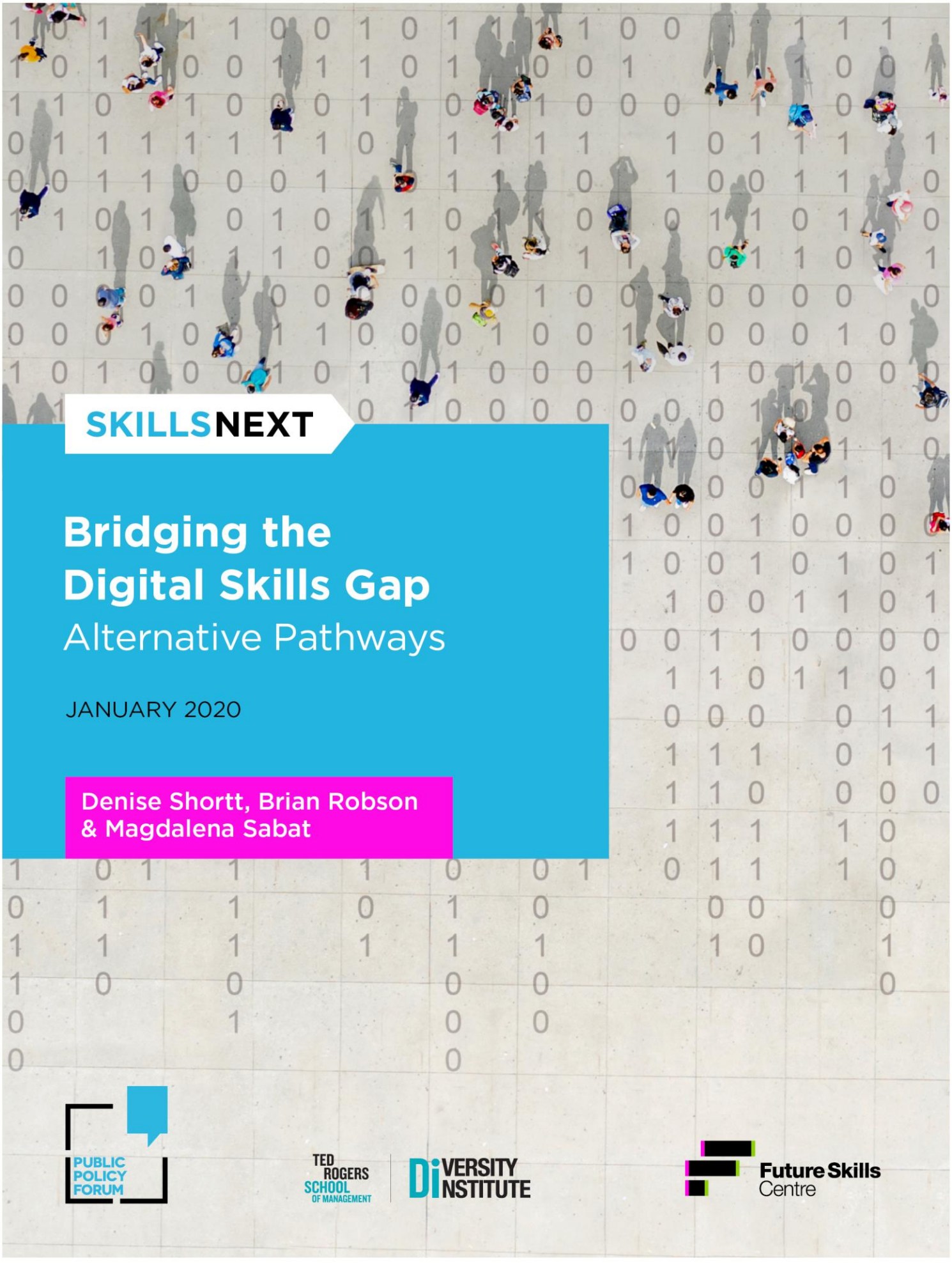

SKILLSNEXT

Bridging the Digital Skills Gap

Alternative Pathways

JANUARY 2020

Denise Shortt, Brian Robson & Magdalena Sabat

PUBLIC POLICY FORUM

TED ROGERS SCHOOL OF MANAGEMENT | DIVERSITY INSTITUTE

Future Skills Centre

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The Diversity Institute conducts and co-ordinates multi-disciplinary, multi-stakeholder research to address the needs of diverse Canadians, the changing nature of skills and competencies, and the policies, processes and tools that advance economic inclusion and success. Our action-oriented, evidence-based approach is advancing knowledge of the complex barriers faced by underrepresented groups, leading practices to effect change and producing concrete results. The Diversity Institute is a research lead for the Future Skills Centre.

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ABOUT THE PROJECT

Canadians' needs for skills training are changing rapidly. Through Skills Next, the Public Policy Forum and the Diversity Institute—in its role as a research lead for the Future Skills Centre—are publishing a series of reports that explore a number of the most important issues currently impacting the skills ecosystem in Canada. Each report focuses on one issue, reviews the existing state of knowledge on this topic, and identifies areas in need of additional research. This strong foundation is intended to help support further research and strengthen policymaking. A diverse set of authors who are engaged in the skills ecosystem through various roles, including through research, activism, and policymaking, have been carefully selected to provide a broad range of perspectives while also foregrounding the Canadian context. Their varied backgrounds, experiences, and expertise have shaped their individual perspectives, their analyses of the current skills ecosystem, and the reports they have authored.

Skills Next includes reports that focus on:

- Global comparison of trends to understand the future of skills
- Knowns and unknowns about skills in labour market information
- Rethinking the relationship between technology and the future of work
- Defining digital skills and the pathways to acquiring them
- Barriers to employment for immigrants and racialized people in Canada
- Barriers to employment for persons with disabilities
- The return on investment of industry leadership in skills and training
- Approaches to improving the transitions of university graduates from education to the workforce

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EXECUTIVE SUMMARY

Digital skills are increasingly in demand across many industries. Recent industry reports argue that a shortage of people in the workforce skilled in information and communications technology (ICT) is inhibiting the growth of innovative companies around the world. Some argue that in Canada, this global challenge is exacerbated by Canadian firms' historic tendency to adopt new technologies at a slower than average speed — a hesitancy many argue is itself the result of previous shortages of skilled technology workers.

While the origins and extent of the "digital skills gap" may be the source of some disagreement, this paper argues that the existence of this gap is real, provided a gap is understood as a lack of candidates with the skills required by particular employers. Critically, however, its causes may be more complex than are commonly understood. For example, the under-employment of skilled immigrants and under-representation of women and other groups in the ICT industry suggests that recruitment and retention policies and practices of the very firms complaining about this gap may be contributing to the problem.

While there are multiple pathways to "digital careers," accessing them requires innovations in skills development and in approaches to defining these roles. Yet a review of the most relevant digital skills frameworks shows there is little common understanding of the actual skills or knowledge that contribute to the skills gap; little common understanding of the dimensions of learning and training needed to improve it; muddled distinctions between areas of knowledge, competencies, skills and tools needed for 21st-century learning or work; and very little identification of skill levels.

In Canada, the National Occupational Classification (NOC) system provides standardized language to describe occupations in the Canadian labour market. But in this classification system, as in others, there is often confusion between a job, the skills and competencies needed to perform the job, and

the specific tools and techniques needed for the job. Moreover, the NOC's usefulness is also somewhat limited in the context of digital skills, as it has not kept pace with the emergence of technology-based occupations, such as cloud engineer, nor has it developed a clear way of including hybrid roles.[1]

Opening new pathways to digital skills, especially for those who are currently under-represented, will require the development of a better understanding around the deployment, monitoring and assessment of emerging approaches to digital skills identification, development and employment. Standard definitions and approaches need to be identified, established and supported. We need better case studies to appreciate the effects of innovative approaches to developing and recruiting digital talent including inclusive training and recruitment practices; reconsidering credentials and assessment; and new forms of training and upskilling. Our approach to developing and applying digital skills will need to evolve, but for this evolution to be successful, we first need to understand what works, what is not working, and how to use inclusion to expand the talent pool.

We need better case studies to appreciate the effects of innovative approaches to developing and recruiting digital talent including inclusive training and recruitment practices; reconsidering credentials and assessment; and new forms of training and upskilling.

[1] The NOC codes are next scheduled to be updated in 2021 and may incorporate new job titles at that time.

OVERVIEW AND CHALLENGES

Digital skills are increasingly in demand.[2] In a 2016 report, the Information Technology Association of Canada (ITAC) pointed out that "[t]he shortage of skilled ICT talent in the technology sector is a major issue hampering the growth of innovative companies in Canada."[3] The Information and Communications Technology Council (ICTC) notes that traditional industries that need to adopt and use new technologies to innovate are especially impacted by these shortages.[4] At the same time, however, the Organisation for Economic Co-operation and Development (OECD) points out that while the skills gap is significant for those firms facing skilled talent shortages, the "shortage of ICT skills remains small" and suggests that "only a small share of enterprises are looking for ICT specialists."[5]

The ICTC estimates that in 2020, 218,000 information and communications technology (ICT) positions will need to be filled in Canada.

While the origins and extent of the "digital skills gap" may be contested—something explored in detail below—this paper argues that the existence of this gap is real, provided a gap is understood as a lack of candidates with the skills required by particular employers.[6] One consequence of this gap is that a number of efforts have been undertaken to remedy it, many of which have focused on "upskilling" as a potential solution. In brief, upskilling refers to "the development of skills an employee will need to perform the same role in the future."[7] But, while much research in this area has focused on increasing capacity in digital skills for graduates and mid-career employees alike, it is also important to recognize that the basic skills required by the workplaces of the future will not be solely technical in nature. For

[2] ICTC. Information Communications Technology Council. (2015a). The smart economy reshaping Canada's workforce: Labour-market outlook (2015)-(2019).

