21)

Figure 3, Definition of key concepts		
Concepts	**Definitions**	**Sources**
Digital Literacy	intellectual capacities	(European Commission: Directorate-General for Education and Culture, 2003, p. 21)
Digital Literacy	includes photo-visual literacy; reproduction literacy; branching literacy; information literacy; and socio-emotional literacy	(Eshet-Alkalai, 2004, p. 93)
Digital Literacy	the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyses and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process	(Martin & Grudziecki, 2006, p. 255)
Digital literacy	the ability to appreciate the potential of ICT to support innovation in industrial, business and creative processes. Learners need to gain the confidence, skills, and discrimination to adopt ICT in appropriate ways. Digital literacy is seen as a 'life skill' in the same way as literacy and numeracy.	(Martin & Grudziecki, 2006, p. 254)
Digital Literacy	the confident and critical use of Information Communication Technology (ICT) for work, leisure and communication. It is underpinned by basic ICT skills: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate via the Internet.	(Demunter, 2006, p. 2)
Media literacy	the set of skills, attitudes and knowledge necessary to understand and utilize various kinds of mediums and formats in which information is communicated from a sender to a receiver, such as images, sound, and video, and whether as a transaction between individuals, or as a mass transaction between a single sender and many receivers, or, vice-versa	(UNESCO, 2008, p. 54)
Media literacy	the knowledge needed to use old and new media technology to having a critical relationship to media content … media literacy implies having *access* to the media, *understanding* the media and *creating/expressing* oneself using the media	(UNESCO, 2008, p. 6)
Media literacy	Interdisciplinary by nature,… media literacy is seen to consist of a series of communication competencies, including the ability to access, analyze, evaluate and communicate information in a variety of forms including print and non-print messages.	(Martin & Grudziecki, 2006, p. 252)

The analysis of the above-named definitions revealed that digital skills consist of stratified and complex convergence of several key skills concepts. These skill concepts are: (a) basic literacy; (b) ICT literacy; (c) information literacy; and (d) media literacy.

Review of digital literacy frameworks

An objective of this study was to develop a proposed framework for the essential digital skills needed in the Canadian workforce on the basis of insights gained from an analytical review of national and international literature and research. This section provides an analysis of various frameworks reviewed to achieve that objective. Although several frameworks were reviewed, only those, which were more closely related to the study objectives, were reported in this section. These digital skills framework are from Australia, New Zealand, United Kingdom, and European Union, United States. The UNESCO framework was also included in the review to gain a broad international perspective of digital skills.

Australia: Digital literacy framework for the 21st century cybercitizen and e-employee

The Australian Communications and Media Authority has developed a digital literacy framework for the 21st century cybercitizen and e-employee (Figure 4). In the context of this framework digital literacy is defined as: "the skills and capabilities needed for effective participation in the digital economy and to encourage social inclusion in a networked economy" (Osborne, 2010, p. 1). Digital skills are viewed as "the tools needed now for a range of tasks in a person's professional and private life" (Smith & Anderson, 2010, p. 6). The focus is on technical digital skills, security skills and content creation skills. The framework is intended to inform digital skills competency development, assessment and certification and has a dual focus (1) helping Australians to become effective and confident 21st century cybercitizen in a digital economy; and (2) helping workers to become effective and confident e-employees in a digital economy. The theoretical orientation of this framework is focused on basic technical digital skills, and situated literacy perspectives.

Figure 4, Digital literacy framework for the 21st century cybercitizen and e-employee	
Skills Clusters	**Definitions**
Use	Use ICT infrastructure, devices to find content and services.
Understanding and Interpretation	Ability to understand and evaluate media content of various forms in order to judge the quality and trustworthiness of online information.
Creation and Participation	Ability to participate in social media and to generate digital content.
Customer Protection/Security	Understand cyber threats and be able to protect oneself against cyber crimes

Source: Adapted from: (Osborne, 2010).

Australia and New Zealand Information Literacy Framework

Australia and New Zealand share a common information literacy framework for their citizens (Figure 5). This framework draws its roots from the information literacy competency standards for higher education developed by the US, Association of Colleges and Research Libraries (ACRL). This framework has six digital literacy standards, which provide the organizational structure for the core informational literacy skills (Bundy, 2004); (Association of Colleges and Research Libraries, 2000).

The focus of this framework is on generic transversal skills (problem solving, collaborative and teamwork, communication and critical thinking); values and beliefs (smart, ethical, and responsible use of information), and information processing skills. This framework was developed to inform digital skills policy formulation, competency development, and assessment at all levels of education and training. The theoretical orientation of this framework is on situated literacy and cognitive and metacognitive skills perspectives.

Figure 5. Australia and New Zealand Information Literacy Framework	
Skills Clusters	**Definitions**
Standard One	Recognize the need for information and determine the nature and extent of the information needed
Standard Two	Find needed information effectively and efficiently
Standard Three	Critically evaluates information and information seeking process
Standard Four	Manage information collected or generated

Figure 5. Australia and New Zealand Information Literacy Framework	
Skills Clusters	**Definitions**
Standard Five	Apply prior and new information to construct new concepts or create new understanding
Standard Six	Use information with understanding and acknowledge cultural, ethical, economic, legal and social issues surrounding the use of information.

Source: (Bundy, 2004). Australian and New Zealand information literacy framework: Principles, standards and practice.

UK: ICT user digital skills framework

The United Kingdom has developed a national digital ICT skills framework for users of digital technologies. This framework has four main clusters: (1) Improving productivity using IT; (2) Using IT systems; (3) Using IT to find and exchange information; and (4) Use IT software applications (Figure 6). The UK Sector Council for Business and Information Technology has developed comprehensive National Occupational Standards and Information Technology Qualification (ITQ) structure for each of these digital skills clusters.

The framework sets out ICT user qualifications structures appropriate for England, Wales and Northern Ireland. An adapted version of the same framework is also used in Scotland. The framework is intended to facilitate the development of individuals' ICT user skills necessary to promote employability, social inclusion, participation in the e-economy and the capacity to benefit from online services. The theoretical orientation of this framework is on situated literacy and basic technical digital skills perspectives.

Figure 6. UK ICT user digital skills framework	
Skills Clusters	**Definitions**
Improving productivity using IT	Ability to plan, evaluate and improve the use of ICT to improve efficiency and productivity
Using IT systems	Ability to use ICT systems safely, securely, sensibly and purposefully to meet needs
Using IT to find and exchange information	Ability to access, search, retrieve and exchange information using ICT, using digital networks and communication systems
Use IT software applications	Ability to select and use software applications to process data and to produce and present information

Source: (e-skills UK Sector Skill Council, 2009b).

U.S.: Educational Testing Service ICT Literacy Framework

In 1992, Educational Testing Service (ETS) mandated an international panel of experts from Australia, Brazil, Canada, France, and the United States to examine the assessment of ICT literacy across countries. The Panel on ICT Literacy believed that more consideration should be given to the cognitive skills supporting the use of digital systems and tools: "Technology skills alone, without corresponding cognitive skills and general literacy, will not decrease the gaps defined by a digital divide" (Educational Testing Service, 2002, p. 6). Consequently, the panel proposed a reconceptualised ICT literacy paradigm, which included not only the ICT technical skills, but also complex cognitive skills as shown in Figure 7. This ICT literacy framework encapsulates three core ICT skills clusters: (1) technical proficiency; (2) cognitive proficiency; (3) ICT proficiency. The ICT concepts and their corresponding definitions have been used in the development of several other frameworks.

The focus of this framework is on information processing skills, foundational and transversal skills and digital technical skills. This framework was developed to inform digital skills competency development, assessment for K-12, post-secondary and higher education, 21st century cybercitizen workers in general. It can also be used for designing and conducting large-scale national and international comparability assessment of digital skills. The theoretical orientation of this framework is focused on multiple and situated literacy, and on cognitive and metacognitive skills perspectives.

Figure 7. Educational Testing Service ICT Literacy Framework	
Skills Clusters	**Definitions**
ICT Proficiency	The integration and application of cognitive and technical skills, which facilitates optimized use of digital tools to promote innovations, individual transformation and societal change
	Define: Use digital technology to identify information needs Access: Use digital technology to collect and/or retrieve information Manage: Organize and classify digital information Integrate: Interpret, summarize, compare and contrast digital information Evaluate: Judge the quality, relevance, usefulness or efficiency of digital information Create: Adapt and apply existing information to generate new knowledge Communicate: Use digital technology to exchange information with others
Cognitive Proficiency	Foundational skills including literacy, numeracy, problem solving and spatial/visual literacy
Technical Proficiency	Foundational knowledge of hardware, software applications and networks

Source: Adapted (Educational Testing Service, 2002) & (Education Testing Service, no date).

U.S.: California ICT Digital Literacy Framework

The Governor of California has enacted an ICT Digital Literacy Policy, which aimed to render all residents of the state digitally literate. Within the policy ICT literacy was defined as the ability to use: "digital technology, communication tools and/or networks to access, manage, integrate, evaluate, create and communicate information in order to function in a knowledge society" (California Emerging technology Fund, 2008, p. 5). California conducted an international review of digital literacy frameworks and the conclusion reached was that all international frameworks essentially shared some common skills concepts. The California ICT Digital Literacy Framework was developed on the basis of insights gained from this review and using these common skills concepts (Figure, 8). The elements, definitions, and competencies included in this framework are to be used for developing benchmarks, metrics, assessments and certifications of digital literacy skills of California's residents, students and workers (ibid). The theoretical orientation of this framework is focused explicitly on information processing and communication skills perspectives. The use of digital technology is implicitly assumed.

Figure 8. California ICT Digital Literacy Framework		
Elements	**Definitions**	**Competencies**
Access	Knowing about and knowing how to collect and/or retrieve information.	Search, find, and retrieve information in digital environment

Figure 8. California ICT Digital Literacy Framework		
Elements	**Definitions**	**Competencies**
Manage	Applying an existing organizational or classification scheme.	Conduct a rudimentary and preliminary organization of accessed information for retrieval and future application
Integrate	Interpreting and representing information - summarizing, comparing, and contrasting	Interpret and represent information by using ICT tools to synthesize, summarize, compare, and contrast information from multiple source
Evaluate	Making judgments about the quality, relevance, usefulness, or efficiency of information	Judge the currency, appropriateness, and adequacy of information and information sources for a specific purpose (including determining authority, bias, and timelines of materials).
Create	Generating information by adapting, applying, designing, inventing, or authoring information	Adapt, apply, design, or invent information in ICT environments (to describe an event, express an opinion, or support a basic argument, viewpoint or position)
Communicate	Communicating information persuasively to meet needs of various audiences through use of an appropriate medium	Communicate, adapt, and present information properly in its context (audience, media) in ICT environments and for a peer audience

Source: (California Emerging technology Fund, 2008, p. 3)

European Union: DigEuLit Digital Literacy Framework

The DigEuLit project was implemented to promote digital literacy in European countries. One of the project objectives was to develop a European framework for digital literacy. In this framework digital literacy was conceptualized as the successful application of digital competence in using digital systems, tools and resources to perform a specific task or solve a particular problem. This framework includes three level of digital literacy development, namely: (1) digital competence; (2) digital usage; and (3) digital transformation. Digital competence, which is the dimension of key interest for this project, was framed around thirteen processes as depicted in Figure 9 (Martin & Grudziecki, nd).

The DigEuLit framework consists of a definition, a generic structure and a set of tools designed to assist educators, trainers and learners to have a common understanding of digital literacy and how it can be integrated in education and training practices across the European Union. The priority is on the empowerment of learners with the essential digital skills to facilitate achievement of goals in the individual's life-situation. The framework has a theoretical orientation which is focused on information processing, cognitive and metacognitive skills perspectives.

Figure 9. Digital Competence	
Skills	**Definitions**
Statement	To state clearly the problem to be solved or task to be achieved and the actions likely to be required
Identification	To identify the digital resources required to solve a problem or achieve successful completion of a task
Locate	To locate and obtain the required digital resources
Evaluate	To assess the objectivity, accuracy and reliability of digital resources and their relevance to the problem or task
Interpretation	To understand the meaning conveyed by a digital resource
Organization	To organise and set out digital resources in a way that will enable the solution of the

Figure 9. Digital Competence	
Skills	**Definitions**
	problem or successful achievement of the task
Integration	To bring digital resources together in combinations relevant to the problem or task
Analysis	To examine digital resources using concepts and models which will enable solution of the problem or successful achievement of the task
Synthesis	To recombine digital resources in new ways which will enable solution of the problem or successful achievement of the task
Creation	To create new knowledge objects, units of information, media products or other digital outputs which will contribute to task achievement or problem solution
Communication	To interact with relevant others whilst dealing with the problem or task
Dissemination	To present the solutions or outputs to relevant others
Reflection	To consider the success of the problem-solving or task-achievement process, and to reflect upon one's own development as a digitally literate person

Source: (Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, nd, p. 257).

Netherlands: Internet Digital Skills Framework

Researchers Alexander van Deursen and Jan van Dijk have conducted a study for measuring the Internet digital skills among the Dutch population. Since they were unable to identify a suitable framework, which operationally defines the Internet digital skills, they had to develop their own framework (Figure 10). This framework encapsulates four skill clusters, namely: (1) operational skills; (2) formal skills; (3) informational skills; and (4) strategic skills. The theoretical orientation of this framework is focused on basic technical digital skills, cognitive and metacognitive skills and, situated literacy perspectives.

Figure 10, Netherlands Internet Digital Skills Framework	
Skills	**Definitions**
Operational skills	Skills to operate digital media
Formal skills	Skills to handle the structures of digital media
Informational skills	Skills to locate information in digital media
Strategic skills	Skills to employ the information contained in digital media towards personal (and professional) development

Source: (van Deursen & van Dijk, 2008), Measuring digital skills.

U.S. : Bloom's Digital Literacy Framework

Andrew Churches believed that the taxonomy of the cognitive domain developed by Benjamin Bloom in 1956, which was later revised by Lorin Anderson and David Krathwohl in the 1990s, had become inadequate to inform evaluation and assessment decisions, due to the increase use of ICTs for education and training purposes. He proposed a digitized version of Bloom's taxonomy, which can be viewed as a framework (Figure 11) for promoting digital skills development and assessment (Churches, 2009). This framework outlines the key concepts and their definitions from lower to higher order thinking skills.

Bloom's taxonomy was initially designed and developed for assessment and evaluation of education and training outcomes. Very often, Bloom`s taxonomy is improperly used for developing instruction. The theoretical orientation of this framework is focused exclusively on information processing, cognitive and metacognitive skills perspectives.

Figure 11. Bloom's Digital Literacy Framework

	HOTS: Higher Order Thinking Skills	Communication Spectrum
Key Concepts	**Definitions**	
Creating	Designing, constructing, planning, producing, inventing, devising, and making	Collaborating Moderating Negotiating Debating Commenting Networking Contributing
Evaluating	Checking, hypothesising, critiquing, experimenting, judging, testing, detecting, and monitoring	
Analysing	Comparing, organizing, deconstructing, attributing, outlining, finding, and structuring	
Understanding	Interpreting, summarizing, inferring, paraphrasing, classifying, comparing, explaining, and exemplifying	
Remembering	Recognizing, listing, describing, identifying, retrieving, naming, locating, and finding	
	LOTS: Lower Order Thinking Skills	

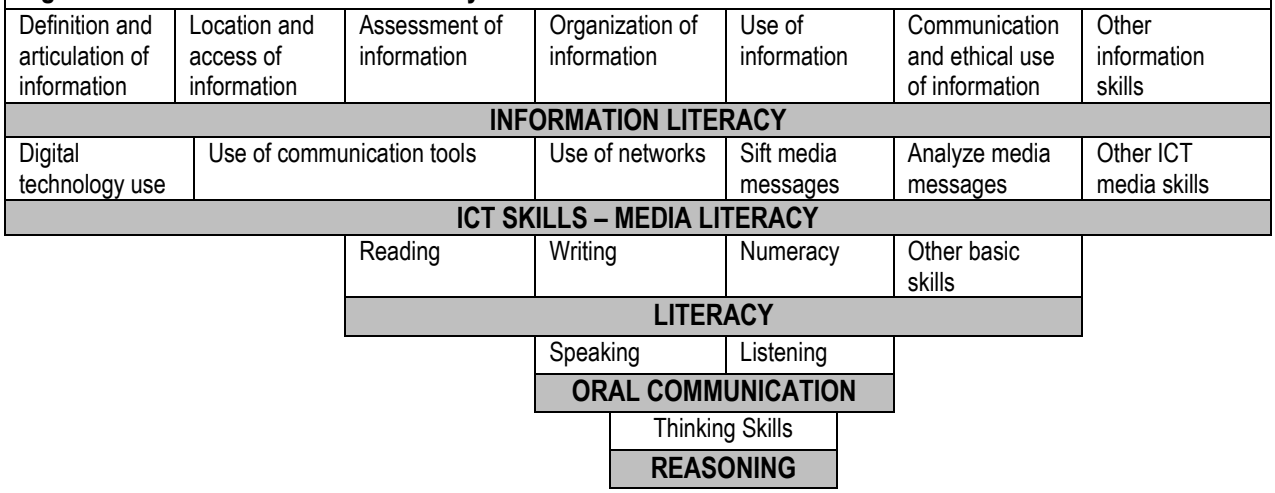
Source: Adapted from (Churches, 2009, p. 7)

UNESCO: Digital Literacy Framework

UNESCO has a mandate for promoting information literacy among its Member States. To monitor and measure progress toward information literacy development within Member states, UNESCO has developed an information literacy framework and appropriate information literacy indicators. Although UNESCO has labeled its framework "information literacy" a closer examination of the skills concepts embedded within clearly indicated that the true focus is on "digital literacy"(Figure 12).

The theoretical orientation of this framework is focused on basic technical digital skills, multiple literacies, cognitive and metacognitive skills and, situated literacy perspectives. The range of skills covered by this framework is very comprehensive and includes basic foundational skills, enabling transversal skills, communication skills, ICT/ media literacy skills, and information literacy skills. The framework is intended to facilitate the comparability of digital skills across UNESCO Member States. This framework can also be used to facilitate digital skills development, assessment, and certification for citizens, students, and workers.

Figure 12. UNESCO Information Literacy Framework



Source: Adapted form (Catts & Lau, 2008, p. 18). Towards information literacy indicators.

International: Digital Literacy: A conceptual framework for survival skills in the digital era

Eshet-Alkalai argued that "digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological and emotional skills, which users need in order to function effectively in digital environments" (Eshet-Alkalai, 2004, p. 93). The researcher proposed a digital skills framework involving five key skills concepts and the associated definitions (Figure 13). This framework is essentially a theoretical discussion and the focus is exclusively on information processing, cognitive and metacognitive perspectives. Nevertheless, it has important implications for practice.

Figure 13. Digital Literacy: A conceptual framework for survival skills in the digital era	
Photo-visual literacy:	Read, understand and use information displayed in visual and graphical formats
Reproduction literacy:	Create mew meanings from different pieces of information gleaned
Information literacy:	Make educated and smart use of information
Branching literacy:	Create knowledge with randomly acquired information
Socio-emotional literacy:	Share emotions by means of digital communication tools

Source: Adapted from (Eshet-Alkalai, 2004, p. 93)

This review of these digital skills frameworks indicated that these frameworks may have various theoretical perspectives, namely: (a) technical digital skills; (b) multiple literacies; (c) cognitive literacy; (d) metacognitive; and (e) situated literacy. Some frameworks have multiple theoretical perspectives, such as the one proposed by UNESCO. The most comprehensive frameworks have some common skills concepts embedded within, either implicitly or explicitly. Following are the key digital skills concepts identified during this review, which are of significance to the objective of the study:

- Information literacy — Determine information needs, access information, organize information, integrate information, assess information, apply information, create information and communicate information
- Digital technical skills — Use digital tools, use application software, and apply security measures in digital environments
- Foundational skills — Reading, writing, oral communication, and numeracy
- Cross-cutting of transversal digital skills — Thinking, problem-solving, learning, working with others

Digital skill frameworks are commonly implemented to inform policy formulation, digital skills competency development, assessment, and certifications for students, citizens and workers. They can also be used for designing and conducting large-scale national and international comparability assessment of digital skills.

ELABORATION OF A PROPOSED CANADIAN DIGITAL SKILLS FRAMEWORK

Although there are some important concepts that are being used nationally and internationally to frame ICT literacy, e-skills, digital literacy and information literacy, a suitable framework for digital skills, as the concept was operationalized for this study, could not be located. The HRSDC "Computer Use" essential skill framework captures only skills related to the use of computers and associated software. Although this framework was appropriate when it was initially developed, it needs to be update to reflect recent technological development and current thinking regarding digital skills in the workplace. A major criticism of digital skills frameworks relates to the narrow focus on the use of ICTs, and the disregard for the critical and complex cognitive skills necessary for processing information

effectively and efficiently in digital environments. This evolving tendency was captured in Paul Glister's definition of digital literacy, which emphasizes information processing skills instead of technical skills as core competence:

> the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers. The concept of literacy goes beyond simply being able to read; it has always meant the ability to read with meaning, and to understand. It is the fundamental act of cognition. Digital literacy likewise extends the boundaries of definition. It is cognition of what you see on the computer screen when you use the networked medium. It places demands upon you that were always present, though less visible, in the analog media of newspaper and TV. At the same time, it conjures up a new set of challenges that require you to approach networked computers without preconceptions. Not only must you acquire the skill of finding things, you must also acquire the ability to use these things in your life (Glister, Digital Literacy, 1997, pp. 1-2).

The discussion, which follows, intended to provide explanations justifying this conceptual shift in digital literacy, and an assessment of this shift for digital skills model building.

Conceptual shift towards cognitive and metacognitive skills

The globalization of the world's economic systems and the rapid integration of information and communication technologies in the workplace have significantly altered job content and skills requirements for the workforce. Technology is said to be driving this new economy, but human capital is its fuel (Moe and Boldget, 2000). In the nineteenth century, capital equipment was seen as the single decisive factor driving economic growth while knowledge and skills only played a supporting role. In this economic era, economic prosperity depends on brains rather than brawn.

This transformation from a world largely dominated by physical resources, to a world dominated by knowledge, implies a shift in the locus of economic power as profound as that, which occurred at the time of the Industrial Revolution. The perception of the role of human intervention in the economic transactions has also changed (Chinien et al. 2002). There is an emerging consensus that the "focus is shifting from appreciation of physical labour and the ability to coordinate and regulate to the ability to contribute to knowledge generation and application" (Keursten & Kessels, 2002, p. 1).

Human capital defined as "knowledge, skills, competencies and capabilities that individuals acquire during their life and use to produce goods, services or ideas" (Gasskov, 2001) is not only beneficial to the well-being of the worker, but also viewed as a competitive resource, which gives a comparative advantage to a company. Human capital is also a key element to ascertain a country's national prosperity. In this restructured environment knowledge has therefore become an intellectual capital (Patton, 2001). Information and knowledge that are quickly accessed, properly adapted, and broadly shared are key drivers of economic growth and social prosperity. Consequently, workers` ability to acquire, store, process, use and share information with the assistance of digital technology is becoming increasingly important. Verdonschot and Keursten (2006) have used the *knowledge productivity* to describe the process of: "identifying, gathering and interpreting relevant information, using this information to develop new skills and to apply these skills to improve and radically innovate operating procedures, products and services" (p.1).

Digital technology provides widespread access to an information-rich environment. While this environment facilitates the free exploration of non-linear information, it also challenges some people in important ways as vast amount of information from multiple sources must be quickly processed: "the uncertain quality and sheer abundance of information pose large challenges for society" (Association of Colleges and Research Libraries, 2000, p. 2). Findings of a study conducted to assess reading behaviours in the digital environment indicated that: "with an increasing amount of time spent reading electronic document, a screen-based reading behavior is emerging. The screen-based

reading behavior is characterized by more time spent on browsing and scanning, keyword spotting, one-time reading, non-linear reading, and reading more selectively, while less time is spent on in-depth reading, and concentrated reading" (Liu, 2005, p. 700). The ability to plan the order in which the various chunks of information should be read, to maintain coherence between these chunks of information, and to structure the information being process in an interconnected mental representation, is also of critical importance (Amadieu, Tricot, & Mariné, 2008, p. 1). Therefore to be successful in processing information in a digital technology environment a person must be able to effectively and efficiently determine what information is needed, and to access, organize, integrate, assess and apply that information to create new knowledge. Much of these tasks are governed by the proper control and regulation of information reading.

While this abundant source of complex and nonlinear information is facilitating to some people, it can also be debilitating to others who do not possess strong self-regulatory and metacognitive skills to help them navigate and process information in such an environment (Lee & Baylor, 2006). The nonlinearity of digital information is often disorienting to these individuals (Begoray, 1990), and cause them to lose all sense of direction and location in space (Conklin, 1987). This hampers their ability to make strategic navigational choices and wise selection of information sources (Jacobson, Maouri, Mishra, & Kolar, 1996). A key difference in processing information in a digital environment as compared to other more traditional ones is the need to understand how: "different visually-organized semantic units relate to each other" (Lee & Baylor, 2006, p. 344) in order to make wise navigational decisions. This information processing demands imposed by the digital environment can become a cause of disorientation to people who lack the necessary cognitive skills to construct their reading sequence and establish coherence of unstructured information captured from various sources (Amadieu, Tricot, & Mariné, 2008). Scheele (Scheele, 1993) provided a strong metaphorical illustration of this problem, as encountered by some people: *"in this age of information overload, it is easy to feel like a starving person with a can of soup but no can opener"* (p. 13). Some people are challenged and overwhelmed by the need to evaluate and integrate information (OECD, 2009b). Eshet-Alkalai argued that "digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive skills…which users need in order to function effectively in digital environments" (Eshet-Alkalai Y. , 2004, p. 93).

Another issue of significant importance to consider with regards to information processing tasks is the constructivist concept of knowledge construction. Unlike the behavioural paradigm which assumes that knowledge is objective and exists outside the mind of a person, the constructivist paradigm on the other hand posits that knowledge is constructed by people. The sophistication of knowledge construction is therefore a function of the repertoire of cognitive controls available for processing information. Recent observations made by OCED accurately summarize the issues discussed above:

> Now, as information-based economies are succeeding industrial-based economies, literacy is again being transformed. A new form of text, digital text, makes increased demands on readers, and changes the ways in which text is used. The amount of information available and its uncensored nature emphasise the abilities needed to connect, evaluate and interpret information. In addition, computer technologies have added new dimensions related to the nonlinear, recursive, and interactive nature of these environments. Because individuals now often move through the material in their own ways when searching for information, they very often create their own "texts" in the sense that the total set of information that each individual encounters is unique. Collectively, the skills required to effectively use digital information are less well understood than traditional print skills but suggest that we will need to expand our definition of what it means to be literate (OECD, 2009c).

Additionally, as reflective practitioners workers are constantly constructing new knowledge by evaluating and reflecting on the effectiveness or failure of their actions. A transformative learning process further enriches workers' knowledge. A central tenet to transformative learning is critical reflection, a process of questioning one's own beliefs as well as the social and cultural context within which learning is occurring. According to Mezirow transformation is

beyond simply establishing a new point of view, it is the critical self- reflection of an existing point of view that can lead to a transformed point of view and further, a new habit of mind (Mezirow, 1995). Such transformations can lead to learning which is more inclusive, discriminating, self-reflective and integrative experience (Mezirow.J, 1981).

Human information processing skills

This section briefly examines the human information process to get a better understanding of the implications of the cognitive and metacognitive skills for digital skills. When a piece of information is presented to a person, it goes through the perceptual modalities, namely the ears and eyes (Figure 14). That information is then processed through a filter where a decision is made to memorize, transform or learn that information or simply to reject it. If a decision is made to memorize, transform or learn that piece of information it is briefly transferred to the short-term memory, then moved to the working memory for further processing and finally directed to the long-term memory for storage and retrieval. Because of the rapidity with which this flow of information takes place, the person needs to have highly developed cognitive skills to be able to cope with this information processing demand.

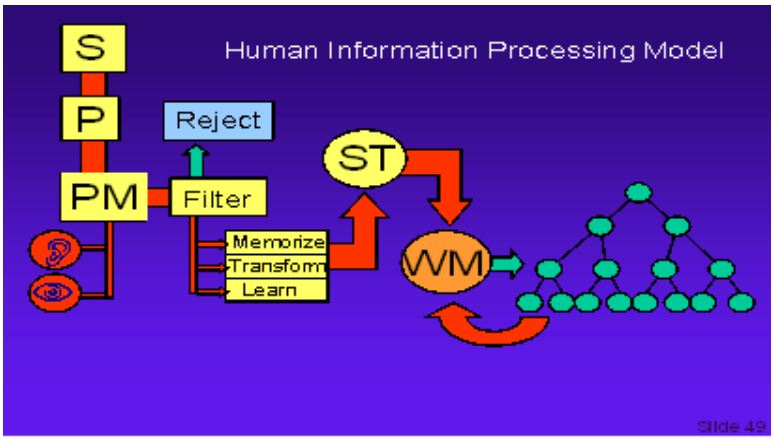


Figure 14, Human information processing model
(Chinien, Boutin, & and Letteri, 1997)

Individual differences among people regarding their preference for various modes of gaining, storing, processing, and using information constitute sources of considerable variations in their ability to process information effectively and efficiently (Chinien, Boutin, & and Letteri, 1997).

Cognitive-based research over the last 15 years has demonstrated that one of the most important factors contributing to information processing differences is the cognitive skills profile of an individual. To succeed in processing information quickly, effectively and efficiently, a person must possess a repertoire of cognitive skills to meet the cognitive demands of the performance tasks. A cognitive skills deficit is a common source of breakdown in information processing (Chinien., Boutin, & and Letteri, 1997). The Education Testing Service International Expert Panel on ICT Literacy similarly argued that the: “digital divide should no longer be defined only in terms of limited access to hardware, software and networks, but rather, one that is also driven by limited literacy levels and the lack of the cognitive skills. Technology skills alone, without corresponding cognitive skills and general literacy, will not decrease the gaps defined by a digital divide” (Educational Testing Service, 2002, p. 6). An analysis conducted by Chinien and Boutin The present analysis showed that individuals who possess a complete repertoire of cognitive skills have the requisite literacy skills to succeed in an ICT-mediated environments (Chinien & Boutin, 2003). This discussion clearly indicates that workers information processing skills can be as important, if not more important than computer skills and that processing information in a digital environment can be a debilitating experience without the

porper cognitive and metacognitive skills. Therefore information processing skills need to form an integral component of a digital skills framework.

Engineering a proposed framework for digital skills in the Canadian workforce

Insight gained form the review of various key digital concepts and major frameworks, buttressed by HRSDC expertise in foundational and transversal skills, constituted the primary source of information that was used as building blocks for developing the framework (Figure 15). As shown, digital skill is not depicted as a new skill concept, but rather it is viewed as a multifaceted concept, which encapsulates four skill clusters, notably: (1) Digital Technical Skills; (2) Digital Information Processing Skills; (3) Foundational Skills; and (4) Transversal Skills.

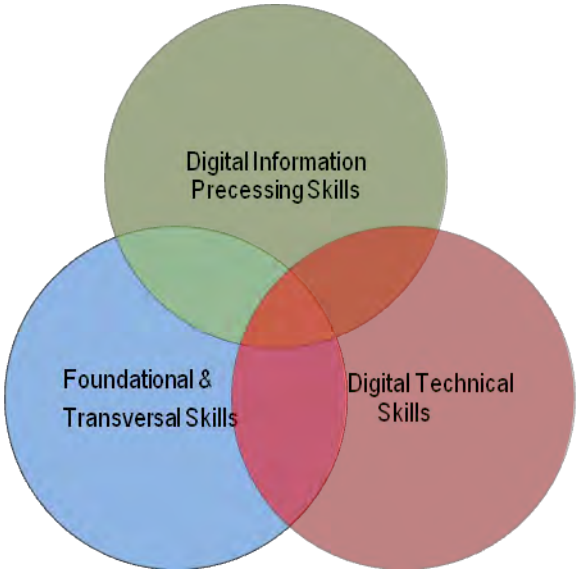


Figure 15, Key clusters of digital skills

As shown in Figure 16, these four skills clusters and their corresponding definitions were grouped together structurally into a proposed digital skills framework. The HRSDC essential skills concepts provide the foundational skills to be able to work with digital technology generally, as well as the essential skills that support and grow with the development of proficiency in technology use – in an ongoing (transversal) way. In addition, the framework breaks down those underlying skills that manifest themselves more particularly when working with digital technology, including both digital technical skills and digital information processing skills. Figure 17, provides a justification for the inclusions of the various skills concepts in the proposed digital skills framework.

The following distinctive features were built into the design of the framework in order to remain consistent with best practices gleaned from the international review of literature and research:

- Adopt multiple theoretical perspectives, namely: (a) technical digital skills; (b) multiple literacies; (c) cognitive literacy; (d) metacognitive; and (e) situated literacy;
- Use of digital systems and tools is only one cluster of the digital skills concept;
- Digital skills conceptualized as the interactive effects of four essential key skills clusters;
- The four essential skills clusters are interconnected and interdependent;
- Information processing has a predominant role in the framework;
- Foundational and transversal skills were built into the framework as enablers.

Figure 16, Proposed Canadian digital skills framework: Essential digital skills in the Canadian workplace*

Digital Information Processing Skills	
Communicate information	Share digital information with others at work
Create information	Generate new digital contents and knowledge by organizing, integrating, adapting and applying digital information
Apply information	Use information of various digital formats effectively and efficiently to perform job tasks
Assess information	Judge the quality, relevance, usefulness, validity and applicability of digital information
Integrate information	Interpret, analyze, summarize, compare and contrast, combine, repurpose and represent digital information
Organize information	Decode, restructure, and protect digital information
Access information	Locate, select and retrieve digital information
Determine information needs	Recognize, define and articulate digital information needs
Input information	Identify, recognize, record and store digital information to facilitate retrieval and use

Transversal Skills

Thinking / Problem-Solving
Continuous Learning/
Work with Others

Transversal skills are the desirable broadly transferable, non-technical skills, which when combined with specific occupational/technical skills, contribute to the optimization of human performance at work.

ESSENTIAL DIGITAL SKILLS IN THE CANADIAN WORKPLACE

Digital Technical Skills

Use Digital Systems and Tools
- Use computers and other hardware to perform job tasks

Use Software Applications
- Select and use appropriate software to perform job tasks

Apply Security measures in Digital Environments
- Protect hardware, software applications, data and personal information

Foundational Skills

Reading, Writing, Oral Communication, Document Use, Numeracy

Foundation skills refer to gateway basic literacy and numeracy skills components for which there is often or always a minimum proficiency level required before someone can engage with digital technology and demonstrate or develop the more precise digital information processing skills.

**This is the final version of the framework which underwent several rounds of iterative developmental evaluations and revisions. This version of the framework was also subjected to key informants' verification and revision. A copy of the original prototypical version of the framework can be found in Appendix A, Figure 1.*

Figure 17. Justification of concepts included in the proposed Canadian Digital Skills Framework

Core skills	Sub-sets of skills	Justification for inclusion
Foundational Skills	Reading, writing, oral communication, document use, and numeracy. These are sub-sets of skills from the HRSDC Essential Skills Framework.	Input and output of digital content for human information processing still relies to a great extent on the mastery of basic literacy and numeracy skills as the great majority of information used at the workplace are in text form. Given that a significant proportion of Canadian adults are performing at a low literacy level and the positive relationship that exists between increase in literacy level and higher intensity in technology use, it is imperative to include basic literacy as a skill set in the proposed Canadian digital skills framework.
Transversal Skills	Thinking / Problem-Solving, Continuous Learning/Work with Others. These are sub-sets of skills from the HRSDC Essential Skills Framework.	Transversal skills are the desirable broadly transferable, non-technical skills, which when combined with specific occupational/technical skills, contribute to the optimization of human performance at work. There is an emerging consensus in the literature that digital skills include the complex critical thinking and problem-solving skills. To address this issue OECD has included a sub-set of skills dealing with problem-solving in ICT-rich environments in the Programme for the International Assessment of Adult Competencies (OECD, 2009c). Rapid and continuous advances in digital technology considerably reduce the

Figure 17. Justification of concepts included in the proposed Canadian Digital Skills Framework		
Core skills	**Sub-sets of skills**	**Justification for inclusion**
		shelf life of workers digital skills. To prevent skills decay and obsolescence workers need to continuously update and retool their digital skills. Learning to learn has therefore become an important 21st century skill. Learning to learn includes highly complex cognitive and metacognitive skills, which facilitate self-directed and transformative learning Education, (PRESTO, 2010), (Chinien., Boutin, & and Letteri, 1997). Learning to learn is an essential transversal skill in the European Lifelong Learning Framework. Working with others is already part of the HRSDC essential skills profile and skill sets advocated in all major frameworks reviewed. These four sub-sets of skills were included in the framework because of their important implications for effective performance in digital work environments.
Digital Technical Skills	Use Software Applications	Using software applications in conjunction with digital systems and tools is essential to perform job tasks in a digitally-mediated work environment (e-skills UK Sector Skill Council, 2009b).
	Use Digital Systems and Tools	Using digital systems and tools is essential to perform job tasks in a digitally-mediated work environment (e-skills UK Sector Skill Council, 2009b).
	Apply Security measures in Digital Environments	Several traditional crimes have migrated online and many new digital-enabled crimes have emerged, including computer intrusion, hacking, virus attack, consumer fraud, identity theft, copyright infringement. (Matinez, 2005). To combat cyber-crimes, every users of digital technology should be skilled in applying security measures in a digitally-mediated work environment (e-skills UK Sector Council, 2009b).
Digital Information Processing Skills	Determine information needs: Recognize, define and articulate digital information needs	The OECD-ILO PISA Experts Panel noted that the conception of digital literacy can no longer be confined to the mastery of technical skills. The panel adopted a definition of digital literacy which is indicative of this complexity: "ICT literacy is the interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in society" (Van Joolingen, 2003, p. 5). Digital literacy skills consist of the juxtaposition of information processing skills on "computer use", ICT skills or e-skills. Digital Literacy is the confident and critical use of Information Communication Technology (ICT) for work, leisure and communication. It is underpinned by basic ICT skills: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate via the Internet. (Demunter, 2006, p. 2)
	Access information: Locate, select and retrieve digital information	
	Organize information: Decode, restructure and classify digital information to facilitate storage, retrieval and use	
	Integrate information: Interpret, analyze, summarize, compare and contrast, combine, repurpose and represent digital information	
	Assess information: Judge the quality, relevance, usefulness, validity and applicability of digital information	
	Apply information: Use information of various digital formats effectively and efficiently to perform job tasks	
	Create information: Generate new digital contents and knowledge by organizing, integrating, adapting and applying digital information	
	Communicate information: Share digital information with	

Figure 17. Justification of concepts included in the proposed Canadian Digital Skills Framework		
Core skills	**Sub-sets of skills**	**Justification for inclusion**
	others at work	

Identification of component skills for the proposed digital skills framework

The identification of additional layers of component skills to further define technical digital skills and digital information processing skills was accomplished through a literature review. This research was not warranted for HRSDC essential foundational and transversal skills clusters because they have already been thoroughly researched.

Although there are several skill inventories available, the great majority of them have a special emphasis in computer literacy, information literacy or digital literacy. Several of the skills identified were also being promoted in the context of K-12 education, post-secondary education or higher education. A substantial proportion of recommended skills were also intended for students conducting research in libraries. Little empirical studies which systematically investigate the digital skills needed by the workforce were identified. Most research in this area has focused on validating digital skills sets for K-12 or higher education students. It is noteworthy also that most digital skills standards developed so far are targeted to ICT specialists and advanced users of ICTs, rather than the basic users of the general workforce. For example the Information and Communication Technology Council has developed ICT Competency Profiles which specify national occupation competencies required for employment in the ICT sector in Canada (Information and Communication Technology Council, no date). The Information Technology User Qualification (ITQ) qualification structure of England, Whales and Northern Ireland for e-skill users is the single most comprehensive occupational standards identified in the international review of literature (e-skills UK Sector Skill Council, 2009b).

Given that no existing inventory of digital skills adequately met the fundamental assumptions embedded in the conception of the digital skills framework adopted for this study, it was necessary to glean skills components from various inventories to describe each layer of digital skills for each of these two skills clusters. A listing of these sub-skills along with the sources from which they were identified is provided in Figure 18. The foundational and transversal skills that are part of the HRSDC Essential Skills Profile were not discussed further, as they are largely well developed elsewhere and this extended beyond the scope of the present study.