[3] Information Technology Association of Canada. (2016). ITAC on talent, 1.

[4] Information Communications Technology Council. (2016c). Digital talent: Road to 2020 and beyond.

[5] Organisation for Economic Cooperation and Development. (2017). OECD Digital Economy Outlook (2017). 178.

[6] The digital skills gap discussed in this paper would thus fall into the category of "skills shortage" according to the taxonomy outlined by Braham and Tobin (p. 5) if seen from the employers' perspective. As is discussed below, however, this categorization may not be completely accurate given employers' inability to recognize the potential of the talent that already exists in the labour market.

[7] Reynolds, J., (2019). 'Upskilling': How employees and businesses can seize the day. *The Globe and Mail.*

example, the World Economic Forum has projected that emotional intelligence, judgment and creativity will all figure in the top-10 skills needed to thrive in the workforce in 2020.[8]

Similarly, authors of an RBC report encourage policy-makers and employers not to lose sight of the importance of the liberal arts, arguing that alongside widespread demand for various digital and ICT capacities, the workplaces of the future will require foundational skills such as critical thinking, co-ordination and social perceptiveness.[9] In fact, business schools are increasingly offering programs designed to target and improve non-cognitive "soft-skill" capacities, with some leaders in business education even suggesting that these soft skills are harder to teach than technical ones.[10] These perspectives support a drive towards upskilling and reskilling efforts rather than increased recruitment into traditional ICT-specific roles.

Some have questioned the existence of a digital skills gap entirely, pointing to a lag between the market demanding more candidates with digital skills and the market rewarding those candidates with the rising wages one would expect to see in a tight market for skilled ICT labour. In other words, economic indicators seem to reflect skills mismatches rather than acute shortages.[11,] For example, the under-employment of skilled immigrants is offered as evidence that the problem is recruitment and retention practices, not a shortage of skilled workers.[12, 13, 14, 15, 16] Moreover, women and other groups are under-represented in ICT roles. Finally, it may be the case that the credentials employers require for many jobs rely on outdated assumptions about what those jobs involve rather than an analysis of the skills required to perform the role.[17, 18]

The evidence suggests there are multiple ways to acquire digital skills and multiple pathways into roles that require them. But opening these pathways further will require innovation in skills training and development. It will also require changes in how businesses, governments and individuals define

[8] World Economic Forum. (2016). The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution.

[9] Royal Bank of Canada. (2018). Humans wanted: How Canadian youth can thrive in the age of disruption.

[10] Johnson, G. (2019). Soft skills are what distinguish one job candidate from the next. The Globe and Mail.

[11] Finnie, R., Mueller, R., and Sweetman, A. (2018). Information and communication technology talent: the skills we need — framing the isses. Canadian Public Policy, 44(S1), Siii -Six.

[12] Brochu, P., and Abu-Ayyash, C. (2006). Barriers and strategies for the recruitment and retention of immigrants in London, Ontario. In Our Diverse Cities. Metropolis, 27–30.

[13] Danso, R. (2009). Emancipating and empowering de-valued skilled immigrants: What hope does anti-oppressive social work practice offer? British Journal of Social Work. 39(3), 539–555.

[14] Hire Immigrants. (2019). Investing in refugee talent: Lessons learned in labour-market integration.

[15] Mahmud, S., Alam, Q., and Härtel, C. (2014). Mismatches in skills and attributes of immigrants and problems with workplace integration: A study of IT and engineering professionals in Australia. Human Resource Management Journal. 24(3), 339–354.

[16] Tiagi, R. (2015). Are immigrants in Canada over-represented in riskier jobs relative to Canadian-born labour market participants? American Journal of Industrial Medicine. 58(9), 933–942.

[17] Garr, S. S. (2019). Diversity and inclusion technology: the rise of a transformative market.

[18] Oreopoulos, P. (2009). Why do skilled immigrants struggle in the labour market? A field experiment with six thousand resumés. National Bureau of Economic Research, NBER Working Papers.

those basic skills which they see as required, as well as in employer approaches to recruiting, training and retaining workers.

It is urgent that Canada develop these pathways. The ICTC estimates that in 2020, 218,000 information and communications technology (ICT) positions will need to be filled in Canada.[19] According to ICTC's projection, about half of these will be new ICT positions while the other half will be replacements for workers leaving the industry.[20] Only 29,000 ICT graduates are expected to join the workforce every year, which is not enough fill these positions through local supply.[21]

In an ICTC survey of employers, 53 per cent of ICT organizations said attracting and retaining skilled employees was a top human resource challenge,[22] and 34 per cent faced at least some difficulty in filling ICT positions.[23] An Engineers Canada assessment of the challenge produced similar results.[24] But, while industry groups report acute skills challenges, the OECD has stated that "the measurement of both the demand for and the supply of such skills falls short of the evidence base that is necessary to inform education and training policies."[25] Nonetheless, while this lack of available and timely data and labour market information represents a challenge in the design of education and training policies aimed at tackling the problems employers report,[26, 27, 28] governments, post-secondary institutions and community organizations have all launched projects to "bridge the skills gap" and build the digital talent pool.[29]

Still, Canada lags behind its international peers. Canada receives high scores in terms of the number of digitally skilled youth who are preparing to enter the workforce and in the widespread use of digital skills in the average person's daily life. Concurrently, however, Canada also receives only average scores in the area of "leveraging innovation to stimulate skills use."[30] This inability to quickly integrate innovative technologies into the economy, and use the skills needed to apply them productively,

[19] Information Technology Association of Canada. (2016). ITAC on talent.

[20] Ibid.

[21] Information Communications Technology Council. (2015b). Digital economy supply: Canada's post-secondary education system.

[22] Information Communications Technology Council. (2016c). Digital talent: Road to 2020 and beyond.

[23] Information Communications Technology Council. (2016d). Skills in the digital economy: Where Canada stands and the way forward.

[24] Engineers Canada. (2015). Engineering labour market in Canada: Projections to 2025.

[25] Organisation for Economic Cooperation and Development. (2017). OECD Digital Economy Outlook (2017), 175.

[26] Drummond, D., and Halliwell, C. (2016). Labour market information: An essential part of Canada's skills agenda. Business Council of Canada.

[27] Information Technology Association of Canada. (2016). ITAC on talent.

[28] Braham, E., Tobin, S. (2020). Solving the skills puzzle: The missing piece is good information. Skills Next. Public Policy Forum, Diversity Institute at Ryerson University, Future Skills Centre.

[29] Information Technology Association of Canada. (2016). ITAC on talent.

[30] Organisation for Economic Cooperation and Development. (2019). OECD skills strategy (2019): Skills to shape a better future (executive summary).

suggests that Canada's comparative strength in digital skills is being under-applied. Other jurisdictions, including the European Union, Australia and Singapore, have made much greater progress in developing the sorts of skills infrastructure, such as programs and taxonomies for digital skills—including digital skills toolkits, roadmaps and frameworks—that are needed.

This paper begins by considering the challenge of defining digital jobs and industries. It then reviews an international sample of digital skills frameworks (i.e., taxonomies and assessment tools) to understand approaches that differentiate between occupations, skills, tools and techniques. Next, it identifies emerging approaches to developing and recruiting digital talent, with a focus on Canadian initiatives, including inclusive training and recruitment practices; reconsidering credentials and assessment; and training and upskilling. The paper concludes with a summary of insights and potential next steps.

DEFINING DIGITAL JOBS AND INDUSTRIES

The nature of digital skills and technology jobs can change quickly, challenging efforts to define and measure the digital labour market. Labour market projections depend on a range of factors and, while important for informing policy, are often inaccurate. This is particularly true in the ICT sector where the direction of technological change may be apparent, but its pace is unclear. Current trends in ICT include a shift towards digitization of government services, telecom growth, demand for platform and storage solutions, automation and a blurring of sector boundaries.[31, 32] The pace of industry change is mainly defined by technology adoption, which is comparatively slow in Canada.[33]

But, given the changing nature of work and the limitations of current occupational classifications, efforts at classification are focusing less on "jobs" and more on "skills" and "competencies." Skills and competencies are abilities an individual acquires through training and experience. Skills are specific, learned activities that range in terms of complexity, while competencies have to do with behaviours that demonstrate the abilities needed to perform job requirements.[34] Skills and competencies can be generic, crossing occupations and levels, or be very specific and tied to particular professions. The evidence suggests both are important for employee success. Current labour-market measurement

5.1 per cent of the Canadian workforce (roughly 935,000 workers) are working in digital occupations, but that the majority are in "digital" jobs (681,000 workers) and not "high-tech" occupations (254,000 workers)

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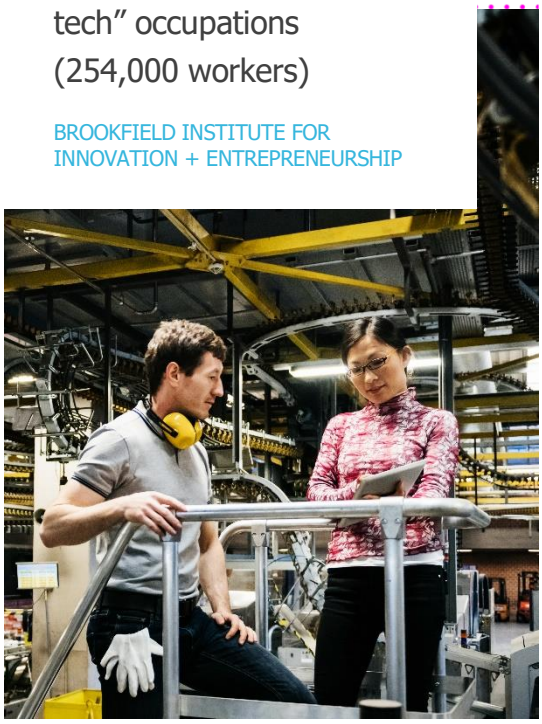


[31] FitchSolutions. (2018). Canada information technology report: Includes 5-year forecast to 2022.