Figure 18, Inventory of potential skills for the proposed Canadian digital skills framework		
	USE DIGITAL SYSTEMS AND TOOLS	**Sources**
TECHNICAL DIGITAL SKILLS	Select digital systems and tools	(e-skills UK Sector Skill Council, 2009b)
	Set up digital systems and tools	(e-skills UK Sector Skill Council, 2009b)
	Install software applications	(e-skills UK Sector Skill Council, 2009b)
	Connect digital systems and tools to the Internet	(e-skills UK Sector Skill Council, 2009b)
	Maintain digital systems and tools	(e-skills UK Sector Skill Council, 2009b)
	Manage operating systems and files	(e-skills UK Sector Skill Council, 2009b)
	Back up files and data	(e-skills UK Sector Skill Council, 2009b)
	Troubleshoot digital systems and tools	(e-skills UK Sector Skill Council, 2009b)
	Customize work environments	(e-skills UK Sector Skill Council, 2009b)
	Select mobile digital devices	(e-skills UK Sector Skill Council, 2009b)
	Set up mobile digital devices	(e-skills UK Sector Skill Council, 2009b)
	Use mobile digital devices	(e-skills UK Sector Skill Council, 2009b)
	Use digital systems and tools to access information	Researcher generated skill
	Use digital systems and tools to process information	Researcher generated skill
	Use digital systems and tools for communicating	Researcher generated skill
	Use digital systems and tools for collaborating	Researcher generated skill
	Use digital systems and tools for learning	Researcher generated skill
	Use digital systems and tools for solving problems	Researcher generated skill
	Use digital systems and tools for designing	Researcher generated skill
	Use digital systems and tools for planning	Researcher generated skill
	Migrate to new digital systems and tools	Researcher generated skill

Figure 18, Inventory of potential skills for the proposed Canadian digital skills framework

	USE DIGITAL SYSTEMS AND TOOLS	Sources
	USE SOFTWARE APPLICATIONS	
TECHNICAL DIGITAL SKILLS	Use computer operating software	(e-skills UK Sector Skill Council, 2009b)
	Use word processing software	(e-skills UK Sector Skill Council, 2009b)
	Use Internet-based software	(e-skills UK Sector Skill Council, 2009b)
	Use audio and video software	(e-skills UK Sector Skill Council, 2009b)
	Use spreadsheet software	(e-skills UK Sector Skill Council, 2009b)
	Use presentation software	(e-skills UK Sector Skill Council, 2009b)
	Use multimedia software	(e-skills UK Sector Skill Council, 2009b)
	Use desktop publishing software	(e-skills UK Sector Skill Council, 2009b)
	Use accounting software	(e-skills UK Sector Skill Council, 2009b)
	Use database software	(e-skills UK Sector Skill Council, 2009b)
	Use data management software	(e-skills UK Sector Skill Council, 2009b)
	Use project management software	(e-skills UK Sector Skill Council, 2009b)
	Use design and imaging software	(e-skills UK Sector Skill Council, 2009b)
	Use drawing and planning software	(e-skills UK Sector Skill Council, 2009b)
	Use custom-designed software	(e-skills UK Sector Skill Council, 2009b)
	Use web development software	(e-skills UK Sector Skill Council, 2009b)
	Comply with legal copyright provisions	(e-skills UK Sector Skill Council, 2009b)
	Use software applications to access information	Researcher generated skill
	Migrate to new software applications	(Smith & Anderson, 2010)
	APPLY SECUTIRY MEASURES IN DIGITAL ENVIRONMENTS	
TECHNICAL DIGITAL SKILLS	Use anti-virus software to protect from cyber attacks	(e-skills UK Sector Skill Council, 2009b)
	Distinguish between hoaxes and real threat warnings.	(Smith & Anderson, 2010)
	Install local firewall on computers	(e-skills UK Sector Skill Council, 2009b)
	Securely send and open digital messages and content	(e-skills UK Sector Skill Council, 2009b)
	Securely connect to networks	(e-skills UK Sector Skill Council, 2009b)
	Encrypt sensitive information	(Weippi, 2005)
	Backup and store digital contents	(Weippi, 2005)
	Delete sensitive digital content	(Matinez, 2005)
	Secure user ID and passwords	(Weippi, 2005)
	Protect digital content against accidental destruction	(Weippi, 2005)
	Protect unauthorized use and modification of digital content	(Weippi, 2005)
	Comply with legal issues of digital contents	(Matinez, 2005)
	Determine trustworthiness of digital sources	(Matinez, 2005)
	Identify digital frauds, suspicious activity and cyber crimes	(Matinez, 2005)
	Practice safe online behaviours	(Matinez, 2005)
	Secure personal information against identity threats	(Matinez, 2005)
	Maintain a secure digital footprint	(Smith & Anderson, 2010)
	Report suspicious online activity	(Matinez, 2005)
	Report breaches in security	(Matinez, 2005)
	Comply with employer's digital policy	(Smith & Anderson, 2010)
	DETERMINE NEEDS, ACCESS, ORGANIZE, INTEGRATE, ASSESS, APPLY, CREATE, COMMUNICATE DIGITAL INFORMATION	
DIGITAL INFORMATION PROCESSING SKILLS	Determine what, when and how much information is needed	(Catts & Lau, 2008)
	Articulate information needs	(Catts & Lau, 2008)
	Locate information sources	(Churches, 2009); (Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006)
	Select information to meet needs	(Catts & Lau, 2008)
	Retrieve information of from various sources	(California Emerging Technology Fund, 2008)
	Scan information visually	(Aviram & Eshet-Alkalai, 2006); (Eshet-Alkalai Y. , 2004)
	Analyze information	(Churches, 2009)
	Evaluate the quality and trustworthiness of information	(Catts & Lau, 2008)
	Determine the usefulness and applicability of information	(Catts & Lau, 2008)
	Decode information presented in multiple format	(Eshet-Alkalai Y. , 2004)
	Restructure randomly acquired information	(Eshet-Alkalai Y. , 2004)
	Organize information in a logical flow	(Catts & Lau, 2008)
	Categorize information	(Catts & Lau, 2008); (Churches, 2009)
	Classify information for ease of storage, retrieval and use	(Churches, 2009)

Figure 18, Inventory of potential skills for the proposed Canadian digital skills framework

	USE DIGITAL SYSTEMS AND TOOLS	Sources
	Interpret information	(Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006)
	Summarize information	(California Emerging Technology Fund, 2008)
	Compare and contrast different information types	(Churches, 2009); (California Emerging Technology Fund, 2008)
	Combine information from different sources	(Eshet-Alkalai Y. , 2004); (Aviram & Eshet-Alkalai, 2006)
	Represent information in various digital formats	(Eshet-Alkalai Y. , 2004)
	Repurpose existing information	(Media Awareness Network, 2010)
	Work with language/symbols/conventions of digital medium	(Aviram & Eshet-Alkalai, 2006); (Eshet-Alkalai Y. , 2004)
	Navigate through complex information-architecture	(Eshet-Alkalai Y. , 2004)
	Navigate through complex hypermedia environments	(Amadieu, Tricot, & Mariné, 2008); (Lee & Baylor, 2006)
	Demonstrate digital screen fluency	(Kelly., 2008)
	Work across multiple environments	(Eshet-Alkalai Y. , 2004)
	Work in environments with multiple input and stimuli	(Eshet-Alkalai Y. , 2004)
	Use information displayed in visual and graphical format	(Eshet-Alkalai Y. , 2004)
	Use charts and graphs to represent information	(Eshet-Alkalai Y. , 2004)
	Memorize essential information	(Churches, 2009)
	Make effective and efficient use of information	(Bundy, 2004)
	Use information to solve problems	(Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006)
	Work on multiple digital task simultaneously	(Osborne, 2010); (Smith & Anderson, 2010)
	Process information under time pressure	(Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006)
	Determine interconnectedness of information	(Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006)
	Generate knowledge using randomly acquired information	(Eshet-Alkalai Y. , 2004)
	Generate new knowledge using digital information	(Educational Testing Service, 2002)
	Apply information for designing & authoring digital contents	(Smith & Anderson, 2010); (Bundy, 2004)
	Contribute to continual improvement of information	Generated by research team
	Use social networks to communicate	(Smith & Anderson, 2010)
	Process information in collaboration with others	(Martin & Grudziecki, DigEuLit: Concepts and Tools for Digital Literacy Development, 2006)
	Assess what information can be shared with others	(Osborne, 2010); (Bundy, 2004)
	Behave and act ethically in handling information	(Bundy, 2004)
	Determine how to dispose information	(Smith & Anderson, 2010)

KEY INFORMANTS' CONSULTATION

Research stage II consisted of a consultation of key informants drawn from various economic sectors across the country in order to obtain a snap shot of their perception regarding the digital skills needs and issues in the Canadian workplace. More specifically the Small and medium-sized enterprises (SMEs) were requested to validate the proposed Canadian digital skills framework and the digital skills embedded within the framework.

The key informants for this consultation consisted of a purposive sample (N=20) of SMEs representatives drawn from the following sectors: manufacturing (n=3), accommodation and food services (n=3), primary health care and social services (n=4), utilities and construction (n=3), wholesale/retail (n=4), and transportation (n=3). Key informants were selected based on recommendations made by key actors from each industry sector of interest. A few of the key informants recommended by the key actors were from larger organizations and their role was to provide a national perspective on digital skills in their respective sector.

Once key informants were identified they were contacted by telephone for a preliminary briefing regarding the goal of the study and the purpose of the consultation. Based on feedback received from this initial contact with the key

informants, and considering the nature of the questions to be addressed by the study, project staff reached the conclusion that an online consultation was the most effective and efficient data collection strategy.

An orientation cover letter and online survey questionnaire were developed to enable the key informants to validate the proposed Canadian Digital Skills Framework, the digital skills clusters and their definitions, and the layers of digital skills associated with each cluster. The questionnaire consisted of the following sections:

- Section 1 Assessment of the relevance, accuracy and clarity of the proposed Canadian Digital Skills Framework, its digital skills clusters and their definition on a four-point rating scale.

- Section 2 Validation of the layers of digital skills included in the proposed digital skills framework in terms of their perceived degree of importance, their frequency of use and workers' proficiency level on a four-point rating scale.

Figure 19. Digital skills rating scales				
Relevance	Extremely relevant	Relevant	Somewhat relevant	Not relevant
Accuracy	Extremely Accurate	Accurate	Somewhat Accurate	Not Accurate
Clarity	Extremely clear	Clear	Somewhat clear	Not clear
Importance	Extremely important	Important	Somewhat important	Not important
Frequency of use	Every day	Weekly	Monthly	Never
Workers' proficiency level	Extremely proficient	proficient	Somewhat proficient	Not proficient

Some open-ended questions were also included in the questionnaire to provide more in depth qualitative insights about industry's perspective on digital skills in the Canadian workplace.

The questionnaire was uploaded on line and was subjected to several rounds of developmental testing and revision to ascertain its robustness, integrity, reliability for collecting responses. The survey questionnaire was pilot tested with two typical key informants not included in the sample. Only minor revisions were made to the questionnaire based on the results of the pilot test. A copy of the cover letter and online consultation questionnaire can be found in Appendix A.

The cover letter giving precise instructions for completing the online survey was e-mailed to the key informants on February 13, 2011, and the deadline for completing and submitting the questionnaire was February 18, 2011. Slightly less than 50 per cent of the respondents had submitted their responses by the established deadline. A friendly e-mail was sent to all late respondents on February 19, 2011 with a submission deadline of February 25, 2011. Project staff had to substitute a few key informants who were on vacation overseas, or others who failed to respond to the follow-up notification. In total twenty key informants participated in the consultation process.

Data collected using the online survey was summarized into frequency counts and percentages distributions. The section, which follows, presents an analysis of the data related to the validation of the proposed Canadian Digital Skills Framework, the digital skills concepts and the digital skills.

Validation of the proposed Canadian digital skills framework, its digital skills concepts and their definitions

The great majority of the key informants (80%) consulted believed that reading was an extremely relevant foundational skill in the digital skills framework (Table 1). Fifty per cent or more of the respondents also indicated that oral communication (55%), document use (55%), and numeracy (50%) were also extremely relevant in the framework. Fewer key informants (45%) rated "writing" as extremely relevant. A significant proportion of the key informants also rated all the foundational skills sets as "relevant". Only document use (5%) and numeracy (10%) were rated as "somewhat relevant" by one and two key informants respectively (Table 1).

Participants in the consultation were also offered the opportunity to provide more in depth input regarding the relevance of the foundational skills in the framework. A key informant suggested that the importance of foundational skill may differ, dependant on the function of the worker, i.e. foreman vs. labourer.

Another key informant argued that while reading and listening skills are crucial to learn new skills and become more knowledgeable, numeracy plays a lesser role in the process. A key informant, who strongly agreed that foundational skills are very important, also believed that "they do not need to be perfectly mastered to be successful".

Table 1. Relevance of Foundational Skills

	Extremely Relevant	Relevant	Somewhat Relevant	Not Relevant
Reading	80.0% (16)	20.0% (4)	0.0% (0)	0.0% (0)
Writing	45.0% (9)	55.0% (11)	0.0% (0)	0.0% (0)
Oral Communication	55.0% (11)	45.0% (9)	0.0% (0)	0.0% (0)
Document use	55.0% (11)	40.0% (8)	5.0% (1)	0.0% (0)
Numeracy	50.0% (10)	40.0% (8)	10.0% (2)	0.0% (0)

(n = 20)

Approximately fifty per cent, or slightly less of the key informants indicated that the descriptive label of reading (52.6%), oral communication (42.1); document use (47.4%), and numeracy 42.1%) were extremely accurate, while only 36.8% rated "writing" label as extremely accurate (Table 2). A sizeable proportion of the key informants also rated all the foundational skills labels as "accurate". It is noteworthy that none of these descriptive labels were rated as "not accurate".

Table 2. Accuracy of descriptive labels of Foundational Skills

	Extremely Accurate	Accurate	Somewhat Accurate	Not Accurate
Reading	52.6% (10)	42.1% (8)	5.3% (1)	0.0% (0)
Writing	36.8% (7)	57.9% (11)	5.3% (1)	0.0% (0)
Oral Communication	42.1% (8)	57.9% (11)	0.0% (0)	0.0% (0)
Document use	47.4% (9)	42.1% (8)	10.5% (2)	0.0% (0)
Numeracy	42.1% (8)	57.9% (11)	0.0% (0)	0.0% (0)

(n = 19)

There was not too much variability in perception among the key informants regarding the clarity of the descriptive labels used for the foundational skills (Table 3). A sizeable proportion rated the labels as "extremely clear", while a significant proportion also rated the same labels as "clear". Very few key informants rated the labels as "somewhat clear" and none of the labels were rated as "not clear".

Qualitative comments of key informants pointed to some issues regarding the clarity of the descriptive labels. One key informant indicated that the accuracy and clarity of the foundational skills are of utmost importance. However, it "is less clear what they actually mean in the digital skills framework".

Table 3. Clarity of descriptive labels of Foundational Skills				
	Extremely Clear	Clear	Somewhat Clear	Not Clear
Reading	42.1% (8)	52.6% (10)	5.3% (1)	0.0% (0)
Writing	36.8% (7)	57.9% (11)	5.3% (1)	0.0% (0)
Oral Communication	36.8% (7)	63.2% (12)	0.0% (0)	0.0% (0)
Document use	47.4% (9)	42.1% (8)	10.5% (2)	0.0% (0)
Numeracy	47.4% (9)	52.6% (10)	0.0% (0)	0.0% (0)

(n = 19)

Validation of Digital Technical Skills Concepts

Close to two-third of the key informants indicated that the skills concepts and their definitions (a) use digital systems and tools (65%) and (b) use software applications (65%) were extremely relevant in the digital skills framework (Table 4). Several others (45%) also believed that "Apply security measures in digital environments" was also extremely relevant. A sizeable proportion also rated all these skill as relevant. It is noteworthy that "Apply security measures in digital environments" was rated as only "somewhat relevant" by 30% of the key informants, and that none of these skills were rated as "not relevant".

A key informant argued that digital skills requirements are driven by digital systems and tools: "various systems and software applications are used in the workplace, which dictate specialized digital skills needs". Comments made by a key informant suggested that security measures have little digital skills implications, because these measures are administered by internal computer infrastructure and record management programs.

Table 4. Relevance of Digital Technical Skills concepts and their definitions				
	Extremely Relevant	**Relevant**	**Somewhat Relevant**	**Not Relevant**
Use digital systems and tools	65.0% (13)	35.0% (7)	0.0% (0)	0.0% (0)
Use software applications	65.0% (13)	30.0% (6)	5.0% (1)	0.0% (0)
Apply security measures in digital environments	45.0% (9)	25.0% (5)	30.0% (6)	0.0% (0)

(n = 20)

A significant proportion of key informants rated the following digital technical skills and their corresponding definitions as extremely accurate (Table 5): (a) use digital systems and tools (68.4%); (b) use software applications (55.6%); and (c) apply security measures in digital environments (44.4%). Nearly two-third of the key informants also rated these skill concepts and definitions as "accurate". None of these skills concepts and corresponding definitions was rated as "not accurate".

Table 5. Accuracy of Digital Technical Skills concepts and their definitions				
	Extremely Accurate	Accurate	Somewhat Accurate	Not Accurate
Use digital systems and tools	68.4% (13)	31.6% (6)	0.0% (0)	0.0% (0)
Use software applications	55.6% (10)	38.9% (7)	5.6% (1)	0.0% (0)
Apply security measures in digital environments	44.4% (8)	33.3% (6)	22.2% (4)	0.0% (0)

* (n is not equal to 20 for some questions)

The great majority of the key informants rated the Digital Technical Skills as either "extremely clear" or "clear" (Table 6). Their ratings were as follows: (a) use digital systems and tools (94.7%); (b) use software applications (94.4%);

and (c) apply security measures in digital environments (72.2%). A small percentage of key informants rated the skill concept- apply security measures in digital environments as "somewhat clear (22.2%) and "not clear" (5.6%).

Table 6. Clarity of the Digital Technical Skills

	Extremely Clear	Clear	Somewhat Clear	Not Clear
Use digital systems and tools	57.9% (11)	36.8% (7)	5.3% (1)	0.0% (0)
Use software applications	44.4% (8)	50.0% (9)	5.6% (1)	0.0% (0)
Apply security measures in digital environments	38.9% (7)	33.3% (6)	22.2% (4)	5.6% (1)

* (n is not equal to 20 for some questions)

Validation of Digital Information Processing Skills concepts

The great majority (80%) of the key informants rated the digital skill *access information* and its definition as "extremely relevant" (Table 7). Fifty per cent or more of the key informants also rated the other skills as extremely important. The great majority of the key informants also rated all the information processing skills as either "extremely relevant" or "relevant": (a) Define information need (90%); (b) access information (100%); (c) assess information (100%); (d) organize information (80%); (e) integrate information (90%); (f) apply information (85%); (g) create information (79%); and (h) communicate information (94.7%). Only a few key informants rated the information processing skills as "somewhat relevant" and fewer still as "not relevant".

Table 7. Relevance of the Digital Information Processing Skills

	Extremely Relevant	Relevant	Somewhat Relevant	Not Relevant
Define information need	55.0% (11)	35.0% (7)	10.0% (2)	0.0% (0)
Access information	80.0% (16)	20.0% (4)	0.0% (0)	0.0% (0)
Assess information	63.2% (12)	36.8% (7)	0.0% (0)	0.0% (0)
Organize information	55.0% (11)	25.0% (5)	20.0% (4)	0.0% (0)
Integrate information	55.0% (11)	35.0% (7)	10.0% (2)	0.0% (0)
Apply information	60.0% (12)	25.0% (5)	10.0% (2)	5.0% (1)
Create information	31.6% (6)	47.4% (9)	15.8% (3)	5.3% (1)
Communicate information	57.9% (11)	36.8% (7)	0.0% (0)	5.3% (1)

* (n is not equal to 20 for some questions)

When asked how accurately the skills concepts and their corresponding definitions accurately describe Digital Information Processing Skills the great majority of the key informants rated all the concepts and definitions as either "extremely accurate" or "accurate" (Table 8): (a) define information need (100%); (b) access information (100%); (c) assess information (100%); (d) organize information (83.3%); (e)integrate information (88.9%); (f) apply information (88.9%); (g) create information (88.2%); and (h) communicate information (94.1%). Very few key informants rated these skills as "somewhat accurate" or "not accurate".

Table 8. Accuracy of the Digital Information Processing Skills

	Extremely Accurate	Accurate	Somewhat Accurate	Not Accurate
Define information need	33.3% (6)	66.7% (12)	0.0% (0)	0.0% (0)
Access information	61.1% (11)	38.9% (7)	0.0% (0)	0.0% (0)
Assess information	55.6% (10)	44.4% (8)	0.0% (0)	0.0% (0)
Organize information	38.9% (7)	44.4% (8)	16.7% (3)	0.0% (0)
Integrate information	38.9% (7)	50.0% (9)	11.1% (2)	0.0% (0)
Apply information	55.6% (10)	33.3% (6)	5.6% (1)	5.6% (1)
Create information	35.3% (6)	52.9% (9)	5.9% (1)	5.9% (1)
Communicate information	52.9% (9)	41.2% (7)	0.0% (0)	5.9% (1)

* (n is not equal to 20 for some questions)

Results indicated that one third or more of the key informants perceived all the information processing skills concepts (with the exception of "create information" 29.4%) and their definitions to be extremely clear (Table 9). The aggregate rating of "extremely clear" and "clear" unquestionably indicated that the great majority of the key informants believed that all these skills and definitions to be clear.

Table 9. Clarity of the Digital Information Processing Skills

	Extremely Clear	Clear	Somewhat Clear	Not Clear
Define information need	38.9% (7)	50.0% (9)	11.1% (2)	0.0% (0)
Access information	38.9% (7)	61.1% (11)	0.0% (0)	0.0% (0)
Assess information	38.9% (7)	61.1% (11)	0.0% (0)	0.0% (0)
Organize information	35.3% (6)	64.7% (11)	0.0% (0)	0.0% (0)
Integrate information	38.9% (7)	55.6% (10)	5.6% (1)	0.0% (0)
Apply information	38.9% (7)	55.6% (10)	5.6% (1)	0.0% (0)
Create information	29.4% (5)	58.8% (10)	5.9% (1)	5.9% (1)
Communicate information	41.2% (7)	52.9% (9)	0.0% (0)	5.9% (1)

* (n is not equal to 20 for some questions)

A key informant qualitative comment to an open-ended question reaffirmed the relevance of the digital information processing skills: "define, access, assess, organize, integrate, apply, create and communicate digital information is the core of our workflow". Another key informant also made a vivid comment to stress the importance of the Digital Information Processing Skills cluster for his sector: "these digital information processing skills concepts are very relevant to the transport sector in every step of the "load offer" process, through mid-trip changes and status updates, time management, pro-active decision making until trip completion."

Validation of the Transversal Skills Concepts

Sixty-three per cent of the key informants rated three transversal skills concepts (thinking skills, problem-solving skills, continuous learning) as "extremely relevant" (Table 10), while fifty-two per cent rated "working with others" as "extremely relevant". A sizeable proportion of the key informants also rated all transversal skills as "relevant". Only one key informant rated the four transversal skills as "somewhat relevant", and one rated *continuous learning* as being "not relevant". The aggregate rating of "extremely relevant" and "relevant" indicated that the great majority of the key informants believed that all these skills were relevant.

Table 10. Relevance of Transversal Skills

	Extremely Relevant	Relevant	Somewhat Relevant	Not Relevant
Thinking skills	63.2% (12)	31.6% (6)	5.3% (1)	0.0% (0)
Problem-solving skills	63.2% (12)	31.6% (6)	5.3% (1)	0.0% (0)
Continuous learning	63.2% (12)	26.3% (5)	5.3% (1)	5.3% (1)
Work with others	52.6% (10)	42.1% (8)	5.3% (1)	0.0% (0)

(n = 19)

Close to two-third of the key informants rated the problem-solving concept as "extremely accurate" and a sizeable proportion also rated thinking skills (41.2%), continuous learning (47.1%) and work with others (29.4%) as extremely relevant (Table 11). A significant proportion of the key informants rated all transversal skills concepts as "accurate", and on few of them rated these skills as "somewhat accurate" or "not accurate".

Table 11. Accuracy of Transversal Skills

	Extremely Accurate	Accurate	Somewhat Accurate	Not Accurate
Thinking skills	41.2% (7)	52.9% (9)	5.9% (1)	0.0% (0)

Problem-solving skills	64.7% (11)	29.4% (5)	0.0% (0)	5.9% (1)
Continuous learning	47.1% (8)	41.2% (7)	11.8% (2)	0.0% (0)
Work with others	29.4% (5)	58.8% (10)	11.8% (2)	0.0% (0)

(n = 17)

The great majority of the key informants rated the four transversal skills as either "extremely clear" or "clear". Very few key informants rated these skills as "somewhat clear" or "not clear" (Table 12).

Table 12. Clarity of Transversal Skills

	Extremely Clear	Clear	Somewhat Clear	Not Clear
Thinking skills	47.1% (8)	47.1% (8)	5.9% (1)	0.0% (0)
Problem-solving skills	52.9% (9)	41.2% (7)	0.0% (0)	5.9% (1)
Continuous learning	41.2% (7)	47.1% (8)	5.9% (1)	5.9% (1)
Work with others	23.5% (4)	76.5% (13)	0.0% (0)	0.0% (0)

(n = 17)

Speaking in support of *transversal skills,* a key informant noted: "we always have to think and to solve problems efficiently. What we do also requires big team effort. Continue to learn at work is what keeps us motivated". Another key informant said that troubleshooting skill is an essential digital skill. The complexity of the problem solving tasks faced by some workers is exemplified by the following comment: "complex skills are needed to be able to adjust to changing technology and regulations and other challenges brought about by innovations, such as chaotic scheduling of "just in time" shipping." One key informant believed that explanations of the *transversal skills* concepts were not adequate.

Usefulness and comprehensiveness of the proposed digital skills framework

Results indicated that 94.8% of the key informants indicated that the Framework was useful for describing the skills needed to work in a digital economy (Table 13). In commenting on the overall usefulness of the framework a key informant noted: "the one area that I didn't see relates to skills in 'sourcing' information - i.e. in knowing where to look for various types of information and how to juxtapose data sources that provide different perspectives on a subject". Another key informant commented on the contextualization of digital skills: [the framework is] "written for an office based environment rather than a truck or mobile based environment".

Table 13. Usefulness of the proposed Canadian Digital Skills Framework

	Extremely useful	Useful	Somewhat Useful	Not Useful
How well does this framework cover the key elements that you consider vital for describing the skills needed to	31.6% (6)	63.2% (12)	5.3% (1)	0.0% (0)

(n = 19)

The great majority (88.9%) of the key informants believed that the Framework included all the essential digital skills concepts requirements for their sector (Table 14).

Table 14. Comprehensiveness of the proposed Canadian Digital Skills Framework

	Yes	No
Does this framework include all the essential digital skills concepts requirements for your sector?	88.9% (16)	11.1% (2)

(n = 18)

VALIDATION OF THE DIGITAL SKILLS EMBEDDED IN THE PROPOSED CANADIAN DIGITAL SKILLS FRAMEWORK

Validation of digital technical skills

The great majority of the skills related to the use of digital systems and tools were perceived to be extremely important to important by two-third or more key informants (Table 15). It is noteworthy that all the key informants (100%) rated the use of digital systems and tools for communicating as extremely important or important. Nearly two third of the key informants perceived the use of digital tools and systems for accessing, processing and communicating information as extremely important. A fairly high proportion of the key informants rated the great majority of the digital skills for using digital systems and tools as either extremely important or important. Between twenty five and forty five per cent of the key informants believed that installing software applications, connecting systems and tools to the internet, managing operating systems and files, selecting, setting up and using mobile devices, and using digital systems and tools for designing were not important skills in the Canadian workforce.

Table 15. Use digital systems and tools: Importance

	Extremely Important	Important	Somewhat Important	Not Important
Select digital systems and tools	30.0% (6)	35.0% (7)	30.0% (6)	5.0% (1)
Set up digital systems and tools	15.0% (3)	25.0% (5)	45.0% (9)	15.0% (3)
Install software applications	10.0% (2)	15.0% (3)	40.0% (8)	35.0% (7)
Connect digital systems and tools to the Internet	30.0% (6)	15.0% (3)	20.0% (4)	35.0% (7)
Maintain digital systems and tools	15.0% (3)	25.0% (5)	45.0% (9)	15.0% (3)
Manage operating systems and files	35.0% (7)	20.0% (4)	20.0% (4)	25.0% (5)
Back up files and data	45.0% (9)	25.0% (5)	25.0% (5)	5.0% (1)
Troubleshoot digital systems and tools	20.0% (4)	30.0% (6)	30.0% (6)	20.0% (4)
Customize work environments	15.0% (3)	45.0% (9)	25.0% (5)	15.0% (3)
Select mobile digital devices	20.0% (4)	15.0% (3)	30.0% (6)	35.0% (7)
Set up mobile digital devices	10.0% (2)	25.0% (5)	20.0% (4)	45.0% (9)
Use mobile digital devices	25.0% (5)	50.0% (10)	0.0% (0)	25.0% (5)
Use digital systems and tools to access information	65.0% (13)	25.0% (5)	10.0% (2)	0.0% (0)
Use digital systems and tools to process information	65.0% (13)	15.0% (3)	15.0% (3)	5.0% (1)
Use digital systems and tools for communicating	65.0% (13)	35.0% (7)	0.0% (0)	0.0% (0)
Use digital systems and tools for collaborating	40.0% (8)	40.0% (8)	20.0% (4)	0.0% (0)
Use digital systems and tools for learning	40.0% (8)	45.0% (9)	15.0% (3)	0.0% (0)
Use digital systems and tools for solving problems	45.0% (9)	30.0% (6)	20.0% (4)	5.0% (1)
Use digital systems and tools for designing	20.0% (4)	25.0% (5)	30.0% (6)	25.0% (5)
Use digital systems and tools for planning	40.0% (8)	40.0% (8)	10.0% (2)	10.0% (2)
Migrate to new digital systems and tools	15.0% (3)	40.0% (8)	35.0% (7)	10.0% (2)

(n = 20)

Use digital systems and tools: Frequency of use

The great majority of the key informants indicated that workers in their sectors were using digital systems and tools on a daily basis for accessing (89.5%), processing (84.2%) and communicating information (89.5%) (Table 16). A sizeable proportion also believed that the workers were practicing the following digital skills everyday: select digital systems and tools (50%); maintain digital systems and tools (42.1%); manage operating systems and files (63.2%); back up files and data (57.9%); use mobile digital devices (63.2%); use digital systems and tools for collaborating (63.2%); use digital systems and tools for learning (42.1%); use digital systems and tools to solve problems (47.4%); and use digital systems and tools for planning (52.6%). It is noteworthy that a significant proportion of key informants believed that the following skills were not currently being used in their sector: install software applications (47.4%);

connect digital systems and tools to the internet (31.6%); select mobile digital devices (36.8%); set up mobile digital devices (42.1%); and migrate to new digital systems and tools (36.8%).

Table 16. Use digital systems and tools: Frequency of use

	Every Day	Weekly	Monthly	Never Use
Select digital systems and tools	50.0% (10)	5.0% (1)	25.0% (5)	20.0% (4)
Set up digital systems and tools	10.5% (2)	21.1% (4)	52.6% (10)	15.8% (3)
Install software applications	5.3% (1)	15.8% (3)	31.6% (6)	47.4% (9)
Connect digital systems and tools to the Internet	26.3% (5)	15.8% (3)	26.3% (5)	31.6% (6)
Maintain digital systems and tools	42.1% (8)	10.5% (2)	36.8% (7)	10.5% (2)
Manage operating systems and files	63.2% (12)	0.0% (0)	21.1% (4)	15.8% (3)
Back up files and data	57.9% (11)	5.3% (1)	26.3% (5)	10.5% (2)
Troubleshoot digital systems and tools	21.1% (4)	15.8% (3)	42.1% (8)	21.1% (4)
Customize work environments	15.8% (3)	31.6% (6)	36.8% (7)	15.8% (3)
Select mobile digital devices	15.8% (3)	21.1% (4)	26.3% (5)	36.8% (7)
Set up mobile digital devices	10.5% (2)	21.1% (4)	26.3% (5)	42.1% (8)
Use mobile digital devices	63.2% (12)	10.5% (2)	5.3% (1)	21.1% (4)
Use digital systems and tools to access information	89.5% (17)	5.3% (1)	5.3% (1)	0.0% (0)
Use digital systems and tools to process information	84.2% (16)	0.0% (0)	10.5% (2)	5.3% (1)
Use digital systems and tools for communicating	89.5% (17)	10.5% (2)	0.0% (0)	0.0% (0)
Use digital systems and tools for collaborating	63.2% (12)	21.1% (4)	15.8% (3)	0.0% (0)
Use digital systems and tools for learning	42.1% (8)	15.8% (3)	42.1% (8)	0.0% (0)
Use digital systems and tools for solving problems	47.4% (9)	26.3% (5)	15.8% (3)	10.5% (2)
Use digital systems and tools for designing	26.3% (5)	21.1% (4)	21.1% (4)	31.6% (6)
Use digital systems and tools for planning	52.6% (10)	15.8% (3)	21.1% (4)	10.5% (2)
Migrate to new digital systems and tools	5.3% (1)	10.5% (2)	47.4% (9)	36.8% (7)

* (n is not equal to 20 for some questions)

Use digital systems and tools: Workers' proficiency

None of the key informants felt that workers in their respective sector were extremely proficient to perform the following digital skills: (a) customize work environments; (b) select mobile digital devices; (c) use mobile digital devices (d) and migrate to new digital systems (Table 17). Only a small proportion of key informants believed that workers were extremely proficient in the other skill areas, the only exception being (a) back up files and data (31.6%), use digital systems and tools to access information (36.8%), process information (26.3%) and communicate (21.1%). A sizeable percentage of the key informants rated workers' skills as "proficient". Digital skills receiving the lowest "proficiency" rating were: (a) installs software applications; (b) back up files and data (c) and troubleshoot digital systems and tools.A significant proportion of the key informants indicated that workers were only "somewhat" proficient for a vast array of digital skills. Several of them however, gave a "not proficient" rating to the following skills: (a) install software applications (36.8%); (b) back up data files 26.3%; (c) troubleshoot digital system and tools (31.6%); (d) select mobile digital devices (36.8%); (e) set up mobile devices (31.6%); (f) use digital systems and tools for designing (42%); (g) and migrate to new digital systems and tools (26.3%).

Table 17. Use digital systems and tools: Workers' proficiency

	Extremely Proficient	Proficient	Somewhat Proficient	Not Proficient
Select digital systems and tools	15.0% (3)	45.0% (9)	30.0% (6)	10.0% (2)
Set up digital systems and tools	10.5% (2)	31.6% (6)	47.4% (9)	10.5% (2)
Install software applications	15.8% (3)	21.1% (4)	26.3% (5)	36.8% (7)
Connect digital systems and tools to the Internet	10.5% (2)	42.1% (8)	31.6% (6)	15.8% (3)
Maintain digital systems and tools	10.5% (2)	21.1% (4)	52.6% (10)	15.8% (3)
Manage operating systems and files	15.8% (3)	31.6% (6)	36.8% (7)	15.8% (3)

Table 17. Use digital systems and tools: Workers' proficiency				
	Extremely Proficient	Proficient	Somewhat Proficient	Not Proficient
Back up files and data	31.6% (6)	21.1% (4)	21.1% (4)	26.3% (5)
Troubleshoot digital systems and tools	10.5% (2)	21.1% (4)	36.8% (7)	31.6% (6)
Customize work environments	0.0% (0)	42.1% (8)	42.1% (8)	15.8% (3)
Select mobile digital devices	0.0% (0)	36.8% (7)	26.3% (5)	36.8% (7)
Set up mobile digital devices	0.0% (0)	31.6% (6)	36.8% (7)	31.6% (6)
Use mobile digital devices	0.0% (0)	68.4% (13)	15.8% (3)	15.8% (3)
Use digital systems and tools to access information	36.8% (7)	36.8% (7)	26.3% (5)	0.0% (0)
Use digital systems and tools to process information	26.3% (5)	36.8% (7)	31.6% (6)	5.3% (1)
Use digital systems and tools for communicating	21.1% (4)	63.2% (12)	15.8% (3)	0.0% (0)
Use digital systems and tools for collaborating	10.5% (2)	57.9% (11)	31.6% (6)	0.0% (0)
Use digital systems and tools for learning	15.8% (3)	57.9% (11)	21.1% (4)	5.3% (1)
Use digital systems and tools for solving problems	15.8% (3)	26.3% (5)	42.1% (8)	15.8% (3)
Use digital systems and tools for designing	15.8% (3)	31.6% (6)	10.5% (2)	42.1% (8)
Use digital systems and tools for planning	10.5% (2)	47.4% (9)	31.6% (6)	10.5% (2)
Migrate to new digital systems and tools	0.0% (0)	36.8% (7)	36.8% (7)	26.3% (5)

* (n is not equal to 20 for some questions)

A cross-comparative analysis of the digital skills ratings in terms of importance, frequency of use and workers proficiency level was performed. Results displayed in Table 18, indicate that the great majority of key informants believed that the skills related to the use of digital systems and tools for accessing, processing, communicating information and collaborating were important, they were being performed every day, and that workers were reasonably proficient in performing these skills.

Table 18, Cross-comparative analysis of the digital skills ratings

Table 18. Cross-comparative analysis of the digital skills ratings	Ratings of extremely important and important combined	Digital skills used Everyday	Ratings of extremely proficient and proficient combined
Use digital systems and tools to access information	90	89.5	73.6
Use digital systems and tools to process information	80	84.2	63.1
Use digital systems and tools for communicating	100	89.5	84.3
Use digital systems and tools for collaborating	80	63.2	68.4

Use software applications: Importance

A sizeable proportion of the key informants indicated that several of the digital skills related to the use of software applications were extremely important (Table 19). Skills receiving the highest ratings for being extremely important were: (a) used internet-based software (63.2%); (b) use computer operating software (52.6%); use word processing software (52.6%); use software applications to access information (52.6%); use spreadsheet software (42.1%); comply with legal copyright provision (42.1%); use data base software (36.8%); use presentation software (31.6%); and use custom-designed software (31.6%). The skills which received the least support for being extremely important included: (a) use desktop publishing software (5.3%); (b) use web development software (5.3%); and migrate to new software applications (10.5%). A sizeable proportion of key informants rated the digital skills related to the use of software applications as “important” and “somewhat important”. A high proportion of key informants also rated the use of several software applications as “not important” for their sector, including: (a) use accounting software (57.9%); use of drawing and planning software (52.6%); use of publishing software (47.4%); use of design and imaging software (47.4%); use of multimedia software (31.6%); and use project management software (31.6%). It is

noteworthy that 21.1% of the key informants indicated that it was not important for workers in their sector to have the necessary skills to comply with copyright provisions.

Table 19. Use software applications: Importance

	Extremely Important	Important	Somewhat Important	Not Important
Use computer operating software	52.6% (10)	21.1% (4)	10.5% (2)	15.8% (3)
Use word processing software	52.6% (10)	31.6% (6)	10.5% (2)	5.3% (1)
Use Internet-based software	63.2% (12)	21.1% (4)	10.5% (2)	5.3% (1)
Use audio and video software	15.8% (3)	21.1% (4)	42.1% (8)	21.1% (4)
Use spreadsheet software	42.1% (8)	21.1% (4)	21.1% (4)	15.8% (3)
Use presentation software	31.6% (6)	36.8% (7)	26.3% (5)	5.3% (1)
Use multimedia software	26.3% (5)	10.5% (2)	31.6% (6)	31.6% (6)
Use desktop publishing software	5.3% (1)	15.8% (3)	31.6% (6)	47.4% (9)
Use accounting software	26.3% (5)	10.5% (2)	5.3% (1)	57.9% (11)
Use database software	36.8% (7)	15.8% (3)	36.8% (7)	10.5% (2)
Use data management software	21.1% (4)	15.8% (3)	36.8% (7)	26.3% (5)
Use project management software	21.1% (4)	5.3% (1)	42.1% (8)	31.6% (6)
Use design and imaging software	26.3% (5)	5.3% (1)	21.1% (4)	47.4% (9)
Use drawing and planning software	15.8% (3)	15.8% (3)	15.8% (3)	52.6% (10)
Use custom-designed software	31.6% (6)	21.1% (4)	21.1% (4)	26.3% (5)
Use web development software	5.3% (1)	15.8% (3)	36.8% (7)	42.1% (8)
Comply with legal copyright provisions	42.1% (8)	36.8% (7)	0.0% (0)	21.1% (4)
Use software applications to access information	52.6% (10)	36.8% (7)	5.3% (1)	5.3% (1)
Migrate to new software applications	10.5% (2)	26.3% (5)	42.1% (8)	21.1% (4)

(n = 19)

Use software applications: Frequency of use

According to a significant proportion of key informants the software applications that were being used every day by workers in their sector were: (a) word processing software 73.7%; (b) internet-based software (68.4%); computer operating software (68.4%); and Software applications to access information (63.2%) (Table 20). Other software applications reported being used every day by a sizeable proportion of key informants include: (a) spreadsheets (36.8%); accounting software (36.8%); data base software (31.6%); design and imaging software (31.6%); custom designed software (47.4%); and comply with legal copyright provisions in using software applications (36.8%). It is noteworthy that a substantial proportion of key informants indicated that several software applications were not being used in their sector.

Table 20. Use software applications: Frequency of use

	Every Day	Weekly	Monthly	Never Use
Use computer operating software	68.4% (13)	0.0% (0)	5.3% (1)	26.3% (5)
Use word processing software	73.7% (14)	15.8% (3)	5.3% (1)	5.3% (1)
Use Internet-based software	68.4% (13)	21.1% (4)	5.3% (1)	5.3% (1)
Use audio and video software	21.1% (4)	21.1% (4)	47.4% (9)	10.5% (2)
Use spreadsheet software	36.8% (7)	31.6% (6)	15.8% (3)	15.8% (3)
Use presentation software	5.3% (1)	36.8% (7)	52.6% (10)	5.3% (1)
Use multimedia software	15.8% (3)	10.5% (2)	42.1% (8)	31.6% (6)
Use desktop publishing software	15.8% (3)	0.0% (0)	42.1% (8)	42.1% (8)
Use accounting software	36.8% (7)	0.0% (0)	5.3% (1)	57.9% (11)
Use database software	31.6% (6)	15.8% (3)	36.8% (7)	15.8% (3)
Use data management software	21.1% (4)	21.1% (4)	15.8% (3)	42.1% (8)
Use project management software	0.0% (0)	31.6% (6)	26.3% (5)	42.1% (8)
Use design and imaging software	31.6% (6)	5.3% (1)	21.1% (4)	42.1% (8)
Use drawing and planning software	21.1% (4)	15.8% (3)	15.8% (3)	47.4% (9)

Table 20. Use software applications: Frequency of use				
	Every Day	Weekly	Monthly	Never Use
Use custom-designed software	47.4% (9)	5.3% (1)	15.8% (3)	31.6% (6)
Use web development software	10.5% (2)	15.8% (3)	26.3% (5)	47.4% (9)
Comply with legal copyright provisions	36.8% (7)	15.8% (3)	15.8% (3)	31.6% (6)
Use software applications to access information	63.2% (12)	10.5% (2)	15.8% (3)	10.5% (2)
Migrate to new software applications	5.3% (1)	10.5% (2)	52.6% (10)	31.6% (6)

(n = 19)

The key informants identified several workers' proficiency gaps regarding the use of software applications in their sector (Table 21). The most notable of these gaps were related to the use of: multimedia software (33.3%); desktop publishing software (38.9%); accounting software (55.6%); drawing and planning software (44.4%); design and imaging software (38.9%); and web development software (50%). Notwithstanding the skills gaps, well above two-third of the key informants rated the workers skills as extremely proficient to somewhat proficient. A significant proportion of key informants rated their workers as being proficient in a wide variety of software applications.