[32] Gonzales, E. (2019). All systems go: Recovering private investment will lead to increased use of industry services. IBISWorld.

[33] Lamb, C., Munro, D. and Vu, V., (2018). Better, Faster, Stronger: Maximizing the benefits of automation for Ontario's firms and people. Brookfield Institute for Innovation+ Entrepreneurship.

[34] Beckett, S. (2018). What's the difference between skills and competencies? Human Resources Systems Group.

approaches, however, are limited in their ability to accurately measure in-demand skills and competencies.

Classification Confusion

According to the Government of Canada, ICT is a $184-billion industry with 623,000 workers employed at over 40,000 companies in Canada. More than half (55 per cent) of the ICT workforce have university degrees, and the annual average salary is $77,600.[35, 36, 37, 38, 39, 40, 41] However, the digital workforce extends far beyond the ICT sector.[42] Digital skills shortages have been identified in sectors including financial services, manufacturing, health care and the public sector. In fact, the Brookfield Institute for Innovation + Entrepreneurship has reported that 5.1 per cent of the Canadian workforce (roughly 935,000 workers) are working in digital occupations, but that the majority are in "digital" jobs (681,000 workers) and not "high-tech" occupations (254,000 workers).[43] In this report, Viet Vu, Creig Lamb and Asher Zahar define digital occupations as "those that typically contribute to the development of computer hardware or software solutions (e.g. software developers or technology architects)," whereas high-tech occupations are those that "require advanced technical skills in which computers are used as a means to other ends (e.g., engineers or scientists)."[44]

The researchers' estimate helps to illustrate how the vast majority of the need for digital skills competencies is outside of the ICT sector. This is an important point because this fact has been a source of confusion for attempts at classification of digital jobs and occupations. Normally, the Government of Canada's National Occupational Classification (NOC) system is used to define and classify occupations in the Canadian labour market. In this classification system, as in others, there is often confusion between occupations (the job), the basic skills and competencies needed to perform the job (e.g., computer programming, which typically takes years to develop), and the specific tools

[35] Innovation, Science, and Economic Development. (2017). 2017 Canadian ICT sector profile: Automotive, transportation and digital technologies branch. Government of Canada.

[36] Gray, T. R. (2018). The perceived digital skills gap in Canada. A background review. Tacit Elements.

[37] Information Communications Technology Council. (2016a). Digital economy annual review (2016).

[38] Innovation, Science and Economic Development. 2016 2016 Canadian ICT sector profile: Automotive, transportation and digital technologies branch. Government of Canada.

[39] Currid, E., and Stolarick, K. (2010). The Occupation-Industry Mismatch: New Trajectories for Regional Cluster Analysis and Economic Development. Urban Studies. 47(2), 337-362.

[40] Gray, T. R. 2018. The perceived digital skills gap in Canada. A background review. Tacit Elements; Information Communications Technology Council (ICTC). 2016a. Digital economy annual review 2016. ICTC;

[41] Innovation, Science, and Economic Development. (2016) 2016 Canadian ICT sector profile: Automotive, transportation and digital technologies branch. Government of Canada.

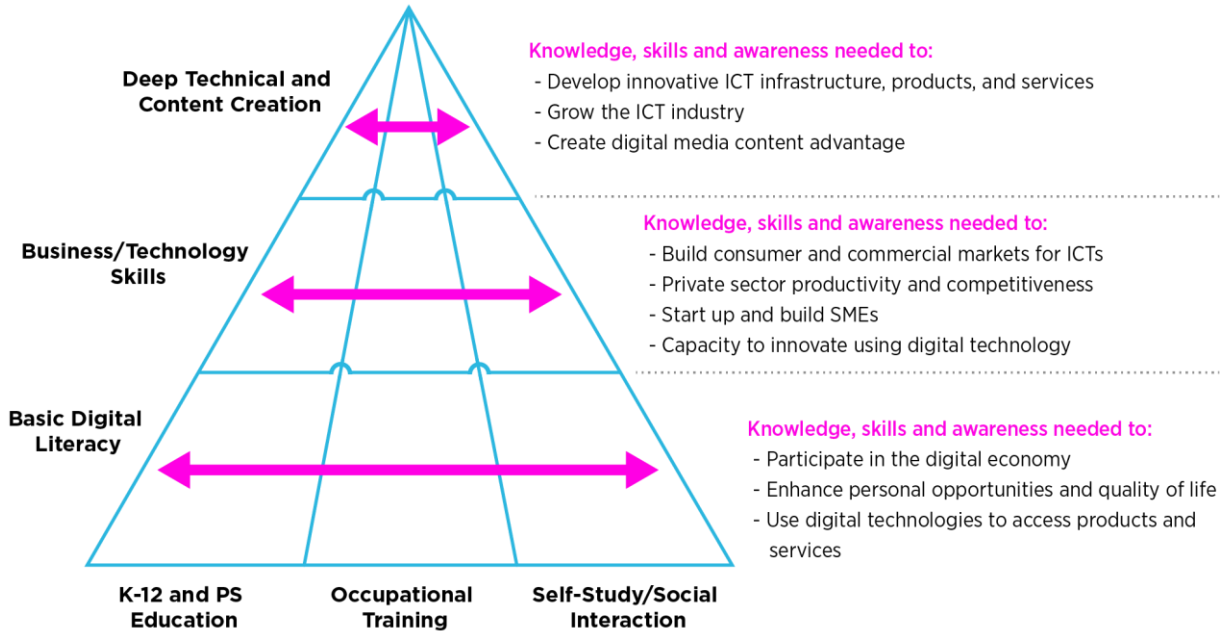
[42] Currid, E., and Stolarick, K. (2010). The Occupation-Industry Mismatch: New Trajectories for Regional Cluster Analysis and Economic Development. Urban Studies. 47(2), 337-362.

[43] Vu, V., Lamb, C., and Zafar, A. (2019). Who are Canada's tech workers? Brookfield Institute for Innovation + Entrepreneurship.

[44] Ibid.

and techniques needed for the job (e.g., JavaScript or Python, which can be taught easily when someone has the foundational skills). Digital jobs vary considerably in terms of key competencies, skills and tools. While often seen as synonymous with engineering and computer science,[45] digital jobs are wide-ranging and do not all require in-depth technology skills (see Figure 1).

Figure 1: Skill Type and Educational Level



Source: Cukier, Wendy, Smarz, S., and Grant, K. (2017). Digital skills and business school curriculum. Ryerson University.

Rise of the hybrids

Unfortunately, the NOC framework does not currently capture the full range of ICT jobs. Specifically, "hybrids," are often missed or poorly categorized. (Hybrids are individuals who possess deep skills in sales, marketing, project management, regulatory processes, business management, strategy and organizational change, content development and more, but also possess enough knowledge of technology to work directly with technicians or developers.) For example, of the five most in-demand digital jobs in Alberta,[46] four—UX/UI designer, data scientist, full stack development and backend developer—are not even currently included in the NOC. Similarly, the most in-demand digital job, software developer, is classified as falling under NOC 2174, Computer Programmers and Interactive

[45] Cukier, W., Smarz, S., and Grant, K. (2017). Digital skills and business school curriculum. International Conference: The Future of Education, Ryerson University. An Integrated Approach to Digital Literacy.

[46] Cutean, A., and McLaughlin, R. (2019). A digital future for Alberta: An analysis of digital occupations in Alberta's high-growth sectors. The Information and Communications Technology Council.

Media.[47] This NOC category includes job titles such as "graphic user interface designer" and "interactive media developer" but excludes "graphic designers and illustrators" (NOC 5241) and "software engineers and designers" (NOC 2173). Further, the NOC 2174 employment requirements specify educational requirements that do not take into account UX/UI designers. Overall, job titles that include "design" are particularly prone to mis-categorization because they tend to include diverse training as well as hybrid skills and job roles.

Similarly, a 2015 Burning Glass Technologies study analyzed job postings to find that three of the four most in-demand job categories — customer relationship management, digital media and design and social media tools and search engine analysis — were all hybrid roles (see Figure 2). Critically, these positions all required the ability to use common software, not sophisticated technology skills.

Figure 2: High-Priority Digital Skills and Occupations

Advanced Digital Skills	Top Occupations			Top Skills
Customer Relationship Management	Sales Representative	Sales Manager	Account Manager / Representative	• Salesforce CRM • SAP CRM • Siebel CRM
Computer and Network Support	Computer Support Specialist	Network / Systems Administrator	Network / Systems Support Specialist	• SQL • Linux • Cisco
Digital Media & Design	Graphic Designer / Desktop Publisher	Marketing Co-ordinator / Assistant	Multimedia Designer	• Adobe Photoshop • Adobe Acrobat • InDesign
Social Media Tools and Search Engine Analysis	Recruiter	Graphic Designer / Desktop Publisher	Search Engine Optimization Specialist	• Social Media Platforms • Blogging • Google Analytics

Source: Burning Glass Technologies. (2015). Crunched by the Numbers: The Digital Skills Gap in the Workforce.

Hybrid workers are particularly valuable because, contrary to people with strictly technical skills, they are able to work effectively with both clients and developers. Consequently, demand for hybrid roles is growing quickly. For example, between 2015-16, demand in Canada for telecommunications services/operations/facilities managers grew by 40 per cent and demand for electronics technicians

[47] Government of Canada. (2019). NOC 2174 computer programmers and interactive media developers.

grew by 12 per cent.[48] While deep technical skills are necessary for some roles, basic digital literacy and general business and technology skills are sufficient for many day-to-day business functions.[49]

Shifting roles

Another challenge to classifying jobs and skills is the emergence of roles that combine skills from previously distinct positions. A recent Brookfield Institute report emphasizes the emergence of these hybrid roles. Often, employers are looking for a special blend of digital and non-digital skills.[50] To further understand the demand, Viet Vu, Creig Lamb and Rob Willoughby have developed a new measure for digital skills, where specific skills are placed on a continuum based on relative digital intensity and then grouped into four clusters, ranging from most-general and least digitally intensive to specific and most digitally intensive. A notable takeaway from their study is that "the least digitally intensive skills are the most widely demanded."[51] Further, their report underlines opportunities for skill transfers between roles, especially given the spectrum of digital skills.

Examples of the importance of this sort of analysis can be found if we look at Calgary's 2015 economic downturn. At this time, high rates of displacement were observed among highly skilled "deep" technology occupations such as petroleum engineers and geoscientists, while roles that blended digital skills and competencies, such as software developers, data analysts and UX/UI designers, were in demand. Yet while many people in "deep" technology occupations have the skills for other types of roles—for example, the average geoscientist has nearly 60 per cent of the core skills and competencies needed to become a data analyst—they lacked the skills needed to transfer their expertise to in-demand positions. This was compounded by employers being unaware of these transferrable skills, which represents a significant lost opportunity when the average time required to upskill these workers is a year or less.[52] An improved classification system could potentially alleviate some of these problems and help to ameliorate the digital skills gap.

Research further supports the idea that better mapping of skills and competencies could help employers find the workers with the skills they need and help workers better use the skills they have to find the jobs they want. Alexandra Cutean and Ryan McLaughlin used the U.S. Department of Labor's Occupational Information Network (O*NET) database to map occupational codes to skills and

[48] Information Communications Technology Council. (2016b). Fastest growing ICT professions in Canada.

[49] Cukier, W., Smarz, S., and Grant, K. (2017). Digital skills and business school curriculum. International Conference: The Future of Education, Ryerson University. An Integrated Approach to Digital Literacy.

[50] Vu, V., Lamb, C., and Willoughby, R. (2019). I, Human: Digital and Soft Skills in a New Economy. Brookfield Institute for Innovation + Entrepreneurship.

[51] Ibid.

[52] Cutean, A., and Davidson, R. (2018). Mapping Calgary's digital future: tech employment opportunities for displaced workers. Information and Communications Technology Council.

found that there is demand for a broad range of skills beyond pure technology.[53, 54] Critical thinking, creativity and flexibility were identified as the most important skills in the hiring process, while active listening, oral expression and inductive reasoning were identified as strongly associated with high-growth occupations.

Companies are increasingly recognizing the importance of multiple disciplines as pathways to jobs that rely on digital skills.[55] For instance, a recent survey of skills required to work in artificial intelligence confirmed the importance of deep technology skills as well as sales, marketing and product-management abilities.[56] Some companies have said that it is easier to take someone with those skills and teach them about technology than to take someone with deep technology skills and teach them how to effectively sell.[57] Accumulating research stresses the importance of non-technical skills even in the technology sector.[58, 59, 60, 61] This message is also echoed by employers, who are looking for candidates with digital capacity and who are fluent with digitally intensive tools, but not at the expense of soft skills, namely "strong interpersonal, project management and problem-solving skills."[62]

Essential skills

Economic and Social Development Canada's (ESDC) Essential Skills Framework defines nine essential skills and is used to design and assess various skills development initiatives across the country (see Figure 3). According to ESDC, essential skills are the foundation for learning all other skills, and they are what enable people to prepare for, get and keep a job, as well as enable them to adapt and succeed at work.[63]

[53] Cutean, A., and McLaughlin, R. (2019). A digital future for Alberta: An analysis of digital occupations in Alberta's high-growth sectors. The Information and Communications Technology Council.

[54] Lewis, P., and Norton, J. (2016). Identification of "hot technologies" within the O*NET® System. National Center for O*NET Development.

[55] Vasseur, L., and VanVolkenburg, H. (2018). The non-linear paths of women in STEM: The barriers in the current system of professional training. Brock University.

[56] Küpper, D., et al. (2018). AI in the factory of the future: The ghost in the machine. The Boston Consulting Group.

[57] Barbosa, S., and Cockton, G. (2018). Humans wanted: our many roles in designing for innovation, IoT, and AI. Interactions, 25(6), 5.

[58] Adecco Group. (2017). The soft skills imperative.

Cukier, W, Hodson, J., and Omar, A. (2015). "Soft" skills are hard: A review of the literature. Ryerson University.

[59] Madsbjerg, C. (2017). *Sensemaking: The power of the humanities in the age of the algorithm*. New York: Hachette Books.

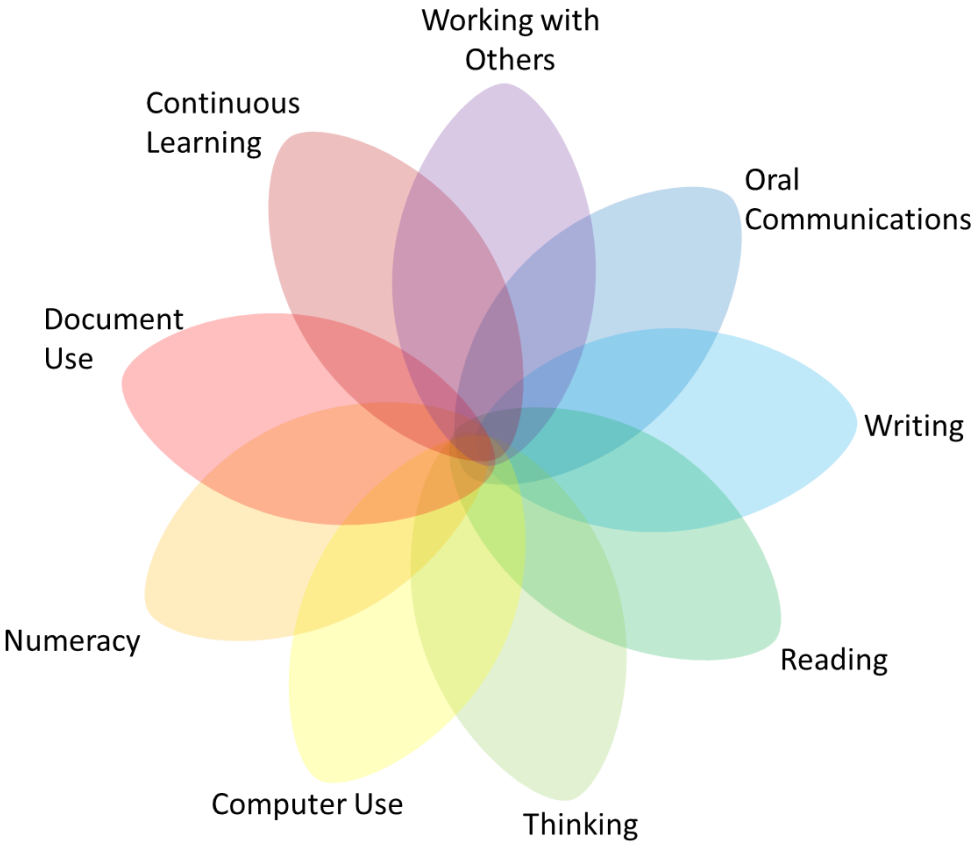
[60] Samuel, A. (2016). The soft skills of great digital organizations. Harvard Business Review.

[61] Walker, V., Bowkett, G., and Duchaine, I. (2018). All companies are technology companies: preparing Canadians with the skills for a digital future. *Canadian Public Policy*. 44(S1), S153–S158.

[62] Vu, V., Lamb, C., and Willoughby, R. (2019). I, Human: Digital and Soft Skills in a New Economy. Brookfield Institute for Innovation + Entrepreneurship.

[63] Government of Canada. (2015). Understanding Essential Skills.

Figure 3: ESDC Nine Essential Skills



Source: Smith, T. (2011). Literacy Newfoundland and Labrador. Tech Soup Canada.

Academics and organizations are mapping these essential skills to other taxonomies and frameworks and are considering additional skills. Annalise Huynh and Andrew Do have proposed that communication, collaboration, critical thinking, problem-solving, flexibility, creativity, entrepreneurial thinking and organizational skills should be included as 21st-century skills.[64] Will Markow, Debbie Hughes and Andrew Bundy suggest including critical thinking, creativity, communication, collaboration, and analytic skills.[65]

The World Economic Forum breaks 21st-century skills into foundational literacies (how students apply core skills to everyday tasks) including literacy, numeracy, scientific literacy and ICT literacy; competencies (how students approach complex challenges) including critical thinking/problem solving, creativity, communication and collaboration; and character qualities (how students approach the

[64] Huynh, A., and Do, A. (2017). Digital literacy in a digital age. Brookfield Institute for Innovation + Entrepreneurship.

[65] Markow, W., Hughes, D., with Bundy, A. (2018). The new foundational skills of the digital economy: Developing the professionals of the future. Burning Glass Technologies.

changing environment) including curiosity, initiative, persistence/grit and social and cultural awareness.[66]

While there are common themes among these and other skills frameworks, there is little consistency in the categories and definitions; limited evidence that they can be objectively defined and tested; and challenges translating them into frameworks that can be commonly used by employers and other stakeholders.