Table 21. Use software applications: Workers' proficiency level				
	Extremely Proficient	Proficient	Somewhat Proficient	Not Proficient
Use computer operating software	22.2% (4)	44.4% (8)	11.1% (2)	22.2% (4)
Use word processing software	22.2% (4)	55.6% (10)	16.7% (3)	5.6% (1)
Use Internet-based software	27.8% (5)	50.0% (9)	22.2% (4)	0.0% (0)
Use audio and video software	5.6% (1)	38.9% (7)	38.9% (7)	16.7% (3)
Use spreadsheet software	11.1% (2)	50.0% (9)	22.2% (4)	16.7% (3)
Use presentation software	16.7% (3)	44.4% (8)	22.2% (4)	16.7% (3)
Use multimedia software	11.1% (2)	33.3% (6)	22.2% (4)	33.3% (6)
Use desktop publishing software	5.6% (1)	16.7% (3)	38.9% (7)	38.9% (7)
Use accounting software	22.2% (4)	11.1% (2)	11.1% (2)	55.6% (10)
Use database software	16.7% (3)	33.3% (6)	27.8% (5)	22.2% (4)
Use data management software	16.7% (3)	27.8% (5)	27.8% (5)	27.8% (5)
Use project management software	5.6% (1)	33.3% (6)	33.3% (6)	27.8% (5)
Use design and imaging software	16.7% (3)	22.2% (4)	22.2% (4)	38.9% (7)
Use drawing and planning software	11.1% (2)	33.3% (6)	11.1% (2)	44.4% (8)
Use custom-designed software	27.8% (5)	38.9% (7)	5.6% (1)	27.8% (5)
Use web development software	5.6% (1)	16.7% (3)	27.8% (5)	50.0% (9)
Comply with legal copyright provisions	22.2% (4)	44.4% (8)	11.1% (2)	22.2% (4)
Use software applications to access information	22.2% (4)	50.0% (9)	22.2% (4)	5.6% (1)
Migrate to new software applications	5.6% (1)	16.7% (3)	55.6% (10)	22.2% (4)

(n = 18)

Apply security measures in digital environments: Importance

Very few of the key informants rated the digital security skills as "somewhat important" and "not important" (Table 22). The great majority of them rate all these skills as either "extremely important" or "important". The skills that were considered to be most important by a high proportion of key informants were: (a) use anti-virus software (78.9%); (b) install local firewall (63.2%); (c) securely send and open digital messages (73.7%); (d) securely connect to networks (68.4%); (e) secure user ID and password (94.7%); protect digital content against accidental destruction (68.4%); secure personal information against identity threats (63.2%); comply with employer's digital policy (72.2%).

Table 22. Apply security measures in digital environments: Importance				
	Extremely Important	Important	Somewhat Important	Not Important
Use anti-virus software to protect digital tools and systems from cyber	78.9% (15)	10.5% (2)	0.0% (0)	10.5% (2)
Distinguish between hoaxes and real threat warnings.	52.6% (10)	26.3% (5)	15.8% (3)	5.3% (1)
Install local firewall on computers	63.2% (12)	5.3% (1)	10.5% (2)	21.1% (4)
Securely send and open digital messages and content	73.7% (14)	10.5% (2)	5.3% (1)	10.5% (2)
Securely connect to networks	68.4% (13)	15.8% (3)	5.3% (1)	10.5% (2)
Encrypt sensitive information	31.6% (6)	31.6% (6)	21.1% (4)	15.8% (3)
Backup and store digital contents	52.6% (10)	26.3% (5)	10.5% (2)	10.5% (2)
Delete sensitive digital content	31.6% (6)	31.6% (6)	15.8% (3)	21.1% (4)
Secure user ID and passwords	94.7% (18)	0.0% (0)	0.0% (0)	5.3% (1)
Protect digital content against accidental destruction	68.4% (13)	15.8% (3)	5.3% (1)	10.5% (2)
Protect unauthorized use and modification of digital content	42.1% (8)	36.8% (7)	10.5% (2)	10.5% (2)
Comply with legal issues of digital contents	47.4% (9)	36.8% (7)	10.5% (2)	5.3% (1)
Determine trustworthiness of digital sources	42.1% (8)	36.8% (7)	10.5% (2)	10.5% (2)
Identify digital frauds, suspicious activity and cyber crimes	36.8% (7)	26.3% (5)	26.3% (5)	10.5% (2)
Practice safe online behaviours	57.9% (11)	36.8% (7)	0.0% (0)	5.3% (1)
Secure personal information against identity threats	63.2% (12)	26.3% (5)	5.3% (1)	5.3% (1)
Maintain a secure digital footprint	44.4% (8)	33.3% (6)	16.7% (3)	5.6% (1)
Report suspicious online activity	31.6% (6)	42.1% (8)	15.8% (3)	10.5% (2)
Report breaches in security	42.1% (8)	31.6% (6)	10.5% (2)	15.8% (3)
Comply with employer's digital policy	72.2% (13)	16.7% (3)	0.0% (0)	11.1% (2)

* (n is not equal to 20 for some questions)

Apply security measures in digital environments: Frequency of use

The majority of key informants indicated that the vast majority the digital security skills were being used every day in their sector (Table 23). The skills that received the least "every day" use support were: (a) encrypt sensitive information (27.8%; (b) delete sensitive digital content (33.3%); (c) report suspicious activity (27.8%); and (d) report breaches in security (33.3%). The security skills that were least frequently being used includes (a) install local firewall (27.8%); (b) encrypt sensitive information (33.3%); (c) delete sensitive digital content (22.2%); (d) comply with legal issues of digital content (22.2%); (e) identify digital frauds, suspicious activity and cyber-crimes (33.3%); (f) report suspicious activity (27.8%); and (d) report breaches in security (38.9%).

Table 23. Apply security measures in digital environments: Frequency of use				
	Every Day	Weekly	Monthly	Never Use
Use anti-virus software to protect digital tools and systems from cyber	78.9% (15)	0.0% (0)	10.5% (2)	10.5% (2)
Distinguish between hoaxes and real threat warnings.	44.4% (8)	11.1% (2)	33.3% (6)	11.1% (2)
Install local firewall on computers	38.9% (7)	11.1% (2)	22.2% (4)	27.8% (5)
Securely send and open digital messages and content	72.2% (13)	11.1% (2)	5.6% (1)	11.1% (2)
Securely connect to networks	83.3% (15)	5.6% (1)	5.6% (1)	5.6% (1)
Encrypt sensitive information	27.8% (5)	11.1% (2)	27.8% (5)	33.3% (6)
Backup and store digital contents	44.4% (8)	22.2% (4)	16.7% (3)	16.7% (3)
Delete sensitive digital content	33.3% (6)	16.7% (3)	27.8% (5)	22.2% (4)
Secure user ID and passwords	88.9% (16)	5.6% (1)	0.0% (0)	5.6% (1)
Protect digital content against accidental destruction	61.1% (11)	11.1% (2)	16.7% (3)	11.1% (2)
Protect unauthorized use and modification of digital content	55.6% (10)	11.1% (2)	16.7% (3)	16.7% (3)
Comply with legal issues of digital contents	55.6% (10)	16.7% (3)	5.6% (1)	22.2% (4)
Determine trustworthiness of digital sources	55.6% (10)	11.1% (2)	16.7% (3)	16.7% (3)
Identify digital frauds, suspicious activity and cyber crimes	44.4% (8)	11.1% (2)	11.1% (2)	33.3% (6)
Practice safe online behaviours	77.8% (14)	11.1% (2)	0.0% (0)	11.1% (2)
Secure personal information against identity threats	66.7% (12)	11.1% (2)	5.6% (1)	16.7% (3)

Table 23. Apply security measures in digital environments: Frequency of use				
	Every Day	Weekly	Monthly	Never Use
Maintain a secure digital footprint	58.8% (10)	11.8% (2)	17.6% (3)	11.8% (2)
Report suspicious online activity	27.8% (5)	11.1% (2)	33.3% (6)	27.8% (5)
Report breaches in security	33.3% (6)	0.0% (0)	27.8% (5)	38.9% (7)
Comply with employer's digital policy	76.5% (13)	11.8% (2)	0.0% (0)	11.8% (2)

* (n is not equal to 20 for some questions)

Apply security measures in digital environments: Proficiency

A comfortable proportion of key informants believed that workforce were extremely competent to perform the vast majority of the digital security skills (Table 24). The skills receiving the lowest rating on "extremely proficient" were (a) report suspicious online activity (11.1%); and (b) report breaches in security (11.1%). Similarly, digital skills (a) encrypt sensitive information (16.7%) and identify digital frauds, suspicious activity and cyber-crimes (11.8%) received the lowest rating in the "proficient" category. Moreover, the digital skills for which more key informants believed that workers were not proficient were: (a) Install local firewall on computers (27.8%); (b) delete sensitive digital content (27.8%); (c) identify digital frauds, suspicious activity and cyber-crimes (35.3%), (d) report suspicious online activity 27.8%); and (e) report breaches in security (33.3%).

Table 24. Apply security measures in digital environments: Proficiency				
	Extremely	Proficient	Somewhat Proficient	Not Proficient
Use anti-virus software to protect digital tools and systems from cyber	50.0% (9)	22.2% (4)	22.2% (4)	5.6% (1)
Distinguish between hoaxes and real threat warnings.	27.8% (5)	44.4% (8)	16.7% (3)	11.1% (2)
Install local firewall on computers	33.3% (6)	27.8% (5)	11.1% (2)	27.8% (5)
Securely send and open digital messages and content	44.4% (8)	38.9% (7)	0.0% (0)	16.7% (3)
Securely connect to networks	44.4% (8)	38.9% (7)	5.6% (1)	11.1% (2)
Encrypt sensitive information	22.2% (4)	16.7% (3)	38.9% (7)	22.2% (4)
Backup and store digital contents	38.9% (7)	22.2% (4)	22.2% (4)	16.7% (3)
Delete sensitive digital content	27.8% (5)	33.3% (6)	11.1% (2)	27.8% (5)
Secure user ID and passwords	50.0% (9)	38.9% (7)	5.6% (1)	5.6% (1)
Protect digital content against accidental destruction	33.3% (6)	38.9% (7)	11.1% (2)	16.7% (3)
Protect unauthorized use and modification of digital content	27.8% (5)	33.3% (6)	16.7% (3)	22.2% (4)
Comply with legal issues of digital contents	27.8% (5)	38.9% (7)	11.1% (2)	22.2% (4)
Determine trustworthiness of digital sources	27.8% (5)	27.8% (5)	33.3% (6)	11.1% (2)
Identify digital frauds, suspicious activity and cyber crimes	29.4% (5)	11.8% (2)	23.5% (4)	35.3% (6)
Practice safe online behaviours	38.9% (7)	33.3% (6)	16.7% (3)	11.1% (2)
Secure personal information against identity threats	27.8% (5)	22.2% (4)	38.9% (7)	11.1% (2)
Maintain a secure digital footprint	23.5% (4)	35.3% (6)	29.4% (5)	11.8% (2)
Report suspicious online activity	11.1% (2)	38.9% (7)	22.2% (4)	27.8% (5)
Report breaches in security	11.1% (2)	33.3% (6)	22.2% (4)	33.3% (6)
Comply with employer's digital policy	22.2% (4)	38.9% (7)	16.7% (3)	22.2% (4)

* (n is not equal to 20 for some questions)

Validation of the Digital Information Processing Skills

Digital information processing skills: Importance

There was considerable variability in the degree of importance that the key informants attributed to the digital information processing skills for their sector (Table 25). Fifty per cent or more of the key informants rated the following skills as extremely important: (a) scan information visually (63.2%); (b) analyze information (57.9%); (c)

interpret information (63.2%); (d) make effective and efficient use of information (63.2%); (e) use information to solve problems (52.6%); and (f) behave and act ethically in handling information (73.7%), which received the highest rating.

Fifty per cent or more of the key informants also believed that eight of the information processing skills were important for their sector: (1) determine what, when, and how much information is needed (57.9%); (2) articulate information needs (63.2%); (3) select information to meet needs (57.9%); (4) organize information in logical flow (52.6%); (5) categorize information (52.6%); (6) classify information for ease of storage, retrieval and use (52.6%); (7) process information under time pressure (52.6%); and (8) process information in collaboration with others (63.2%).

Close to one-third and slightly more of the key informants rated the following digital information processing skills as "not important" (a) decode information presented in multiple formats (31.6%); (b) Work with language, symbols and conventions of the digital medium (31.6%); (c) Navigate through complex information-architecture (36.8%); (d) Navigate through complex hypermedia environments (47.4%); (e) demonstrate digital screen fluency (33.3%); (f) apply information for designing and authoring digital contents (36.8%); and (g) use social network to communicate (47.4%).

Digital information processing skills: Frequency of use

Results indicated that the great majority of key informants believed that several of the digital information processing skills were being used" every day" by workers in their sector (Table 26). Skills that received less than one-third support from the key informants in terms of their "extreme importance" included: (a) Decode information presented in multiple format (27.8%); (b) restructure randomly acquired information (22.2%); (c) represent information in various format (27.8%); (d) navigate through complex information-architecture (27.8%); (e) navigate through complex hypermedia environments (22.2%); (f) demonstrate digital screen fluency (29.4%); (g) generate knowledge using randomly acquired information (16.7%); (h) apply information for designing and authoring digital content (16.7%); (i) contribute to continual improvement of information (27.8%); and (j) use social networks to communicate (22.2%).

According to one-third or more of the key informants the following Digital Information Processing Skills were not being used by people employed in their sector: (a) decode information presented in multiple format (33.3%); (b) work with languages, symbols and conventions in the digital medium (33.3%); (c) navigate through complex information-architecture (50%); (d) navigate through complex hypermedia environments (55.6%); (e) demonstrate digital screen fluency (47.1%); (f) apply information for designing and authoring digital contents (44.4%); and (g) use social networks to communicate (50%).

Digital information processing skills: Workers' proficiency level

Considerable variations were observed regarding key informants ratings of workers' information processing proficiency level (Table 27). Only one-third of the key informants ranked four skills as "extremely proficient". These skills were: (a) scan information visually (33.3%); (b) make effective and efficient use of information (38.9%); (c) use information to solve problems (33.3%); and (d) behave and act ethically in handling information (33.3%). Fifty per cent or more of the key informants indicated that workers in their sector were "proficient" in 19 of the Digital Information Processing Skills.

One third or more of the key informants felt that workers in their sector were not proficient to perform the following six information processing skills: (a) decode information presented in multiple formats (33.3%); (b) navigate through complex information-architecture (38.9%); (c) navigate through complex hypermedia environments (44.4%); (d) demonstrate digital skills fluency (35.3%); apply information for designing and authoring digital contents (38.9%); and (e) use social network to communicate (50%).

Table 25. Digital information processing skills: Importance

	Extremely Important	Important	Somewhat Important	Not Important
Determine what, when and how much information is needed	42.1% (8)	57.9% (11)	0.0% (0)	0.0% (0)
Articulate information needs	31.6% (6)	63.2% (12)	0.0% (0)	5.3% (1)
Locate information sources	47.4% (9)	42.1% (8)	0.0% (0)	10.5% (2)
Select information to meet needs	36.8% (7)	57.9% (11)	0.0% (0)	5.3% (1)
Retrieve information of various types and format from various sources	42.1% (8)	42.1% (8)	5.3% (1)	10.5% (2)
Scan information visually	63.2% (12)	21.1% (4)	5.3% (1)	10.5% (2)
Analyze information	57.9% (11)	31.6% (6)	5.3% (1)	5.3% (1)
Evaluate the quality, trustworthiness, integrity and relevance of information	47.4% (9)	42.1% (8)	0.0% (0)	10.5% (2)
Determine the usefulness and applicability of information	47.4% (9)	36.8% (7)	5.3% (1)	10.5% (2)
Decode information presented in multiple format	21.1% (4)	26.3% (5)	21.1% (4)	31.6% (6)
Restructure randomly acquired information	26.3% (5)	47.4% (9)	10.5% (2)	15.8% (3)
Organize information in a logical flow	31.6% (6)	52.6% (10)	0.0% (0)	15.8% (3)
Categorize information	26.3% (5)	52.6% (10)	15.8% (3)	5.3% (1)
Classify information for ease of storage, retrieval and use	26.3% (5)	52.6% (10)	15.8% (3)	5.3% (1)
Interpret information	63.2% (12)	31.6% (6)	5.3% (1)	0.0% (0)
Summarize information	36.8% (7)	47.4% (9)	15.8% (3)	0.0% (0)
Compare and contrast different information types	26.3% (5)	47.4% (9)	10.5% (2)	15.8% (3)
Combine information from different sources	26.3% (5)	36.8% (7)	26.3% (5)	10.5% (2)
Represent information in various digital formats	21.1% (4)	21.1% (4)	31.6% (6)	26.3% (5)
Repurpose existing information	10.5% (2)	47.4% (9)	26.3% (5)	15.8% (3)
Work with language, symbols and conventions of the digital medium	31.6% (6)	15.8% (3)	21.1% (4)	31.6% (6)
Navigate through complex information-architecture	10.5% (2)	31.6% (6)	21.1% (4)	36.8% (7)
Navigate through complex hypermedia environments	5.3% (1)	15.8% (3)	31.6% (6)	47.4% (9)
Demonstrate digital screen fluency	22.2% (4)	16.7% (3)	27.8% (5)	33.3% (6)
Work across multiple environments	26.3% (5)	21.1% (4)	26.3% (5)	26.3% (5)
Work in environments with multiple input and stimuli	36.8% (7)	15.8% (3)	36.8% (7)	10.5% (2)
Use information displayed in visual and graphical format	36.8% (7)	36.8% (7)	15.8% (3)	10.5% (2)
Use charts and graphs to represent information	36.8% (7)	21.1% (4)	21.1% (4)	21.1% (4)
Memorize essential information	26.3% (5)	36.8% (7)	31.6% (6)	5.3% (1)
Make effective and efficient use of information	63.2% (12)	31.6% (6)	5.3% (1)	0.0% (0)
Use information to solve problems	52.6% (10)	36.8% (7)	10.5% (2)	0.0% (0)
Work on multiple digital task simultaneously	21.1% (4)	31.6% (6)	21.1% (4)	26.3% (5)
Process information under time pressure	31.6% (6)	52.6% (10)	5.3% (1)	10.5% (2)
Determine interconnectedness of information	21.1% (4)	42.1% (8)	26.3% (5)	10.5% (2)
Generate knowledge using randomly acquired information	10.5% (2)	36.8% (7)	36.8% (7)	15.8% (3)
Generate new knowledge by combining, organizing, integrating, adapting information in various digital formats	26.3% (5)	21.1% (4)	36.8% (7)	15.8% (3)
Apply information for designing and authoring digital contents	10.5% (2)	15.8% (3)	36.8% (7)	36.8% (7)
Contribute to continual improvement of information	21.1% (4)	42.1% (8)	26.3% (5)	10.5% (2)
Use social networks to communicate	21.1% (4)	15.8% (3)	15.8% (3)	47.4% (9)
Process information in collaboration with others	26.3% (5)	63.2% (12)	0.0% (0)	10.5% (2)
Assess what information can be shared with others	42.1% (8)	47.4% (9)	0.0% (0)	10.5% (2)
Behave and act ethically in handling information	73.7% (14)	15.8% (3)	10.5% (2)	0.0% (0)
Determine how to dispose information	36.8% (7)	42.1% (8)	10.5% (2)	10.5% (2)

(n is not equal to 20 for some questions)

Table 26. Digital information processing skills: Frequency of use				
	Every Day	Weekly	Monthly	Never Use
Determine what, when and how much information is needed	66.7% (12)	22.2% (4)	11.1% (2)	0.0% (0)
Articulate information needs	66.7% (12)	11.1% (2)	16.7% (3)	5.6% (1)
Locate information sources	83.3% (15)	11.1% (2)	0.0% (0)	5.6% (1)
Select information to meet needs	83.3% (15)	16.7% (3)	0.0% (0)	0.0% (0)
Retrieve information of various types and format from various sources	77.8% (14)	11.1% (2)	5.6% (1)	5.6% (1)
Scan information visually	88.9% (16)	5.6% (1)	0.0% (0)	5.6% (1)
Analyze information	77.8% (14)	16.7% (3)	0.0% (0)	5.6% (1)
Evaluate the quality, trustworthiness, integrity and relevance of information	66.7% (12)	22.2% (4)	5.6% (1)	5.6% (1)
Determine the usefulness and applicability of information	72.2% (13)	16.7% (3)	5.6% (1)	5.6% (1)
Decode information presented in multiple format	27.8% (5)	11.1% (2)	27.8% (5)	33.3% (6)
Restructure randomly acquired information	22.2% (4)	27.8% (5)	38.9% (7)	11.1% (2)
Organize information in a logical flow	44.4% (8)	33.3% (6)	11.1% (2)	11.1% (2)
Categorize information	50.0% (9)	27.8% (5)	22.2% (4)	0.0% (0)
Classify information for ease of storage, retrieval and use	72.2% (13)	11.1% (2)	11.1% (2)	5.6% (1)
Interpret information	88.9% (16)	11.1% (2)	0.0% (0)	0.0% (0)
Summarize information	66.7% (12)	27.8% (5)	5.6% (1)	0.0% (0)
Compare and contrast different information types	38.9% (7)	33.3% (6)	16.7% (3)	11.1% (2)
Combine information from different sources	50.0% (9)	16.7% (3)	27.8% (5)	5.6% (1)
Represent information in various digital formats	27.8% (5)	11.1% (2)	33.3% (6)	27.8% (5)
Repurpose existing information	38.9% (7)	5.6% (1)	44.4% (8)	11.1% (2)
Work with language, symbols and conventions of the digital medium	44.4% (8)	11.1% (2)	11.1% (2)	33.3% (6)
Navigate through complex information-architecture	27.8% (5)	5.6% (1)	16.7% (3)	50.0% (9)
Navigate through complex hypermedia environments	22.2% (4)	5.6% (1)	16.7% (3)	55.6% (10)
Demonstrate digital screen fluency	29.4% (5)	5.9% (1)	17.6% (3)	47.1% (8)
Work across multiple environments	38.9% (7)	0.0% (0)	33.3% (6)	27.8% (5)
Work in environments with multiple input and stimuli	61.1% (11)	0.0% (0)	22.2% (4)	16.7% (3)
Use information displayed in visual and graphical format	61.1% (11)	0.0% (0)	27.8% (5)	11.1% (2)
Use charts and graphs to represent information	33.3% (6)	22.2% (4)	27.8% (5)	16.7% (3)
Memorize essential information	61.1% (11)	11.1% (2)	16.7% (3)	11.1% (2)
Make effective and efficient use of information	83.3% (15)	11.1% (2)	5.6% (1)	0.0% (0)
Use information to solve problems	72.2% (13)	16.7% (3)	11.1% (2)	0.0% (0)
Work on multiple digital task simultaneously	50.0% (9)	11.1% (2)	11.1% (2)	27.8% (5)
Process information under time pressure	50.0% (9)	16.7% (3)	16.7% (3)	16.7% (3)
Determine interconnectedness of information	33.3% (6)	27.8% (5)	22.2% (4)	16.7% (3)
Generate knowledge using randomly acquired information	16.7% (3)	33.3% (6)	38.9% (7)	11.1% (2)
Generate new knowledge by combining, organizing, integrating, adapting information in various digital formats	38.9% (7)	0.0% (0)	50.0% (9)	11.1% (2)
Apply information for designing and authoring digital contents	16.7% (3)	5.6% (1)	33.3% (6)	44.4% (8)
Contribute to continual improvement of information	27.8% (5)	27.8% (5)	33.3% (6)	11.1% (2)
Use social networks to communicate	22.2% (4)	16.7% (3)	11.1% (2)	50.0% (9)
Process information in collaboration with others	38.9% (7)	22.2% (4)	27.8% (5)	11.1% (2)
Assess what information can be shared with others	61.1% (11)	11.1% (2)	16.7% (3)	11.1% (2)
Behave and act ethically in handling information	94.4% (17)	5.6% (1)	0.0% (0)	0.0% (0)