[66] Soffel, J. (2016). What are the 21st-century skills every student needs? World Economic Forum.

DIGITAL SKILLS FRAMEWORKS

As was discussed in the preceding chapter, digital skills and labour shortages are exacerbated by the lack of common nomenclature to define digital skills and a lack of clarity over what qualifies a person to work in a role with significant digital skill requirements. Consequently, various stakeholders have developed digital skill structures, including digital skills maps, toolkits and frameworks to serve educators, students, policymakers, employers and others. One example, developed by Vu, Lamb and Willoughby, groups digital skills on a continuum to better understand where jobs and skills occur on the spectrum from least digitally intensive to most, and where the demand is. Notably, this framework incorporates common soft skills that appear with digital skills, such as teamwork, collaboration, and problem-solving.[67]

Unfortunately, in terms of general knowledge and specific ICT knowledge, there are no clear similarities between frameworks, skills maps and toolkits, other than an emphasis on "soft" or "human" skills (see Appendix A). Most frameworks are structured as general learning and pedagogical tools to widely improve digital literacy (e.g., the EU's DigComp 2.0 map and ITU Digital Skills Toolkit). A few frameworks focus on addressing the digital skills gap in order to support workers in the digital era (e.g., the Brookfield Skills Map and the BTM Learning Outcomes map). Importantly, most frameworks do not identify skills or learner levels, except for Wendy Cukier and colleagues' Digital Skills and Business School Curriculum[68] and ITU's Digital Skills Toolkit,[69] which articulate three skill levels.

Global attempts

Definitions of ICT professionals' knowledge, competencies and skills also vary, but, on the whole, frameworks tend to put more emphasis on skill levels.[70] The European e-Competence Framework (e-CF) provides a reference of 40 competencies as applied to the ICT workplace, using a common language for competencies, skills, knowledge and proficiency levels across Europe.[71] The e-CF was created to provide a generic set of typical roles performed by ICT professionals in any organization and covers the full ICT process. Its five e-CF areas—plan, build, run, enable and manage—are broken down into required competencies and five e-competency levels, from low- or entry-level competency to advanced. Each area provides example skills and knowledge, which allows for individual-level

[67] Vu, V., Lamb, C., and Willoughby, R. (2019). I, Human: Digital and Soft Skills in a New Economy. Brookfield Institute for Innovation + Entrepreneurship.

[68] Cukier, W., Smarz, S., and Yap, M. (2012). Using the Diversity Audit Tool to assess the status of women in the Canadian financial services sector: A case study. International Journal of Diversity in Organisations, Communities and Nations. 11(3), 15–36.

[69] ITU. (2018). Digital Skills Toolkit.

[70] EU/ Skills Panorama. (2016). ICT professionals: Skills opportunities and challenges (2016). CEDEFOP.

[71] European e-Competence Framework. (n.d.). A common European framework for ICT Professionals in all industry sectors.

measurement of each competency and specification of skills. It is a comprehensive tool that enables the identification of competencies and skills that are required to successfully perform duties in the ICT workplace.

Other countries have made similar attempts to define an ICT professional's knowledge, competencies and skills. Below, three such frameworks are discussed: the ICT Profession Core Body of Knowledge (CBOK), the Skills Framework for ICT and the Body of Knowledge. Appendix A contains a table that summarizes and compares the frameworks discussed below, as well as other relevant frameworks. The expanded descriptions below are provided to demonstrate the breadth and the lack of agreement across professional associations globally on how to define the knowledge, competency and skills relating to digital skills generally and ICT specifically. It also shows that there is little agreement on how to distinguish or measure levels of expertise.

Australia's ICT Profession Core Body of Knowledge (CBOK)

The Australian Computer Society (ACS) has defined an ICT Profession Core Body of Knowledge (CBOK), which includes six areas of ICT Professional Knowledge:[72]

1. ethics;
2. professional expectations;
3. teamwork concepts and issues;
4. interpersonal communication;
5. societal issues/legal issues/privacy; and
6. understanding the ICT profession and general ICT knowledge (hardware and software fundamentals, data and information management, networking and technology-building).

The ACS CBOK links to the ICT occupations contained within the Australia and New Zealand Standard Classification of Occupations, identifying 30 different job titles within the ICT field. However, unlike the EU's e-CF, it does not articulate or map specific competencies and skills, or levels of those skills, to the areas of knowledge identified.

[72] Australian Computer Society (ACS). (2015). ACS core body of knowledge for ICT professionals (CBOK).

Singapore's Skills Framework for ICT

In Singapore, the Skills Framework for ICT was developed by the Infocomm Media Development Authority and SkillsFuture Singapore in consultation with ICT industry stakeholders.[73] It lists seven domains for ICT: data, infrastructure, professional services, security, sales and marketing, software and applications and support. Each knowledge domain is subdivided into knowledge categories that include pathways for general skills and ICT-specific skills and diagrams illustrating varying pathways to ICT professions, including vertical progressions and lateral movements.

Canada's ITAC Body of Knowledge

ITAC has developed a detailed Body of Knowledge on specific topics for the Business Technology Management Program, a standard program in business schools across Canada. The Body of Knowledge includes four core knowledge areas: information technology (it), information systems (is), is-it management and business technology management, with six ICT specific knowledge areas within each core area. However, it does not articulate skills that are linked to those areas or levels of those skills.

[73] Infocomm Media Development Authority. (n.d.). Skills Framework for Information and Communication Technology (ICT).

EMERGING AND INNOVATIVE APPROACHES TO CLOSING THE SKILLS GAP

Despite the definitional and taxonomical problems discussed above—such as the lack of a commonly agreed-upon taxonomy of digital jobs and digital skills—efforts are underway by Canadian governments, educational institutions and businesses to address digital skills and labour shortages. Emerging approaches to developing and recruiting digital talent focus on inclusive training and recruitment practices; reconsidering credentials and assessment; and training and upskilling.

Inclusive training, recruitment and hiring practices

One of the most obvious anomalies present in the data that describes the skills gap is that even while there exists a clear shortage of skilled technology workers and hybrid workers with digital skills capacities, a variety of equity-seeking groups—particularly highly skilled immigrants and women—are underrepresented in ICT roles and throughout the ICT pipeline.[74]

Despite many explicit corporate commitments to diversity, decades of initiatives designed to advance women in technology have scarcely had an effect: The proportion of women in engineering and computer science in Canada has changed little in 25 years.[75, 76, 77] Women in STEM are paid less than men,[78, 79, 80] and technology fields fail to attract and retain women. More than 52 per cent of women leave private-sector jobs in science, engineering and technology, with the exit rate highest in the technology sector (56 per cent).[81] Compared with women in other professional fields, women who leave STEM are also less likely to return.[82] Furthermore, false naturalistic narratives are perpetuated across industries, for example, that women are naturally less risk-seeking than men. These kinds of myths are driven by systemic problems in hiring and recruitment practices.[83]

[74] Reitz, J. G., Curtis, J., and Elrick, J. (2014). Immigrant skill utilization: Trends and policy issues. Journal of International Migration and Integration. 15(1), 1–26.

[75] Caranci, B., Judge, K., and Kobelak, O. (2017). Women and STEM: Bridging the divide. TD Economics.

[76] Chicha, M-T. (2006). A comparative analysis of promoting pay equity: Models and impacts. WP/49. International Labour Organization.

[77] Elliott, S. L. (2016). From the editor-in-chief: Questions of gender equity in the undergraduate biology classroom. Journal of Microbiology and Biology Education. 17(2), 186–188.

[78] Caranci, B., Judge, K., and Kobelak, O. (2017). Women and STEM: Bridging the divide. TD Economics.

[79] Cukier, W. (2007). Diversity, the competitive edge: Implications for the ICT labour market. Information and Communications Technology Council.

[80] Information Communications Technology Council. (2017). The next talent wave: Navigating the digital shift — Outlook 2021.

[81] Hewlett, S. A., Luca, C. B., and Servon, L. J. (2008). Stopping the exodus of women in science. Harvard Business Review, 22–24.

[82] Glass, J. L., et al (2013). What's so special about STEM? A comparison of women's retention in STEM and professional occupations. Social Forces. 92(2), 723–756.

[83] Wernick, R., (2019). Opening remarks: Why gender data and analysis matter for the future of work. Diversity and Inclusion Now.

Women are not the only group who could help fill the digital skills gap but are being inhibited from doing so. People with "foreign-sounding" last names, for example, are less likely to be interviewed for positions even if they have the same qualifications as other applicants. Many racialized minorities, as well as First Nations, Inuit and Métis people, face unconscious bias and limited career opportunities, particularly within small- and medium-sized enterprises.[84, 85]

Immigrants are often stuck in precarious and low-paying jobs, despite having high levels of skill and education, in part because foreign work experience and credentials are generally devalued in Canada.[86, 87] University graduates with severe disabilities have the same employment outcomes as those without a high school diploma.[88] People who face multiple barriers, such as disability, age, gender, religion and ethnic or racialized identity have compounding challenges to employment and advancement.[89, 90]

The underrepresentation of First Nations, Inuit and Métis people in STEM fields is of particular importance in the Canadian context. In 2014, Indigenous Canadians accounted for less than two per cent of post-secondary STEM graduates (university and college level) despite representing almost four per cent of the adult population.[91] Looking to the future, Indigenous youth, one of Canada's fastest-growing populations,[92] comprise merely 1.2 per cent of ICT workers.[93]

To fully understand and address skills gaps in First Nations, Inuit and Métis communities, it is necessary to account for the impact of the inter-generational and systemic under-education,[94, 95, 96]

[84] Access Alliance. (2011). Labour-market challenges and discrimination faced by racialized groups in the Black Creek area.