(n is not equal to 20 for some questions)

Table 27. Digital information processing skills : workers' proficiency level				
	Extremely Proficient	Proficient	Somewhat Proficient	Not
Determine what, when and how much information is needed	16.7% (3)	44.4% (8)	38.9% (7)	0.0% (0)
Articulate information needs	16.7% (3)	38.9% (7)	38.9% (7)	5.6% (1)
Locate information sources	16.7% (3)	61.1% (11)	16.7% (3)	5.6% (1)
Select information to meet needs	22.2% (4)	50.0% (9)	27.8% (5)	0.0% (0)
Retrieve information of various types and format from various sources	22.2% (4)	44.4% (8)	27.8% (5)	5.6% (1)
Scan information visually	33.3% (6)	55.6% (10)	5.6% (1)	5.6% (1)
Analyze information	22.2% (4)	61.1% (11)	11.1% (2)	5.6% (1)
Evaluate the quality, trustworthiness, integrity and relevance of information	27.8% (5)	50.0% (9)	16.7% (3)	5.6% (1)
Determine the usefulness and applicability of information	22.2% (4)	55.6% (10)	16.7% (3)	5.6% (1)
Decode information presented in multiple format	16.7% (3)	22.2% (4)	27.8% (5)	33.3% (6)
Restructure randomly acquired information	11.1% (2)	44.4% (8)	27.8% (5)	16.7% (3)
Organize information in a logical flow	22.2% (4)	55.6% (10)	11.1% (2)	11.1% (2)
Categorize information	11.1% (2)	61.1% (11)	22.2% (4)	5.6% (1)
Classify information for ease of storage, retrieval and use	11.1% (2)	50.0% (9)	33.3% (6)	5.6% (1)
Interpret information	27.8% (5)	61.1% (11)	11.1% (2)	0.0% (0)
Summarize information	27.8% (5)	55.6% (10)	16.7% (3)	0.0% (0)
Compare and contrast different information types	22.2% (4)	44.4% (8)	22.2% (4)	11.1% (2)
Combine information from different sources	22.2% (4)	38.9% (7)	33.3% (6)	5.6% (1)
Represent information in various digital formats	11.1% (2)	44.4% (8)	16.7% (3)	27.8% (5)
Repurpose existing information	5.6% (1)	38.9% (7)	38.9% (7)	16.7% (3)
Work with language, symbols and conventions of the digital medium	16.7% (3)	33.3% (6)	22.2% (4)	27.8% (5)
Navigate through complex information-architecture	5.6% (1)	33.3% (6)	22.2% (4)	38.9% (7)
Navigate through complex hypermedia environments	5.6% (1)	22.2% (4)	27.8% (5)	44.4% (8)
Demonstrate digital screen fluency	11.8% (2)	23.5% (4)	29.4% (5)	35.3% (6)
Work across multiple environments	5.6% (1)	33.3% (6)	38.9% (7)	22.2% (4)
Work in environments with multiple input and stimuli	5.6% (1)	44.4% (8)	44.4% (8)	5.6% (1)
Use information displayed in visual and graphical format	22.2% (4)	44.4% (8)	22.2% (4)	11.1% (2)
Use charts and graphs to represent information	16.7% (3)	38.9% (7)	27.8% (5)	16.7% (3)
Memorize essential information	16.7% (3)	50.0% (9)	27.8% (5)	5.6% (1)
Make effective and efficient use of information	38.9% (7)	50.0% (9)	11.1% (2)	0.0% (0)
Use information to solve problems	33.3% (6)	55.6% (10)	11.1% (2)	0.0% (0)
Work on multiple digital task simultaneously	22.2% (4)	38.9% (7)	16.7% (3)	22.2% (4)
Process information under time pressure	16.7% (3)	55.6% (10)	16.7% (3)	11.1% (2)
Determine interconnectedness of information	16.7% (3)	44.4% (8)	27.8% (5)	11.1% (2)
Generate knowledge using randomly acquired information	11.1% (2)	50.0% (9)	22.2% (4)	16.7% (3)
Generate new knowledge by combining, organizing, integrating, adapting information in various digital formats	5.6% (1)	44.4% (8)	33.3% (6)	16.7% (3)
Apply information for designing and authoring digital contents	11.1% (2)	22.2% (4)	27.8% (5)	38.9% (7)
Contribute to continual improvement of information	5.6% (1)	38.9% (7)	38.9% (7)	16.7% (3)
Use social networks to communicate	16.7% (3)	22.2% (4)	11.1% (2)	50.0% (9)
Process information in collaboration with others	16.7% (3)	50.0% (9)	22.2% (4)	11.1% (2)
Assess what information can be shared with others	16.7% (3)	50.0% (9)	22.2% (4)	11.1% (2)
Behave and act ethically in handling information	33.3% (6)	55.6% (10)	11.1% (2)	0.0% (0)
rmine how to dispose information	22.2% (4)	44.4% (8)	16.7% (3)	16.7% (3)

(n is not equal to 20 for some questions)

IMPORTANT DIGITAL SKILLS

In considering a scenario in which only the digital skills rated as important by at least 65% of the key informants were retained for the digital skills framework, a new list of digital skills was generated. This cut off score was used because a 70% agreement among jurisdictions is used for determining common core skills for the National Occupational Analysis of Red Seal Trades. In doing this analysis, the ratings on the scale of "extremely important" and "important" were combined into a single rating: "composite importance". The results of this analysis are presented in the section, which follows.

In the category "Use Digital System and Tools", only ten out of the twenty-one digital skills were rated as extremely important or important by at least 65% of the key informants (Table 28).

Table 28, Use of digital skills rated as extremely important/important by at least 65% of the key informants

Use Digital Systems and Tools	Composite Importance
Use digital systems and tools for communicating	100
Use digital systems and tools to access information	90
Use digital systems and tools for learning	85
Use digital systems and tools to process information	80
Use digital systems and tools for collaborating	80
Use digital systems and tools for planning	80
Use mobile digital devices	75
Use digital systems and tools for solving problems	75
Back up files and data	70
Select digital systems and tools	65

In the category "Use software applications" only six out of nineteen digital skills were rated as extremely important or important by at least 65% of the key informants (Table 29).

Table 29, Use of software application skills rated as extremely important/important by at least 65% of the key informants

Use software applications	Composite Importance
Use software applications to access information	89.4
Use word processing software	84.2
Use Internet-based software	84.3
Comply with legal copyright provisions	78.9
Use computer operating software	73.7
Use presentation software	68.4

In the category “Apply security measures in Digital Environments” all but four digital skills were rated as extremely important or important by at least 65% of the key informants (Table 30).

Table 30, Digital security skills rated as extremely important/important by at least 65% of the key informants

Apply security Measures in Digital Environments	Composite Importance
Secure user ID and passwords	94.7
Practice safe online behaviours	94.7
Use anti-virus software to protect digital tools and systems from cyber attacks	89.5
Secure personal information against identity threats	89.5
Comply with employer’s digital policy	88.9
Securely send and open digital messages and content	84.2
Securely connect to networks	84.2
Protect digital content against accidental destruction	84.2
Comply with legal issues of digital contents	84.2
Backup and store digital contents	78.9
Determine trustworthiness of digital sources	78.9
Distinguish between hoaxes and real threat warnings.	78.9
Protect unauthorized use and modification of digital content	78.9
Maintain a secure digital footprint	77.7
Report suspicious online activity	73.7
Report breaches in security	73.7
Install local firewall on computers	68.5

Among the forty-three information processing skills included in the framework, twenty four of them were rated as extremely important or important by at least 65% of the key informants. It is noteworthy that all key informants agreed that the skill “determine what, when and how much information is needed” is an important skill and that all but one key informant (18/19) also rated the “articulation, selection, interpretation and effective use of information” as important (Table 31).

Table 31, Digital Information Processing skills rated as extremely important/important by at least 65% of the key informants

Digital Information Processing skills	Composite Importance
Determine what, when and how much information is needed	100
Articulate information needs	94.8
Select information to meet needs	94.8
Interpret information	94.8
Make effective and efficient use of information	94.8
Locate information sources	89.5
Analyze information	89.5

Evaluate the quality, trustworthiness, integrity and relevance of information	89.5
Process information in collaboration with others	89.5
Assess what information can be shared with others	89.5
Behave and act ethically in handling information	89.5
Use information to solve problems	89.4
Retrieve information of various types and format from various sources	84.2
Scan information visually	84.3
Determine the usefulness and applicability of information	84.2
Organize information in a logical flow	84.2
Summarize information	84.2
Process information under time pressure	84.2
Categorize information	78.9
Classify information for ease of storage, retrieval and use	78.9
Determine how to dispose information	78.9
Restructure randomly acquired information	73.7
Compare and contrast different information types	73.7
Use information displayed in visual and graphical format	73.6

SUMMARY OF KEY INFORMANTS' COMMENTS

The survey probed key informants' comments on the Digital Information Processing Skills Concepts, the proposed Canadian Digital Skills Framework and on the essential digital skills identified from the literature review. Key informants were also asked to provide examples of job tasks involving the application of digital skills; to identify the most challenging digital skills in their sector; to identify any digital skill gaps in their sector; and to share strategies that are currently being used for assessing digital skills. Following is a brief summary of key observations made form the analysis of these responses. A detailed listing of all the information and comments gathered through this survey is included in Appendix B.

Given that ICTs are evolving faster than the adaptive capacity of organizations, workers are compelled to (a) resort to a trial and error approach when performing in digital environments; (b) take responsibility for their own continuous updating and retooling; and (c) personally monitor their own progress. As a consequence, it is imperative to help workers in developing their learning to learn skills.

Key informants acknowledged the widespread use of digital systems and tools at the workplace. However, they also noted that the range of workers who use digital technology in the different sectors of the economy is broad, and that in larger organisations, the highly technical tasks are performed by IT specialists. For example, deploying security measures for protecting digital systems and tools are often performed by IT network professionals. According to a key informant, the digital skill's proficiency of workers is dependent on the access to, and usage of the digital systems and tools. This observation points to a critical need for upgrading workers' proficiency and increasing usage of digital technology to facilitate global competition. Finally, a key informant indicated that the digital skills concepts interdependent and interconnected. Through a synergetic effect, each skill contributes to the development and effectiveness of the other skills. However, it appears that some skills are dominant; therefore the primary focus of skills development and improvement efforts should concentrate on digital skills that are the fundamental building blocks to others.

Examples of job tasks involving the application of digital skills

Following is a list of job tasks involving the application of digital skills that were identified by key informants:

- complete sales, orders, customs clearance and duty payment ;
- do payroll, invoicing, accounting, inventories, bookkeeping, financial statements; perform data entry, data analysis, job and task tracking;
- fill online forms; manage complex scheduling and production control; develop and update websites; do presentations; create marketing pieces (brochures and flyers);
- translate web pages and email messages;
- perform online searches; share data with co-workers;
- observe, record, assess and evaluate changes by comparing with previous readings;
- retrieve and analyze laboratory results;
- plan; design; compute; scale;
- create a logo and graphics;
- Interpret 3D images;
- send mass e-mails;
- use various mobile technologies for training;

- transform or create digital data.

Most challenging digital skills issues

The most challenging digital skills issues identified by key informants were: typing and keyboard use; using portable interact machines; adapting to fast technological changes on a daily basis; continuous updating of systems and employees; finding the right individual to train workers; staying up-to-date with social media; keeping pace with the increasing volume of information; keeping current with new digital terminology; integrating and using systems thinking.

When asked about the digital skill gaps in their sector, several key informants pointed to the need for workers to keep updating their skills and for employers to increase training provision. Key skills gaps identified by key informants included knowledge of how to use a cellular phone; knowledge of basic software, such as word, excel, e-mail; and knowledge of how to create, save and retrieve a file, and knowledge transfer.

In response to the question on strategies used for assessing digital skills, key informants indicated that in some sectors, there were no provisions in place for assessing digital skills. Workers are assumed to have the skills or to organically acquire them on the job. The strategies reported for assessing digital skills were: self-assessment of digital skills; demonstration of digital skills; pre-screening & testing of computer skills; the use of on-line essential skills assessment tool; the use of performance assessment as an indicator of digital skill training needs; Test of Workplace Essential Skills (TOWES) is also being used to assess essential skills related to reading, document use and numeracy.

ASSESSMENT OF DIGITAL SKILLS

This section consists of a review of national and international tools and procedures in current use for assessing digital skills. Some best practices, exemplary assessment tools and procedures are described.

Research indicates that IT ignorance, or deficiency in digital skills can have a very devastating effect on national economies. For example the annual cost of digital skills deficiency for the Italian economy is estimated to be 15,6 billion €, and estimate of that cost per generic user is 2,331 € annually. On the other hand, the Digital Literacy Forum estimated that "providing digital literacy training within the workforce will give Ireland a 2.1 billion € productivity gain annually" (Digital Media Forum, 2010, p. 5). In New Zealand, estimates also indicate that improvement of workers' digital skills, and more effective use of digital technology could yield a 70% labour productivity improvement, resulting in an annual productivity gain of $1.7 billion. Similar gain has been estimated in UK: "adoption and exploitation of ICT could generate an additional £35 billion of Gross value Added (GVA) to the UK economy over the 5 to 7 years" (e-skills UK Sector Council, 2009, p. 52). It appears that the digital skills readiness of the workforce is of significance importance to the national economies.

Although it is important to ensure that the general workforce has the appropriate digital skills necessary to contribute to labour productivity, there seems to be a shortage of procedures and tools for assessing workers' digital skills. The California Emerging Technology Funds have noted that:

> the lack of a standard assessment and certification of basic ICT digital literacy contributes to a general confusion as to what assessment measures what skill, and if all competencies are covered by the various

assessments, and most importantly, if the candidate can be certified as competent at a basic level of ICT digital literacy (California Emerging Technology Fund, 2008, p. 8).

The selection of a process and tool for assessing digital literacy should be done in strategic alignment to a digital skills framework, and should be in compliance to recognized evaluation standards. The Canadian Evaluation Society has adopted the Joint Committee on Standards for Education Evaluation developed in the US, which includes four standards (Canadian Evaluation Society, 2011):

- Propriety standards: Ensure that assessment is conducted legally, ethically, and with due regard for the welfare of examinees
- Utility standards: Drive assessment process to make it informative, timely, and influential.
- Feasibility standards: Ensure stakeholders support for the assessment and its successful implementation considering impeding time and resources constraints;
- Accuracy Standards: Ensure that procedures and assessment instruments used are defensible and will generate sound information

There are basically three levels of digital skills assessments described in the literature. The first macro level aims to provide labour market information regarding supply and demands for digital skills in the economy. The second assessment level is designed to evaluate whether citizens have the digital skills necessary to fully participate in the information and knowledge society. Finally, the third level of assessment is designed to evaluate the digital skills proficiency of individual worker. The section which follows will provide a brief discussion regarding some assessment procedures and tools available to assess the skills concepts included in the proposed digital skills framework developed during this study, namely: (1) the foundational skills, (2) the transversal skills; (3) the digital technical skills; (4) and the digital information processing skills.

Assessment of Foundation skills and Transversal Skills

The Program for International Assessment of Adult Competencies (PIAAC) is "the most detailed and comprehensive survey of adult skills yet undertaken" (National Research and Development Center (NRDC), 2010, p. 1), and Statistics Canada has been a major partner of the OCED in its development. The assessment will be conducted in 2011, in twenty seven countries, including Canada. The PIAAC will measure five key skills, namely: (1) Problem solving in technology-rich environments; (2) literacy; (3) reading component of literacy; (4) numeracy; (5) Skills at work (for adults in employment only). As shown in Figure 22, these skills are paralleled (by design) to the foundational skills and the transversal skills of the digital skills framework developed during this study.

Figure 22, PIAAC Measures

Adult skills	Definition	Measured by
Problem solving in technology rich environments	the ability to use technology to solve problems and accomplish complex tasks	the ability to solve problems using multiple sources of information on a laptop computer, with an emphasis on information, access, evaluation, retrieval and processing. Tasks vary in levels of difficulty, both in respect of the cognitive demands and the demands in relation to the technological skills
Literacy	The ability to understand and use information from written texts to achieve goals and develop knowledge and potential	Both extending and drawing on previous international surveys. Will provide an overall measure of reading literacy whilst permitting countries to report prose and document literacy result separately.

Adult skills	Definition	Measured by
Reading components of literacy	The building blocks of literacy and basic reading component skills including: word recognition; decoding skills; vocabulary knowledge and fluency.	Adults demonstrating lower literacy levels will be assessed to determine how far they have developed the basic reading component skills.
Numeracy	the ability to use, apply, interpret and communicate mathematical information and ideas.	Using 60% of items from Adult Literacy Survey, and 40% items developed specifically for PIAAC. Will cover quantity and number; dimension and shape; data, chance and pattern; relationships and change.
Skills at work (adults in employment only)	Use of reading and numeracy skills on the job; mastery of information technology; communication; presentation and team working skills.	It will use a 'Job Requirements Approach' to ask adults about the type and level of generic skills used in the workplace.

Source: (National Research and Development Center (NRDC), 2010, p. 109).

Assessment of Digital Technical Skills and Assessment of Digital Information Processing Skills

Several international tools and procedures are used for assessing the digital literacy of adult workers, each focussing on particular aspects. The Danish Technical Institute identified three different categories of tools and methods to assess digital literacy skills: the Test-based digital literacy indicators; Digital literacy indicators based on self-reports; and qualitative assessments of digital literacy (Danish Technological Institute, no date, p. 17). Following are examples of the most prominent tests used in each category.

The Test-based digital literacy indicators

The Educational Testing service (ETS) has developed a test of ICT skills based on a model of ICT literacy which include three proficiency domains: cognitive proficiency, technical proficiency and ICT proficiency (Educational Testing Service, 2002). The technical proficiency dimension includes similar skills to "digital technical skills" included in the proposed digital skills framework developed in the context of this study. The ICT proficiency includes seven skills, namely: define, access, manage, integrate, evaluate, create, and communicate. These skills are similar to the digital information processing skills of the proposed framework. The ETS test of ICT skills uses scenario-based tasks to measure technical skills as well as cognitive skills such as critical thinking and problem solving (Educational Testing service (ETS), 2007). These higher order skills (critical thinking and problem solving) are also part of the transversal skills cluster of the proposed digital skills framework. This ICT literacy assessment developed by ETS has been subjected to a few name changes: (a) ICT literacy Assessment; (b) iSkills; and finally (c) ETS iCritical thinking. The test is suitable for students and employees.

The UK Skills for Life Survey is design to test the ICT skills of entire populations using a large-scale survey. The survey covers a fair number of basic skills as well as several Windows-based tasks. The digital skills assessment strategy is best seen as a test of computer skills rather than broader digital skills assessment" (Danish Technological Institute, no date). The assessment process was comprised of two test: (1) a test of awareness; and (2) a test of practical skills (Department for Education and Skills (DEfS), 2003).

Digital literacy indicators based on self-reports

Self-report surveys are often used to gather information on the levels of digital skills. The Eurostat's Adult Education Survey (AES), has been used by the European Union member states between 2005 and 2007 to assess ICT skills (Danish Technological Institute, no date). In this particular survey, the self-reported frequency of use and self-reported familiarity with ICT were assumed to provide a close approximation of ICT skills levels.

The SIBIS-project (Statistical Indicators Benchmarking the Information Society) carried out with the participation of the Danish Technological Institute (Danish Technological Institute, no date, p. 18) between 2001-2004, is another example of international survey of the population using a self-reporting strategy to assess digital literacy skills and confidence in using different digital tools. Finally, the Job requirement approach is a different type of self-reported ICT-skills used by UK Skills Surveys of 1997 and 2001. Participants were asked to assess "the sufficiency of skills, including ICT skills in the context of the job of the respondent" (Danish Technological Institute, no date, p. 18).

Although the assessment of computer skills and Internet skills has become a specialized line of research, most of the efforts however, have focused on people's perception of their own skills, rather than more systematic assessment of people's abilities against a standard or through actual observations of task performance (Hargittai, 2005). Self-report of skill assessment may provide some useful information, however the major threat to validity in this particular type of survey is the tendency of participants with poor ICT skills to overrate their competence (Danish Technological Institute, no date). Other research has demonstrated that there is a strong relationship between people's perception of their computer skills and their actual abilities as measured by using more systematic assessment or observations (Hargittai, 2005). The implication of this finding is that self-reporting ICT skills can be used as a proxy for more formal measurement and evaluation (Demunter, How skilled are Europeans in using computers and the Internet, 2006). However, research seems to be non-conclusive regarding the validity of self-rating of computer skills. Survey measures of web-oriented digital literacy often serve as proxies for observed skill measures, which are much more expensive and difficult to collect for large samples.

Qualitative assessments of digital literacy

A number of qualitative methods are being used to assess digital literacy skills such as "Observation of individuals' task solution using ICT, and the registration and use of process-data in connection with the solving of ICT tasks" (Danish Technological Institute, no date, p. 18). Biographical approaches and/or detailed account of an individual experience with ICTs are sometimes used to infer the level of competency.
The downside of these qualitative methods is that they are difficult to apply to large scale populations and that they usually cannot generate the needed information to inform policy making. However, qualitative assessments used in conjunction with quantitative data are very useful to support and exemplify them.

Scenario-based testing of ICT skills usually includes a qualitative and a quantitative assessment. This method: "can be used to measure both cognitive and technical skills and to generate information on approaches and processes in relation to ICT-related tasks" (Danish Technological Institute, no date, pp. 18-19). Given that ICT-mediated job tasks usually require the worker to draw upon a considerable amount of cognitive skills to process complex information and to instantly make meaning from various juxtaposed layers of information, few test instruments can capture the skills deployed to perform these task. A think aloud strategy can be used to make explicit and assess the thinking and information processing skill used in performing tasks involving high degree of cognitive skills.

Certiport (2006) provides an *Internet and Computing Core Certification* - IC³ 2005 Standard – Computing Fundamentals, which is an internationally recognized standard for digital literacy needed in the workplace. This exam covers the following areas:

Computer Hardware:

- Identify types of computers, how they process information and how individual computers interact with other computing systems and devices
- Identify the function of computer hardware components
- Identify the factors that go into an individual or organizational decision on how to purchase computer equipment
- Identify how to maintain computer equipment and solve common problems relating to computer hardware

Computer Software:

- Identify how software and hardware work together to perform computing tasks and how software is developed and upgraded
- Identify different types of software, general concepts relating to software categories, and the tasks to which each type of software is most suited or not suited
- Identify fundamental concepts relating to database applications

Using an Operating System:

- Identify what an operating system is and how it works, and solve common problems related to operating systems
- Manipulate and control the Windows desktop, files and disks
- Identify how to change system settings, install, and remove software (Centiport, 2006, p. 1).

Systematic assessment of Internet digital skills

The researchers designed and developed nine assignments to measure the Internet digital skills of the Dutch population. The Internet digital skills were operationalized with a framework encapsulating four skills clusters: (1) operational; (2) formal; (3) information; and (4) strategic. The performance of the participants was measured using three indicators: (1) successful task completion; (2) main outcome achieved; and (3) time spent on task completion. Performance was assessed for each of the three skills clusters.

Best practice and success story in digital skills assessment

After reviewing several commercial instruments for assessing digital skills the California Emerging Technology Funds made the following conclusions:

> A variety of commercial assessment instruments are currently available for assessment of various performance indicators of ICT digital literacy skills. However, no overarching standardized continuum of skills exists that is in alignment with the California definition of ICT digital literacy or globally recognized ICT digital literacy certifications. Furthermore, the available assessments tend to be costly to the candidate, and most likely cost prohibitive to the public sector for large scale benchmarking at a regional or state level (California Emerging Technology Fund, 2008, p. 8).

The European Computer Driving License (ECDL) is a European Union success story with regards to the standardization, assessment and certification of digital skills. It is also a best practice because it is a non-proprietary program that was established in partnership with not-for profit organization. The adoption of the program by government departments and state-owned organizations also contributed to its success (Knowledge Weavers, 2010).

The ECDL has spread its network across 148 countries and has touched the life of more than 10 million people. Because of its international reach the ECDL is also known as the International Computer driving Licence (ICDL). Canada is home to a branch of the ICDL: http://www.ecdl.org/locations.jsp?cat=32

The International Computer Driving Licence offers testing and certification programs for various levels of individual users and employees. The ICDL for Work certify individuals for ICT workplace readiness. Certification can be packaged according to individual needs along eight modules focused on foundation, advanced and specialized levels:

Module 1 - Concepts of Information and Communication Technology (ICT)
Module 2 - Using the Computer and Managing Files
Module 3 - Word Processing
Module 4 - Spreadsheets
Module 5 - Using Databases
Module 6 - Presentation
Module 7 - Web Browsing and Communication
Module 8 - 2D Computer-Aided Design
Module 9 - Image Editing
Module 10 - Web Editing
Module 11 - Health Information Systems Usage
Module 12 - IT Security

It is noteworthy that the ICDL targets the assessment of technical digital skills only, and does not assess the essential enabling foundational, transversal and information processing skills, which support digital skills.

COMPLEXITY-RATING SCALE FOR DIGITAL SKILLS

Review of computer use complexity scale

HRSDC has developed a complexity rating scale for assessing the workers' proficiency level of the "Computer Use" essential skills. This scale has five levels and has been successfully used for many years to rate the complexity level of "computer use" for several occupations. However, it was necessary to revisit the current complexity rating scale and to propose a new scale to facilitate the transition from "computer use" to digital skills.

Issues regarding "Computer Use" complexity scale

The emphasis of the "computer use" concept is mainly on the use of computers and software applications. Results of this study have demonstrated that the digital skill concept is much broader than "computer use" and involves complex cognitive and metacognitive skills. A deficit in cognitive and metacognitive skills creates a "cognitive divide" which hinders the effective and efficient use of digital tools and systems (Chinien., C.; Boutin., F., 2003). It is therefore necessary to bridge the rating of technical digital skills with the essential enabling information processing skills.

In this study, digital skills has been operationalized as a suite of basic skills that all Canadian workers need to appropriately use digital technology and communication tools in the context of the workplace. The emphasis is on generic broadly transferable digital skills rather than occupationally specific digital skills.

The nature of the tasks given as illustrative of "computer use summary" is indicative that the main focus of the complexity scale for this essential skills dimension is on occupationally specific skills (Text Box 2). It is highly unlikely that the general Canadian workforce will be expected to use these highly specialized software applications. There is an incongruity between the fundamental assumptions of "computer use" as an essential skill for all Canadian

workers, and the complexity rating scale. This incongruity is also of relevance to the digital skills concept, which was operationalized in this study as the essential skills needed for all Canadian workers to effectively and efficiently use digital technology at work.

Text Box 1, Essential skills computer use summary

- Use graphics software (e.g., Corel Draw, Harvard Graphics, Adobe Photoshop, Adobe Illustrator).
- Use a database (e.g., dBase, MS Access, MS Act, Claris FileMaker, PC File).
- Use a spreadsheet (e.g., MS Excel, Lotus 1-2-3, Quattro Pro).
- Use financial software (e.g., Bedford Accounting, AccPac, QuickBooks).
- Use statistical analysis software (e.g., SPSSx, SAS, Statistica).
- Do programming and systems and software design (e.g., Fortran, Cobol, Clipper, Visual Basic, Macromedia Director).
- Use computer-assisted design, manufacturing and machining (e.g., CAD/CAM, AutoCAD, CNC (Computer Numerical Control) equipment), (HRSDC, 2007)

An ambiguity was also found when comparing and contrasting computer use complexity scale and computer use summary with the "Computer Use Self-Assessment" instrument (HRSDC, 2009). While the emphasis of scale and computer summary was on specific occupational skills, the focus of the assessment instrument was on generic computer skills. There is a disconnect between the definitions and description of the various dimensions used in the computer use complexity scale.

Another issue identified with the computer use complexity rating scale is the absence of layers of sub-skills embedded within the competence dimension. This issue can compromise the standardization and assessment of computer use.

Development of a new complexity-rating scales

The HRSDC "computer use" essential skill consists essentially of technical skills. In contrast the digital skills concept developed here consists of a combination of three types of proficiencies: (1) cognitive proficiencies which manifest themselves as foundational and transversal skills; (2) technical proficiencies related to the use of digital systems, tools and software applications; and (3) information processing proficiency. This amalgamation of highly interconnected and interdependent skill clusters, that also have their own layer of subordinate skills, poses considerable challenges to the design and development of a complexity rating scale. The discussion which follows will propose alternative complexity rating scales only for the two skill clusters that were investigated in this study, namely: (1) technical digital skills; and (2) digital information processing skills.

At least three approaches can be used for developing a digital skills complexity rating scale: (1) establishing the minimum competency level at which a particular skill can be performed to effectively and efficiently contribute to improved quality and productivity; (2) establishing a scale to rate the complexity of each skill independently; and (3) establishing a scale based on workers' proficiency level.

The first approach. The first strategy assumes that the layers of skills embedded within each cluster are of increasing level of complexity (Educational Testing Service, 2002) as shown in Figure 23. Under this assumption a complexity rating scale will be competency-based. A complexity level is therefore attributed to each layer of skill. The attribution of complexity levels to the digital skills should be attributed by a panel of experts working in a focus group environment. For illustrative purposes only complexity levels have been intuitively attributed to digital skills that were

perceived to be extremely important/important by the key informants involved in the study. Figures 24 and 25 show the complexity scale generated for: (1) technical digital skills; (2) and digital information processing skills.

Figure 23, Assumption of Increasing complexity of knowledge and expertise of digital information processing skills

Enter information	Determine information needs	Access information	Organize information	Integrate information	Assess information	Apply information	Create information

→

Increasing complexity of knowledge and expertise of digital information processing skills

There are three indicators that can be used to determine the complexity level of a digital skill (e-Competence.Eu, 2010, p. 9). The indicators are:

- The workers level of autonomy, which may range between "making personal choices" to "responding to instructions";
- Skills complexity level, which may range between "the ability to conceive" to "the ability to apply"; and
- Context complexity level, which may range between "unpredictable – unstructured" to "structured – predictable.

Figure 24, Prototypical Complexity scale for digital information processing skills perceived as important by key informants

DETERMINE NEEDS, ACCESS, ORGANIZE, INTEGRATE, ASSESS, APPLY, CREATE, COMMUNICATE DIGITAL INFORMATION		Level 1	Level 2	Level 3	Level 4	Level 5
DIGITAL INFORMATION PROCESSING SKILLS	Determine what, when and how much information is needed					
	Articulate information needs					
	Locate information sources					
	Select information to meet needs					
	Retrieve information of from various sources					
	Scan information visually					
	Analyze information					
	Evaluate the quality and trustworthiness of information					
	Determine the usefulness and applicability of information					
	Restructure randomly acquired information					
	Organize information in a logical flow					
	Categorize information					
	Classify information for ease of storage, retrieval and use					
	Interpret information					
	Summarize information					
	Compare and contrast different information types					
	Use information displayed in visual and graphical format					
	Make effective and efficient use of information					
	Process information under time pressure					
	Process information in collaboration with others					
	Assess what information can be shared with others					
	Behave and act ethically in handling information					
	Determine how to dispose information					

Figure 25. Prototypical Complexity scale for technical digital skills perceived as important by key informants

USE DIGITAL SYSTEMS AND TOOLS		Level 1	Level 2	Level 3	Level 4	Level 5
TECHNICAL DIGITAL SKILLS	Select digital systems and tools					
	Set up digital systems and tools					
	Install software applications					
	Connect digital systems and tools to the Internet					
	Maintain digital systems and tools					

Figure 25. Prototypical Complexity scale for technical digital skills perceived as important by key informants

	Manage operating systems and files					
	Back up files and data					
	Troubleshoot digital systems and tools					
	Customize work environments					
	Select mobile digital devices					
	Set up mobile digital devices					
	Use mobile digital devices					
	Use digital systems and tools to access information					
	Use digital systems and tools to process information					
	Use digital systems and tools for communicating					
	Use digital systems and tools for collaborating					
	Use digital systems and tools for learning					
	Use digital systems and tools for solving problems					
	Use digital systems and tools for designing					
	Use digital systems and tools for planning					
	Migrate to new digital systems and tools					
USE SOFTWARE APPLICATIONS		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
TECHNICAL DIGITAL SKILLS	Use computer operating software					
	Use word processing software					
	Use Internet-based software					
	Use presentation software					
	Use software applications to access information					
	Comply with legal copyright provisions					
APPLY SECURITY MEASURES IN DIGITAL ENVIRONMENTS		**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
TECHNICAL DIGITAL SKILLS	Use anti-virus software to protect from cyber attacks					
	Distinguish between hoaxes and real threat warnings.					
	Install local firewall on computers					
	Securely send and open digital messages and content					
	Securely connect to networks					
	Backup and store digital contents					
	Secure user ID and passwords					
	Protect digital content against accidental destruction					
	Protect unauthorized use and modification of digital content					
	Comply with legal issues of digital contents					
	Practice safe online behaviours					
	Secure personal information against identity threats					
	Maintain a secure digital footprint					
	Report suspicious online activity					
	Report breaches in security					
	Comply with employer's digital policy					

The second approach. The second approach for establishing complexity levels of digital skills is to develop a scale which is designed to rate each skill independently, as shown in Figure 26. A complexity scale can then be developed for each layer of skills. HRSDC has developed a complexity rating for the "finding information" essential skill. This scale employs two complexity indicators (HRSDC, 2009):

- The complexity of locating the desired information; and
- The complexity of extracting and protecting this information.

An adapted version of the *finding information complexity rating scale* (Figure 27) can be used for assigning complexity levels to digital skills "access information". Similar complexity rating scale can be developed for the other elements of the digital information processing skills and the digital technical skills.

Figure 26, Leveling information processing skills

Level 5								
Level 4								
Level 3								

Level 2								
Level 1								
Complexity Levels	Enter information	Determine information needs	Access information	Organize information	Integrate information	Assess information	Apply information	Create information

Figure 27, Finding Information Complexity Rating Scale

Dimension	Level 1	Level 2	Level 3	Level 4
The complexity of locating the desired information	Consulting established sources.	No established source but a source can be easily identified.	Worker must conduct a more complex search for the information.	Information from several different sources must be brought together or there is no source; the information must be created.
The complexity of extracting/ processing the information	Information is usable in the form in which it is obtained.	Simple processing, such as selecting information according to some predetermined criteria.	Some analysis required. Information must be understood to be acted upon.	Complex analysis or synthesis. Information from various sources is synthesized. Information is used in the process of generating a solution to a problem. Information is created.

The third approach. A third approach that can be used for developing a complexity scale is to focus on workers proficiency level. Typical proficiency levels could include:

- Novice or beginners
- Advanced users
- Proficient users
- Expert users

Given the interconnectedness and interdependency between the digital information processing skills and the technical digital skills, it could be beneficial to cross the complexity scale for digital information processing to that of digital technical skills (Educational Testing Service, 2002) (Figure 28). The implication of having a low or high level of information processing proficiency on a low or high level of technical digital skills, and vice versa can be investigated:

- What are the effects of having high digital technical skills proficiency and low digital information processing skills proficiency?
- What are the effects of having high digital information processing skills proficiency and low digital technical skills proficiency?

Figure 28, Developing complexity scale by Crossing digital information processing proficiency with technical skills proficiency level.

	Low digital technical skills proficiency	High digital technical skills proficiency
High digital information processing skills proficiency	A	B
Low digital information processing skills	C	D

proficiency		

Source: Adapted from (Educational Testing Service, 2002).

Irrespective of the approach used for designing and developing a complexity rating scale, the end product should meet following quality assurance criteria:

- consistent with the fundamental assumptions of generic essential skills;
- competency-based to make it more objective;
- valid;
- reliable;
- defensible;
- facilitate the establishment of inter and intra-ratters' reliability,
- promote prior learning assessment and recognition;
- promote the recognition of informal and non-formal learning;
- facilitate the determination of digital skills gaps;
- inform training and retooling to address skills gaps;
- facilitate self-assessment;
- facilitate digital skills training and delivery;
- can be easily updated;
- easy to use;
- facilitate continuous learning to improve digital skills;

KEY FINDINGS

Digital skills development is currently the number one economic recovery policy in the great majority (15) of OECD Member States, and it also ranks number 6 in their long term economic policies. Additionally, due to the increased demands from the knowledge-based economy for processing large amount of information effectively and efficiently, people have gradually realized that working with digital systems and tools to perform most job tasks involve complex cognitive and metacognitive skills, over and above the basic ICT skills for operating computers. An analytical and international survey of literature and research indicated that several countries have developed a national framework to facilitate digital skills development, assessment and certification in educational, training and workplace contexts. Examination of a cross-section of these frameworks revealed that most well-structured frameworks share some common skills concepts, notably: (1) Information literacy; (2) Digital technical skills; (3) Foundational skills; and (4) Cross-cutting or "transversal" skills.

The validation of the proposed Canadian digital skills framework developed during this study revealed that 80% or more of the key informants perceived that the framework was useful and comprehensive. They also felt that all the digital skills clusters (foundational skills, transversal skills, use of digital systems and tools, applying security measures, and informational processing skills) embedded in the framework were relevant, accurate and clearly defined. Approximately two-third of key informants rated several of the layers of skills included in each cluster as important: (1) use of digital systems and tools (10 out of 20 skills); (2) use of software applications (6 out of 19 skills); (3) application of security measures in digital environments (17 out of 21 skills); and (4) processing of digital information 24 out 43 skills). Key informants' rating of the frequency of use of these skills at the workplace showed wide variation in the level of use across these various digital skills. The same observations were made with regard to workers' proficiency in performing these skills. Key informants' ratings of all the skills embedded in the four digital skills clusters (use of digital systems and tools; use of software applications; application of security measures in digital environments; and processing of digital information) suggested that, to various degrees, all these skills

legitimately belong to the digital framework. Key informants inputs suggested that Canadian workers are frequently applying important digital skills for which they may not be adequately proficient.

There are various approaches that can be used for assessing digital skills. However, in selecting one approach over another, consideration should be given to sustainability and conformity to evaluation standards. The European/International Computer Driving License (E/CDL) is a European Union success story and a best practice with regards to the standardization, assessment and certification of digital skills. It should be noted however, that the main emphasis of the assessment is on digital technical skills.

Considering that several skills concepts converge to form digital skills, the HRSDC computer use complexity rating scale may not be appropriate for leveling technical digital skills and information processing skills. New complexity rating scales should be developed and validated for each digital skills cluster.

RECOMMENDATIONS

The following recommendations for further research were made based on the findings of the study:

- A review of the submissions made to the recent Government of Canada digital strategy consultation, revealed strong stakeholders support for this digital skills research. This support is exemplified by the recommendation made by Dr. Elaine Soetaert, on behalf of the NorQuest College in Alberta:

  > *"As the Conference Board of Canada developed the "employability skills" that drove curriculum development and learning in PSIs [post-secondary institutions] over the past 20 years, we now need a similar document which outlines the critical skills to be developed by Canadians to enable their engagement in the digital economy and knowledge society. What are the benchmarks for digital skills? Such a government developed and endorsed document would provide the evidence that PSIs need to create institutional outcomes based on those identified skills"* (Soetaert, 2010, p. 9).

  The digital skills framework developed for this study has the potential to meet that important expectation. However there is a need to conduct further validation of the framework before it can be promoted to stakeholders across Canada.

- The great majority of the key informants consulted for this study have fully embraced the digital skills framework, its digital skills concepts, their definitions and the skills components for each concept. This is the first step towards establishing a foundation upon which a national digital skills standards, training, assessment and certification can be built upon. Given the strategic importance of this framework, its further validation through a series of focus group meeting across the country is highly recommended in order obtain widespread stakeholders' support for the framework.

- Use the digital skills framework as a foundation for updating HRSDC's Essential Skills occupational profiles, to replace "computer use" with "digital skills" and integrate a new complexity scale that accounts for this broader concept.