[85] MacLaine, C., Lalonde, M., and Fiser, A., (2019). Working together: Indigenous recruitment and retention in remote Canada. The Conference Board of Canada.

[86] Reitz, J. G., Curtis, J., and Elrick, J. (2014). Immigrant skill utilization: Trends and policy issues. Journal of International Migration and Integration. 15(1), 1–26.

[87] Fitzsimmons, S., Baggs, J., and Schuetze, H. (2019). Fixing the migrant mismatch: What happens when firms value immigrants differently than governments? University of Victoria.

[88] Turcotte, M. (2014). Persons with disabilities and employment. Insights on Canadian Society. Statistics Canada.

[89] Chaze, F., and Medhekar, A. (2017). The intersectional oppression of South Asian immigrant women and vulnerability in relation to domestic violence: A case study. Ontario Bar Association.

[90] El-Lahib, Y. (2016). Troubling constructions of Canada as a 'land of opportunity' for immigrants: a critical disability lens. Disability and Society. 31(6), 758–776.

[91] Expert Panel on STEM Skills for the Future. (2015). Some assembly required: STEM skills and Canada's economic productivity. Canadian Council of Academies.

[92] Statistics Canada. (2019). Aboriginal peoples fact sheets.

[93] Information Communications Technology Council. (2017). The next talent wave: Navigating the digital shift - Outlook 2021.

[94] Beresford, Q., (2012). Separate and unequal: An outline of Aboriginal education 1900-1996. Beresford, Q., Partington, G., Gower, G. (Eds.), Reform and Resistance in Aboriginal Education. UWA Publishing, Crawley, W.A., 85–119.

[95] Giroux, D., (2012). Closing the gap in First Nations education. Policy Options.

[96] National Committee on Inuit Education. (2011). First Canadians, Canadians first: National Strategy on Inuit education. Inuit Tapiriit Kanatami (ITK).

the disproportionate number of Indigenous children who have navigated the care system[97] and overall conditions of systemic and long-standing disadvantage.[98] All these factors and more contribute to disproportionately low high school and post-secondary graduation rates amongst First Nations, Inuit Métis youth and adults.[99, 100, 101] Workplace anti-Indigenous discrimination represents a significant additional barrier to Indigenous candidates accessing and/or remaining in the workforce.[102] The multiple systemic and organizational barriers specific to technology education and fields, particularly in credential assessment, recruitment and hiring practices only add additional obstacles to the already challenging path into digital occupations faced by Indigenous Canadians.[103, 104]

Limited progress addressing persistent barriers for diverse groups across employment sectors compounds labour and skills shortages.[105] Strategies such as recruitment from particular communities, diversity training and mentoring programs have produced uneven results.[106, 107] Organizations may have significant representation of underrepresented groups, but expect them to conform in the workplace. In workplaces where this expectation exists, the gains that can be had from diversity are constrained.[108, 109] Consequently, attention has shifted to the creation of "inclusive" organizations that

[97] Fallon, B., et al. (2013). Placement decisions and disparities among Aboriginal children: further analysis of the Canadian Incidence Study on Reported Child Abuse and Neglect part A: Comparisons of the (1998) and (2003) surveys. Child Abuse and Neglect 37, 47–60.

[98] Mitrou, F., et al. (2014). Gaps in Indigenous disadvantage not closing: A census cohort study of social determinants of health in Australia, Canada and New Zealand from 1981–2006. BMC Public Health 14, 201.

[99] Fallon, B., et al. (2013). Placement decisions and disparities among Aboriginal children: further analysis of the Canadian Incidence Study on Reported Child Abuse and Neglect part A: Comparisons of the (1998) and (2003) surveys. Child Abuse and Neglect 37, 47–60.

[100] Qikiqtani Inuit Association, (2013). Qikiqtani Truth Commission Final Report: Achieving Saimaqatigiingniq. Inhabit Media Inc.

[101] Truth and Reconciliation Commission of Canada. (2015). Honouring the truth, reconciling for the future: Summary of the Final Report of the Truth and Reconciliation Commission of Canada.

[102] MacLaine, C., Lalonde, M., and Fiser, A., (2019). Working together: Indigenous recruitment and retention in remote Canada. The Conference Board of Canada.

[103] Many of the barriers that contribute to this underrepresentation are discussed in other Skills Next papers. See Ng, E., Gagnon, S. (2020). Employment gaps and underemployment for racialized groups and immigrants in Canada: Current findings and future directions. Skills Next. Public Policy Forum, Diversity Institute at Ryerson University, Future Skills Centre.

[104] Also see Tompa, E., Boucher, N. and Samosh, D. (2020). Skills gaps, underemployment and equity of labour-market opportunities for persons with disabilities in Canada. Skills Next. Public Policy Forum, Diversity Institute at Ryerson University, Future Skills Centre.

[105] Morris, L., and Daniel, L., (2008). Perceptions of a chilly climate: Differences in traditional and non-traditional majors for women. Research in Higher Education. 49(3), 256–73.

[106] Healy, G., Kirton, G., and Noon, M. (2011). Inequalities, intersectionality and equality and diversity initiatives. Equality, Inequalities and Diversity. Macmillan International, 1–17.

[107] Kalev, A., Dobbin, F., and Kelly, E. (2006). Best practices or best guesses? Assessing the efficacy of corporate affirmative action and diversity policies. American Sociological Review. 71(4), 589–617.

[108] Davidson, M., and Ferdman, B. (2001). Diversity and inclusion: What difference does it make? The Industrial-Organizational Psychologist. 39(2), 36–38.

[109] Hewlin, P. F. (2003). And the award for best actor goes to… Facades of conformity in organizational settings. The Academy of Management Review, 28.

espouse a commitment to integrating different identities and valuing them.[110, 111] This move aligns with research that has highlighted the importance of a deep understanding of complex interactions between context and organization and individual initiatives and change, rather than focusing only on individual perceptions.[112, 113, 114] Without systemic change, everyday bias persists,[115] as does the risk of backlash against diversity initiatives.[116]

As recruiting diverse talent has proven a challenge, employers are developing new recruitment practices. For example, many organizations partner with Specialisterne to provide employment pathways for people on the autism spectrum.[117] Other stakeholders have developed new event-style approaches to recruitment, such as Capital One's use of hackathons to recruit women to work with the firm,[118] or have focused on international recruitment to fill gaps or have even relocated closer to the talent pools they need. There are also dedicated HR firms and HR professionals in general HR agencies whose role is to search for tech talent. Tech-specific networking websites and websites that connect employers directly with freelancers or entrepreneurs are also common.

But for many communities, even these techniques will not be effective. Understanding the specific community in question is essential to successful recruitment. For instance, workplaces can significantly improve the experience of Indigenous employees by providing measures such as mentorship and peer-support schemes for Indigenous members of staff and cultural awareness training amongst non-Indigenous employee groups.[119] Ultimately, however, the continued underrepresentation of many equity-seeking groups shows that significant innovation and work are still needed.

[110] Ely, R. J., and Thomas, D. A. (2001). Cultural diversity at work: The effects of diversity perspectives on work group processes and outcomes. Administrative Science Quarterly. 46(2), 229–273.

[111] Shore, L. M., et al. (2011). Inclusion and diversity in work groups: A review and model for future research. Journal of Management. 37(4), 1262–1289.

[112] Gagnon, S. M., et al. (2014). Beyond belonging and identification: A theory of inclusive practices and why they work. Academy of Management Proceedings, 2014(1).

[113] Roscigno, V. J., and Wilson, G. (2014). The relational foundations of inequality at work I: Status, interaction, and culture. 58(2), 219-227.

[114] Clerkin, C., and Wilson, M. S. (2017). Gender differences in developmental experiences. In S. R. Madsen. Handbook of Research on Gender and Leadership. Cheltenham: Edward Elgar Publishing. 378-394.

[115] Fiol, C. M., Pratt, M. G., and O'Connor, E. J. (2009). Managing intractable identity conflicts. The Academy of Management Review. 34(1), 32–55.

[116] Nishii, L. H. (2013). The benefits of climate for inclusion for gender-diverse groups. Academy of Management Journal. 56(6), 1754–1774.

[117] For more information, see Specialisterne. (n.d.). Welcome to Specialisterne Canada.

[118] For more information, see Capital One. (n.d.). About.

[119] MacLaine, C., Lalonde, M., and Fiser, A., (2019). Working together: Indigenous recruitment and retention in remote Canada. The Conference Board of Canada.

Credentials, Assessment and Measurement

Historically, employers have viewed credentials as strong indicators of the skills and competencies possessed by an applicant. But with the pace of technological change continuing to accelerate, examining credentials may no longer be the best way of assessing a candidates' job readiness. Google, Apple and IBM have decided that a university degree is no longer the best indicator of a candidate's aptitude, and technology companies including Shopify, Telus and Slack are either relaxing or phasing out educational requirements and identifying talent in new and novel ways.[120] Thus, even though studies suggest that post-secondary education, particularly in STEM fields of study, increases the likelihood of acquiring employment in an ICT occupation by as much as 15 per cent,[121] there are increasingly other pathways into tech jobs. Indeed, most of the women who lead the largest ICT companies in the U.S. do not have computer science or technology degrees.[122, 123, 124]

Employer and recruiter perspectives vary on the importance of traditional credentials, depending on the job title and skills required. For instance, Randstad, a human resources services firm, states that business systems analysts typically need to hold an undergraduate degree in an IT-related field, and some may need a graduate degree. However, web developers can have a degree or diploma from a wider range of fields, including computer science, communications, business or design. A computer science degree and a design degree are very different, yet both may be suitable for the same job. Further, in some cases, self-taught web developers with an impressive portfolio of work may be able to altogether bypass formal education requirements.[125] This message is echoed in the report by Vu, Lamb and Willoughby, where their analysis emphasized the importance of mixed skills. Notably, their data are reflective of employer beliefs about the roles and skills needed for their organization, which did not always reflect credentials.[126]

[120] The article references research conducted by Glassdoor, see Counter, R. (2018). Want a job in Canadian tech? Don't worry about that university degree. Canadian Business.

[121] Innovation, Science, and Economic Development. (2017). 2016 Canadian ICT sector profile: Automotive, transportation and digital technologies branch. Government of Canada.

[122] Cukier, W., Smarz, S., and Yap, M. (2012). Using the Diversity Audit Tool to assess the status of women in the Canadian financial services sector: A case study. International Journal of Diversity in Organisations, Communities and Nations. 11(3), 15–36.

[123] Tandon, N. (2012). A bright future in ICTs: Opportunities for a new generation of women. International Telecommunication Union.

[124] Vasseur, L., and VanVolkenburg, H. (2018). The non-linear paths of women in STEM: The barriers in the current system of professional training. Brock University.

[125] See Randstad "web developer" page and description: Randstad. (n.d.). Web Developer job postings.

[126] Vu, V., Lamb, C., and Willoughby, R. (2019). I, Human: Digital and Soft Skills in a New Economy. Brookfield Institute for Innovation + Entrepreneurship.

In *Future Computed*, Microsoft president Brad Smith and executive vice president of artificial intelligence and research Harry Shum emphasize that lessons from a liberal arts education are necessary for the proper development of people who work with artificial intelligence (AI), stating that:

> … skilling-up for an AI-powered world involves more than science, technology, engineering and math. As computers behave more like humans, the social sciences and humanities will become even more important. Languages, art, history, economics, ethics, philosophy, psychology and human development courses can teach critical, philosophical and ethics-based skills that will be instrumental in the development and management of AI solutions.[127]

Employers are finding it increasingly difficult to evaluate the legitimacy and quality of training and education programs.[128] In response, portfolio approaches (including e-portfolios), "badging platforms," hackathons and work-integrated learning are increasingly being used by employers to assess competencies, particularly as more job-seekers have diverse backgrounds and as jobs are changing. New techniques designed to test and recognize these credentials are emerging, including self-assessments to test attitudes and behaviours; general standardized tests to assess essential skills; and tests to measure skills in specific tools or techniques (with the latter often provided by the industry leader who makes or distributes the tool as shown in Appendix C). But it's not clear whether individuals can accurately and objectively assess their own skills and skill levels, and there is debate about whether the onerous, often time-consuming and unpaid assessment and interview process is fair to candidates; some see it as exploitation in the recruitment process.[129, 130, 131]

Training and upskilling programs

Post-secondary institutions are developing programs to better respond to industry needs. Examples include the Queen's University MBA in Artificial Intelligence and the George Brown College Bachelor of Digital Experience Design.[132, 133] The changes are not limited to post-secondary institutions; there is growing emphasis on digital skills in public elementary schools, and many provinces are making coding a mandatory part of the primary or secondary curriculum.[134]

[127] Microsoft Corporation. Smith, B., and Shum, H., (Eds). (2018). The Future Computed: Artificial Intelligence and its Role in Society, 19.

[128] Gray, T. R. (2018). The perceived digital skills gap in Canada. A background review. Tacit Elements.

[129] McEwan, M. (2018). The latest trend for tech interviews: Days of unpaid homework. Quartz at Work.

[130] Moy, R. (2017). Is your technical interview process too long? Stack Overflow.

[131] Popomaronis, T. (2019). Here's how many Google interviews it takes to hire a Googler. CNBC.

[132] Weingarten, H. (2018). Adapting post-secondary education for the future. Policy Options.

[133] Lapointe, S., Turner, J. (2020). Leveraging the skills of social sciences and humanities graduates. Skills Next. Public Policy Forum, Diversity Institute at Ryerson University, Future Skills Centre.

[134] Julie, A. (2017). Teaching coding in Canadian schools: How do the provinces measure up? Global News.

At the same time, traditional educational institutions take a long time to add to or adapt curricula or programs, which has meant that higher education often lags behind industry.[135, 136] The resulting education and training void has increasingly been filled by innovation centres in post-secondary institutions, public online platforms, private training companies and government-funded upskilling programs.

Short training programs (e.g., Bitmaker, Brainstation, Miami Ad School) focus on specific tools or techniques. Some company and public-sector organization upskilling programs—such as those at AT&T, the Government of Canada and Amazon Web Services—upskill existing employees. Work-integrated learning (WIL) programs (e.g., nPower and ADaPT) and community-based models (e.g., Canada Learning Code) are also working to upskill and reskill workers. New programs, such as Skills for Change, develop pathways for internationally educated individuals in ICT trades and professions to shift from one sector to another or seek to level the field for underrepresented groups in technology. Appendix B identifies some of these training and upskilling models.

The ADaPT (Advanced Digital and Professional Training) program is one example of a stand-alone, employer-driven WIL skills development and work placement program for recent graduates, run by Ryerson University.[137] ADaPT addresses the skills gap between employer needs and graduate skills by providing intensive training for university graduates or senior students that is adjacent to, but not embedded in, formal programming. It is conducted in collaboration with employers and industry partners in the form of a paid work term. This program is particularly innovative because it recruits from across the social sciences, offering graduates from non ICT-specialist programs an opportunity to grow their capacities in digital literacy, communications and business financials. Short work placements with industry partners help graduates amplify their non-cognitive soft skills with practical experience and technical know-how. WIL programs such as ADaPT are designed to respond to changing trends in global workforces that forecast a growing demand for these non-technical skills.

Many companies and organizations outsource to third-party training companies to train employees in digital skills. For example, Google, RBC, Uber and Deloitte use Brainstation to offer courses in design, data and development.[138] Udacity has been used by companies such as AT&T to train staff in data science, machine learning and artificial intelligence, business and marketing, web programming,

[135] See Hazan, E. (2017). Reinventing schools for the digital age. McKinsey & Company

[136] Lewington, J. (2019). Why are Canadian universities so slow to adopt digital learning? Maclean's.

[137] Royal Bank of Canada (RBC). (2019). Bridging the Gap: What Canadians told us about the skills revolution.

[138] See BrainStation. (n.d.). BrainStation 2019 Outcomes Report Data & Methodology.

cutting-edge technology and mobile programming.[139] Galvanize is similar to Udacity in its training delivery, but focuses on training employees in a range of technology skills using cloud computing.[140]

Training and upskilling is big business. Coding boot camps alone are estimated to be a $240-million business in North America.[141] Lighthouse Labs, Red Academy, HackerYou and others offer intensive coding training (in as few as 10 weeks) focused on hands-on experience and placing participants in jobs. Lighthouse Labs claims that 93% of its graduates are hired within 120 days of program completion.[142]

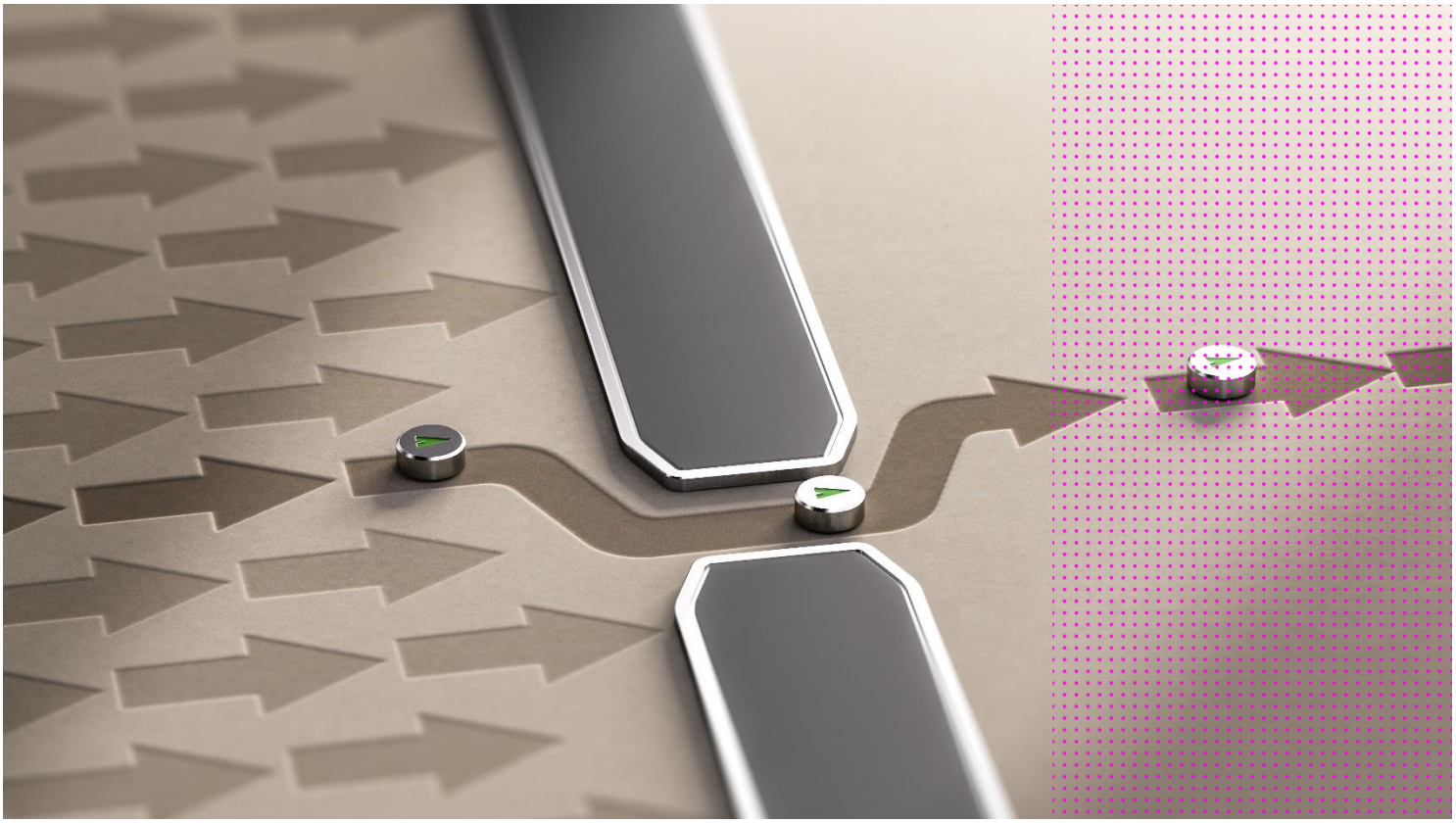
While the approaches to addressing the skills gap discussed above provide a sense of both the problem and potential solutions, much is still unknown about the effectiveness and outcomes of relying upon different skills frameworks. Further, where different methods are being applied to try to close the skills gap, there is as yet inadequate data to understand whether these actions are serving to address skills and labour-market shortages.