- Conduct further research to investigate the interconnectedness and interdependency of the four skill cluster included in framework;

- As conceptualized in the framework, digital skill includes not only the technical skills but also some underpinning complex metacognitive skills, since workers information processing skills can be as important,

if not more important than computer skills. People who lack those skills will be unable to contribute to, or benefit from the digital economy. It is imperative to bridge the rapidly growing "cognitive divide" in the technology-based and knowledge-intensive workplace (Chinien & Boutin, 2003). It is noteworthy that recent research findings indicate that Canadian employers believed that the largest gap in employees' skills was in the area of "thinking skills" (Ekos Research Associates Inc, 2007, p. iii). Given that little is known regarding these skills it will be difficult to provide cognitive augmentation to these workers. Therefore research investigating the cognitive and metacognitive skills which support the acquisition and efficient practice of digital skills is warranted. Research investigating whether training in information skills augmentation facilitates the development and application of digital skills at higher level of proficiency is highly recommended. DWM-Consultants has developed a self-instructional workbook to assist youth and adults to improve their information processing skills that can be used as a key resource for such an endeavour.

- Most of the existing assessment tools are primarily focused on the assessment of the use of digital systems and tools. There is now an awareness that the efficient and effective use of digital technology is governed by the deployment of complex cognitive skills. Research investigating the appropriate instruments for assessing these cognitive stills is warranted.

- The Information and Communication Technology Council recommended the establishment of a defined measurement for digital skills similar to "the way in which bilingualism is categorized at various levels (Information and Communication Technology Council, no date, p. 9). The digital framework developed in this study can be used as the underpinning foundation for researching and developing such a benchmark. Australia and New Zealand have used their digital literacy framework for developing standards, learning outcomes and enabling objectives. A Canadian digital skills standard would be a very useful tool to facilitate digital skills development and assessment.

- Digital literacy demands and their definitions need to remain fluid as they must be adapted to reflect changes in technology. Research must be conducted to support periodic updating of the proposed digital skills framework and the enabling skills embedded within to reflect technological changes.

- The OECD Information Technology Economic Outlook for 2010 suggested that digital technology systems and tools can have: "considerable direct environmental impacts in terms of energy use, materials throughput and end-of-life treatment" (OECD, 2010). Given the important need to embrace a development strategy focused on a harmonious economic, social and environmental development, research to facilitate the "greening" of digital skills in Canadian workforce is needed.

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APPENDIX A: Instrumentation

Copy of online questionnaire used for Key Informants consultation sent separately from the Interim Report as an e-mail attachment

PROPOSED CANADIAN DIGITAL SKILLS FRAMEWORK:
ESSENTIAL DIGITAL SKILLS IN THE CANADIAN WORKFORCE

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February, 13, 2011

Dear ,

Congratulations for being nominated as a key informant for the digital skills study, which we are conducting under funding assistance from Human Resources and Skills Development Canada. Key actors within your sector have highly recommended your participation in this study. Thank you for agreeing to take time from your extremely busy schedule to lend your expertise to this project that we hope will have important implications for Canadian employers and workers.

As you know, the Government of Canada has recognized that our pathway for becoming the most innovative, competitive, productive and prosperous nation, resides to a large extent in our ability to fully harness and exploit digital technologies. To achieve this goal, we must have a workforce that is equipped with the essential digital skills needed for participating in a knowledge-based economy. However, the Government of Canada's recent digital strategy consultation paper (Improving Canada's Digital Advantage) highlighted that:

> *For Canada to become a leader in the digital economy, digital skills development must be fostered in all Canadians. Digital skills are important, not only for the ICT sector, but for the entire workforce, as well as all other Canadians, be they homemakers, students or seniors. A significant challenge in determining if Canadians have the skills and competencies required for the digital economy is a lack of a precise understanding of what digital skills are, and how Canada is faring in this regard compared to its competitors.*

For the purpose of this research project, essential digital skills should be broadly understood as a suite of basic skills necessary to appropriately use digital technology and communication tools in the context of the workplace. Digital skills involve more than computer skills. This research aims to expand our understanding of the complex elements that form the skills required to use, and work with digital technology in the 21st century.

Given that there has not yet been any effort to systematically examine the digital skills needed in the Canadian workplace, we have little information regarding the nature of these skills, their importance, and workers' proficiency level in applying these skills. As a preliminary attempt to fill this information gap, we are reaching out to employers from various economic sectors to increase our understanding of digital skills and their implications for the Canadian workplace. Based on the feedback that we have received from our key informants and considering the nature of the questions to be addressed by the study we have concluded that an online consultation is the most effective and efficient strategy for gathering your input.

We have reviewed several digital skills frameworks developed by major industrialized nations. Using the insight gain from this analysis we have developed the *proposed Skills Framework: Essential Digital Skills in the Canadian Workforce* (Figure 1), to provide Canada with a blueprint for digital skills development and assessment. This framework consists of four key digital skills concepts: (1) transversal skills, (2) foundational skills, (3) digital technical skills and (4) digital information processing skills. Although we recognize that all these concepts are important, for the

purpose of this study we are focusing only on digital technical skills and digital information processing skills. Consequently, we have broken-down these two key digital skills concepts into sub-set skills using a review of national and international literature.

We need to know to what extent this framework and these digital skills components are relevant to the Canadian workplace. There are two parts to this consultation:

1. The first part consists of the validation of a the Digital Skills Framework;

2. The second part consists of the validation of the sub-set skills for digital technical skills and digital information processing skills.

Considering that this is a new area of exploration and given the breadth of the survey topic, you may encounter some questions for which the answers must be based on perception rather than hard evidence. We acknowledge this limitation and will keep it in perspective when reporting the findings and drawing conclusions. Although the Digital Skills Framework will be available online, for your convenience we are attaching an electronic version that you can print and use as reference while you are completing the survey.

You will need approximately one hour to complete this online questionnaire. We strongly suggest that you complete the survey in one sitting. To help us meet our deadline we would be most grateful if you could complete and submit the questionnaire to us by February 18, 2011. Please let us know if you will not be able to meet this deadline so that we can make some special arrangement. Specific instructions for completing the questionnaire are available online. Although we are using an online consultation strategy, our staff will be available to answer all of your questions around the clock during the data collection period. The telephone numbers to reach us are: 514-288-7139 or 514-402-1661. You can also reach us by e-mail: chris.chinien@gmail.com.

If while completing the questionnaire you need to have a brief pause or to interrupt the session, you *need to press the <NEXT> button before exiting,* and the system running the survey will automatically save your responses. You will be able to resume your survey session anytime, anywhere and on any computer using the same assigned link and password. You will also be able to edit your previous responses. *If you exit the survey without pressing the <NEXT> button you will lose responses previously entered.*

We would like to reassure you that your responses to these survey questions will be kept strictly confidential. While excerpts of some comments may be part of the final report, under no circumstances will your name, your employer's name or any identifying characteristics be included in this report. No distinctive demographic or personal information will be shared with Human Resources and Skills Development Canada or any other agencies or individuals.

You can access your online questionnaire using the following link: https://www.surveymonkey.com/s/digitalskills

Thank you very much for your most valuable contribution to this digital skills study.
Best Regards from the WDM-Consultants Team
Chris Chinien, Ph.D.
WDM-Consultants
Senior Research Fellow, UNESCO-International Centre for
Technical and Vocational Education and Training

Kindly help us to meet our deadline. Please complete and submit the questionnaire by February 18, 2011

PROPOSED CANADIAN DIGITAL SKILLS FRAMEWORK:
ESSENTIAL DIGITAL SKILLS IN THE CANADIAN WORKFORCE

NOTE: *You will need to refer to this framework when completing the online questionnaire. This framework is available through the online survey. However, you may want to print a hard copy to avoid going back and forth between pages as you make reference to the framework.*

There are some important concepts that are being used nationally and internationally to frame digital skills in the workplace context. We have grouped some of the most important concepts together to build a digital skills framework or model (Figure 1) which we believe is appropriate for Canada. During this online consultation we will ask you to indicate whether or not these digital skills concepts and their corresponding definitions are of relevance to workers employed in your sector. It includes the generic Essential Skills that we understand as foundations to be able to work with digital technology generally, as well as the Essential Skills that support and grow with the development of proficiency in technology use – in an ongoing (transversal) way. In addition, the framework breaks down those underlying skills that manifest themselves more particularly when working with digital technology, including both technical skills and information processing skills.

Figure 1, Proposed Canadian Digital Skills Framework: Essential Digital Skills in the Canadian Workforce

Proposed Canadian Digital Skills Framework: Essential Digital Skills in the Canadian Workforce		
Transversal Skills Thinking / Problem-Solving Continuous Learning/ Work with Others	**Digital Information Processing Skills**	
	Communicate information	Share digital information with others at work
	Create information	Generate new digital contents and knowledge by organizing, integrating, adapting and applying digital information
	Apply information	Use information of various digital formats effectively and efficiently to perform job tasks
	Assess information	Judge the quality, relevance, usefulness, validity and applicability of digital information
	Integrate information	Interpret, analyze, summarize, compare and contrast, combine, repurpose and represent digital information
	Organize information	Decode, restructure and classify digital information to facilitate storage, retrieval and use
	Access information	Locate, select and retrieve digital information
	Determine information needs	Recognize, define and articulate digital information needs
	Digital Technical Skills	
	Use Software Applications	Select and use appropriate software to perform job tasks
	Use Digital Systems and Tools	Use computers and other hardware to perform job tasks
	Apply Security measures in Digital Environments	Protect hardware, software applications, data and personal information
	Foundational Skills Reading, Writing, Oral Communication, Document Use, Numeracy	

APPENDIX B: Key Informants' Comments

Digital Information Processing Skills Concepts: General comments

A key informant comment reiterated the importance of these concepts: "these concepts are really important but we don't always master them perfectly or completely".

Two key informants made specific suggestions for improving the Digital Information Processing Skills cluster:

- The ability of end users of information systems to create digital information as they are documenting a critical task is a very important skill that was not addressed by the digital information processing cluster.
- Integration and systems thinking are very crucial skills to ensure that a person is fully competent in digital information processing.

Another key informant argued that digital skills requirements are driven by digital systems and tools: "various systems and software applications are used in the workplace, which dictate the specialized digital skills needs"

The proposed Canadian Digital Skills Framework: General comments

- The use of examples might help clarify some digital skills concepts;
- A key informant inquired whether the information processing skills were listed in a logical sequence;
- A key informant suggested that in spite of the interdependencies and interconnectedness among the digital skills, additional attention must be given to some dominant ones: "It is important to note that each skill helps in the development of the other skills. They complement each other. However, there are some skills that are needed to be prioritized to ensure that they are used to build other skills".
- The difficulty faced by workers to cope with digital technologies on an ongoing basis is exemplified by the following comment: "I think the digital world surrounded us really quickly since about 10 -15 years. The major concern is that we need and use digital information every day, without always knowing what we are doing (especially with software, tools and equipment). We often use the "trial and error" way, since it is all really new and also evolving so fast".
- In our sector we use an electronic log system with a text based message system.

Use digital systems and tools: General comments

- My sector contains 3 or more distinct levels of professionals, I am answering for the top level.
- In my sector, there are a wide variety of digital tools - in addition to computers and communication devices, many instruments and monitoring systems are now using digital technologies, some of which are very complex and require engineers to support them. The range of users of these tools in my sector is very broad, and I found it difficult to answer the questions around the maintenance of digital devices, since most are maintained by specialist staff.

- Measuring, calculating and recording information using digital equipment is becoming common place on many work sites.

- I made my choices based upon my knowledge of workers in my sector, some of whom are highly proficient, but many of whom are far from proficient. This does not change the need for the sector to move toward proficiency and high usage in order to compete globally. Not all workers even have access to adequate internet services, so the lack of proficiency and/or use is not always a failure to recognize the importance.

- Design, set up & selection of digital devices are always in the purview of IT.

- All answers are based on Elogs and text based messages.

- In larger company, there are people in charge of the "select, setup, install, backup, troubleshoot, etc." and all the more technical stuff related to the digital system.

Additional digital skills suggested:

- Integrate digital systems
- Training co-workers using digital systems and tools

Use of software applications: General Comments

- Most staff use specialized commercial record systems, desk top applications (such as word processing) to a lesser extent, and only a small number of staff would use business applications (such as accounting software).

- It is crucial to know a broad selection of digital systems and be proficient in using them.

- Some digital technical skills listed in the framework are all important but are also handled by different professionals, not only one person.

Apply Security Measures in Digital Environments Skills: General Comments

Comments made by a key informant suggested that security measures have little digital skills implications, because these measures are administered by internal computer infrastructure and record management programs.

Comments made by two key informants suggested that the framework places too much emphasis on digital security skills:

- Only those in IT would be responsible for setting up security software and maintaining most security related measures.

- Security measures are not high on the list except for IT and network professionals.

Example of job tasks involving the application of digital skills

Key informants were requested to give example of tasks drawn from various occupations included in their sector, which are illustrative of the relevant digital skills concepts. The following digital skills were reported:

- Search for digital reference materials. Retrieve and analyze laboratory results; manage complex scheduling, confidential email communications.

- All points of sales, cash registers are all electronics; Computers are used to do all the inventories, to complete all orders, and to do bookkeeping and Financial Statements.

- Online searches for global information, use of Google translate to translate web pages and email messages, online searches to locate people and their contact information, sharing data with co-workers, online application forms (fillable documents); and mass e-mailing.

- Company use custom designed software to run company server, for all accounting, sales, financial and inventory control. Apply EDI system to connect with customers for invoicing and orders receiving. Also connect with authorities to obtain customs clearance and duty payment, all paperless operation. Using digital designed images for sales and also for production control overseas. All communications conducted in digital format.

- Observing and recording, assessing and evaluating changes by comparing to previous readings, etc. process on-line insurance claims; interpreting 3D images using specialized software.

- Develop and update websites; use email to communicate with former and potential customers; use software applications for accounting, bookings, etc.; develop marketing pieces, e.g. brochures, flyers; research similar types of operations for trends and new ideas; understand how to access and utilize specialized software.

- Research and report writing. Both tasks require diverse and complex application of digital skills.

- Effective use of various mobile technologies for teaching and designing teaching/training curriculum materials.

- Data entry, task tracking, payroll processing, engineering design, metallurgical testing, production data entry, training, presentations, data analysis, job tracking, planning, research, tasks involving skills sets from entry level to PhDs.

- Research of data posted on internet.

- L'utilisation de logiciels de calcul; l'élaboration de logiciels de calcul - utilisation de logiciels de dessin assisté par ordinateur - utilisation de bases de données …(*Google translated version* : *the use of computing software ; the development of computing software - using software for computer aided design - use of data bases ....*)

- Access all sorts of applications for various tasks on secured and remote networks, with numerous platforms.

- We transform or create digital data.

- Using a computerized scaling system; using computer controlled equipment; maintain and reorder inventory of parts, safety equipment etc using a computerized inventory control system.

- All the maintenance manuals are now on adobe.

Additional comments to improve understanding of digital skills

- The future in this domain is about to explode, with new user interfaces.

- Unfortunately digital skills are in conjunction with English language skills. This puts people who do not master the English language at a disadvantage.

- The sector needs greater access to high speed, reliable internet; must learn and utilize digital skills to grow their business.

- Increasingly the workplace is becoming a digital work environment. Additionally, the digital systems and tools that workers must use both at an individual and collective level are also changing rapidly. This increases the complexity and the richness of the workplace environments. The biggest change I see, is that ICTs are evolving faster than the adaptive capacity of organizations, which compel workers to take responsibility for their own continuous updating and retooling and to personally monitor their own progress. It is imperative to develop the capacity to learn.

- Conceptions et préparation de documents. *Google translated version : (design and preparation of documents).*

- Use technology to compensate for lack of skilled workers.

Most challenging skills that new digital technologies have demanded of workers

- Dysfunctional applications are too slow and too coarse to provide good insights. Not enough human factors engineering goes into commercial products because it is too expensive.

- Using the portable interact machines was the most challenging problem we encountered. To start with, entry level workers, mostly poorly educated immigrants, have difficulty understanding the whole concept of paying with a card on a portable machine. They also have language barrier, not being fluent in French, the supervisor can't help them.

- Adapting to new technology as needed, for example creating and using html tags or a fillable document, or sending mass emails, creating a logo, graphics... I think this is because there isn't a log of who is proficient in the workplace at what skill, so finding the right individual to train you wastes time, whereas the actual training is rarely time consuming.

- To learn new software or new system customers are using. To be digitally connected with customers, we have to update our systems all the time, so as the employees.

- Recording data in consistent ways using computerized records and terminologies or drop-down lists (as compared to previously recording their observations through narrative and dictated comments).

- Staying up-to-date with social media, as many have not even grasped the essentials yet, in terms of the importance of these skills and technologies, to the sustainability of their businesses.

- Keeping pace with how to use ever changing products and the increasing volume of information.

- Our field positions have moved from not using technology at all to utilizing laptops within the last 10 years. They have had to make the greatest leap in the organization as far as acquiring & using digital skills.

- Keeping current after they have left the education system, demise of the mouse and entry of virtual keyboards, new digital terminology emerging, nanotechnologies and its implications for the workplace.

- Rapid pace of changing technologies, computer programs, communication methods, etc.

- Le plus gros changement que je vois, les TICs évoluent plus rapidement que la capacité d'adaptation des organisations. Ce qui oblige les gens à se former personnellement pour suivre l'évolution. Il faut absolument développer la capacité d'apprendre à apprendre. Google translated version: The biggest change I see, ICTs are evolving faster than the adaptability of organizations. This is what compels people to train themselves to monitor progress. It is imperative to develop the capacity to learn how to learn.

- Typing / Keyboard use. Repetitive Strain Injuries.

- Being able to integrate and use systems thinking. These skills are very important. A person can be very knowledgeable in digital technologies but may not be effective or efficient in providing business solutions.

- Être informés et suivre l'évolution technologique ainsi que l'évolution de différents logiciels utilisés; bien cerner leurs domaines et limites d'applications. Demeurer critique face aux résultats obtenus de l'utilisation de logiciels complexes (valider par d'autres façons). Google translated version: Be informed and keep pace with technology and the evolution of different software used, identifying their limitations and areas of applications. Remain critical of the results obtained from the use of complex software (validated through other means).

- A major challenge is for older workers and computer illiterate people to adapt to fast technological changes on a daily basis. More training, time and money need to be spent to provide for these people.

- The technology we are using is always changing and evolving. Sometimes our tools are developed as we use them. We always must change and adapt our ways of working.

- It doubles the work load because we have to now rewrite everything also on the computer.

Digital skills gaps

The key informants were asked to identify any lack of technology skills, computer skills or similar skills concepts that have been identified in their sector. The following comments were captured:

- A large proportion of workers in our sector are new immigrants, many of them are poorly educated. Our sector is often the sector they choose as a first level entry job. They don't have any digital knowledge; they don't even know how to use a cellular phone. On top of the technology barrier, they often have a language barrier, since many of them don't speak the language (French) very well. Most of them also have to deal with a Culture shock. Even with good employees, when they try to access management jobs, they don't know how to use computers, we need to train them from the beginning, they don't know what a computer file is, they don't know how to create a file, how to save a file, or how to retrieve a file. They need to know the basic software, word, excel, e-mail, even our entry level position require some digital skills knowledge.

- Yes, but you don't know you don't have them until you need them and then you find out no one else knows either.

- Given the average age of workers is 45+, and computerization is relatively new, a pre-requisite to many new systems implementations is basic keyboarding and computer literacy skills training.

- yes.....but it is an on-going learning problem.

- We have identified a lack of computer skills as being a detriment to potential job candidates and to our ability to move forward quickly as an organization.

- Dans mon secteur, il est clair pour les organisations que les « digitals skills » deviennent d'une nécessité incontournable et que la plupart des organisations accusent un retard de formation auprès de leurs employés. *Google Translation : In my area, it is clear to organizations that digitals skills become an unavoidable necessity and that most organizations are lagging behind in training its employees.*

- Average age of workers is 55. Most still use paper documents. The degree to which employees are under trained in tech use is the bottom part of the iceberg.

- Yes, half of my colleagues are not technology savvy although it is a required skill in my line of work. Technology skills must be learned and then integrated.

- Oui, la firme est très concernée par l'évolution technologique qui lui permet d'offrir des services de meilleure qualité et d'être plus performante. L'intégration de nouvelles technologies, leur mise à jour et la formation du personnel sont des préoccupations constantes. *Google translation: Yes, the firm is very concerned with the technological changes that enable it to offer better services and be more efficient. The integration of new technologies, their maintenance and staff training are constant concerns.*

- Yes a lot of people are not computer literate and especially older workers as mentioned in an earlier question.

- Our tools (and technology in general) are evolving fast so it is hard to keep up to date.

- This is just starting to take place. Essential skills gap analysis is coming to the forefront and knowledge transfer is becoming the buzz word.

Assessment of digital skills

Participants were asked to share their knowledge regarding any assessment strategies that are currently being used for assessing digital skills in their sector. Following are the comments made:

- It is not difficult to assess workers' digital skills, since the great majority of them don't have any digital skill.
- Usually it is self-identify. Identify what you need at a point in time and you initiate the continuing education accordingly.
- Workers might be tested or required to demonstrate their digital skills. Managers are assumed to have the skills or to acquire them.
- We are currently using pre-screening of computer skills with all job candidates & testing for computer skills for certain positions.
- Use a beta on-line essential skills assessment tool.
- L'évaluation du rendement informe sur l'habileté du personnel à utiliser les supports et ressources informatiques et leur besoin de formation. Google translation: The performance assessment is a good indicator of the ability of staff to use the materials and electronic resources and their training needs.
- The training provided is vague, corporate are penny pinchers, less is better attitude.
- We have access to various tutorials, etc. but the great part of learning is still accomplished via co-worker's collaboration and help.
- TOWES is being used to assess ES concerns for READING DOCUMENT USE AND NUMERACY

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