[139] Udacity's "nanodegrees" have been offered for mostly coding. For more information on Udacity and AT&T training partnership see, Udacity. (n.d.). AT&T Software Development Internships 2019.

[140] For more information, see Galvanize. (n.d.). Accelerate Innovation with Enterprise Education

[141] Cutean, A., and McLaughlin, R. (2019). A digital future for Alberta: An analysis of digital occupations in Alberta's high-growth sectors. The Information and Communications Technology Council.

[142] For more information, see Lighthouse Labs. (n.d.). Homepage.



NEXT STEPS

Digital skill and labour shortages are the product of multiple overlapping challenges, including the limitations of ICT occupational definitions; the difficulties inherent in identifying "digital skills;" the lack of consistency around digital skills/competency frameworks; and employers limiting their recruitment and retention practices in ways that disproportionately exclude certain populations. Opening new pathways for people to work in digital jobs—or to acquire the necessary digital skills to do their job in workplaces of the future—requires clarity and consistency in defining jobs and skills, innovation in skills development programming, and changes to how employers' hire, train and retain skilled workers.

There is general agreement that there is a need to reduce the conceptual confusion between a job, the skills needed to perform a job and the tools used to complete it. Part of this problem stems from the fact that existing classification systems, while helpful for more traditional occupation groupings, are not yet capturing emerging or hybrid-roles sufficiently.

There is also increasing acceptance of the need to focus on skills rather than credentials. In support of this, there are a number of emerging and innovative approaches that can, and are increasingly being used to, fill the perceived shortage of skilled workers, including corporate-upskilling initiatives, event-style recruitment (Hackathons) and HR services dedicated to sourcing tech-talent. This report's appendices provide data on digital skills frameworks (Appendix A), digital training models (Appendix

B) and assessment tools (Appendix C). This data may form the foundation for research and further reviews on the state of the field of approaches to addressing the skills gap.

Moving forward, there is a need to promote the development, identification and support of a larger group of standard definitions and approaches to make significant progress on digital skills. Indeed, an over-abundance of skills frameworks, training models and assessment tools is one of the sources of existing confusion and uncertainty around the best way to make progress in this area. Achieving agreement on a set of standard definitions and approaches will not be simple or easy, but doing so will be an important step forward because it will help provide a foundation for the deployment, monitoring and assessment of new and emerging approaches to digital skills identification, development and employment. In so doing, such agreement will help open new pathways to digital skills, especially for those who are currently underrepresented, thereby creating an exciting opportunity to close the digital skills gap.

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Appendix A - Comparing Digital Skills Frameworks

Model	Date	Aim	Core demographic	Sample of core knowledge identified	Sample of ICT-specific knowledge identified	Dimensions identified to address skills gap	Levels identified
General Digital Skills Frameworks							
"DigComp 2.0: The Digital Competence framework for Citizens," European Commission	2014	General tool for improving digital literacy for EU citizens	General: EU citizens	Communication; content creation; safety; problem-solving	Information-processing	5 competence areas	--
"Digital Skills and Business School Curriculum," Cukier, Smarz and Grant	2017	General pedagogical tool for business school curriculum mapping and development	K-12 grade school students; students/ occupational training level; general audience (self-study/ social interaction)	Start up and build SMEs; enhance personal opportunities and quality of life	Develop innovative ICT infrastructure; capacity to innovate using digital technology	3 levels x 3 age groups = 9 dimensions	3: Basic literacy; business/ technology skills/deep technical and content creation
"Digital Skills Toolkit," International Telecommunications Union	2018	To address the digital skills gap globally and support youth employment	General audience; youth	Word processing; using keyboards and touch screens	AI; cybersecurity; IoT	3, reflecting the levels	3: Basic; intermediate; advanced
"New Vision for Education: Unlocking the Potential for	2015	General pedagogical tool	General audience	Numeracy; literacy; financial	ICT literacy	3: Foundational literacies; competencies; character qualities	--

technology," World Economic Forum/ Boston Consulting Group				literacy; communication			
"Bryn Mawr College Digital Competencies Framework," Bryn Mar College	2016	General pedagogical tool	General audience	Digital survival skills; digital communication	Data analysis and presentation; data management and preservation	5 competencies	--
"JRC Conceptual Model," Pete Cranston/Euforic Services/ITAD	2011	General tool for improving digital literacy for citizens	General audience	Problem-solving; collaboration; creativity and expression	ICT literacy; information management; application skills for networked visual and dynamic media	4: unclear	--
"Brookfield Skills Map," Do and Huynh, Brookfield Institute	2017	General tool to address the digital skills gap and support workers in the digital era	Labour force	Problem-solving; flexibility; entrepreneurial thinking; collaboration	Computational thinking	3: technical skills; cognitive abilities; critical thinking	3: Baseline; workforce; professional
"BTM Learning Outcomes," BTM Forum and ITAC	2009	General tool to address the digital skills gap and support workers in the digital era	Labour force	Project management; teamwork; organizational learning; decision-making	Data-warehousing; digital-marketing; packaged software	3: foundations; roles and skills; outcomes Sub-divided into 7: 1) integrative; 2) personal and interpersonal; 3) business; 4) technology; 5) technology in business, 6) innovation; 7) processes, projects and change	--

"All Aboard: Digital Skills in Higher Education", Government of Ireland	2017	Pedagogical tool for post-secondary educators	Students; teachers	Presentation skills; project management; producing content; time management	Operating systems; coding; app development	6: Tools and technologies; teach and learn; find and use; communicate and collaborate; create and innovate; identity and wellbeing	--
"New Foundational Skills of the Digital Economy: Developing the Professionals of the Future," Burning Glass Technologies/ BHEF	2018	Pedagogical tool and general use tool to address the digital skills gap and support workers in the digital era	Students; teachers; working professionals in the labour force	Analytical skills; critical thinking; project management	Digital design; digital security and privacy; analyzing data	3: Human skills; digital building blocks; business enablers	--
ICT Specific Skills Frameworks							
"Business Technology Management (BTM) Body of Knowledge (BOK) Framework," ITAC and BTM Forum	2017	Tool for stakeholders working in, training and hiring business technology professionals	HR professionals, employers, BTM professionals	People and knowledge management; project management; services management; business analysis	System integration; software; model-driven engineering	4: Information technology (it); information systems (is); IS-IT management; business technology management	--
"European Framework for ICT Professionals/ e-Competence Framework,"	2018		HR professionals; employers; ICT professionals	Needs identification; project and portfolio management; relationship management	Application design; technology trend monitoring; systems engineering	3: Areas; competencies; e-levels	5: e-1 to e-5
"ICT professional Core Body of Knowledge	2015	Tool for ICT professionals; employers and	HR professionals; employers;	1) ethics, 2) professional expectations,	Hardware and software fundamentals;	4: Problem solving, abstraction and design; ethics and professionalism;	--

(CBOK)," Australian Computer Society		other stakeholders in the labour market	ICT professionals	|3) teamwork concepts and issues, 4) interpersonal communication 5) societal issues/legal issues/privacy, and 6) understanding the ICT profession	data and information management; networking; technology building	teamwork concepts and issues; interpersonal communication	
Skills Future SG (Singapore)	current	Skills mapping to strengthen adult training infrastructure	Aspiring ICT professionals	6 levels of proficiency mapped for numerous skills	Data, infrastructure, professional services, security, sales and marketing, software and apps, support	6 levels * 33 roles	Levels 1 to 6
O*NET	Current	Classification of occupation-based skills	General	Comprehensive database	Communication; teamwork; transdisciplinary thinking; sense-making; problem-solving; leadership	7 dimensions: Data, infrastructure, professional services, security, sales and marketing, software and applications, support	Multiple
WEF	2018	Classification of skills used, based on O*NET content model	General stakeholders	Numerous competencies bundled by broader areas — e.g. emotional intelligence	Technology selection, monitoring and control	26 bundles of competencies	--

Appendix B - Digital Training Models

Model Type	Stakeholders offering this training	Typical focus of training	Target demographic	Method of delivery	Examples of Innovative Approaches
Elementary and high school new curriculums focused of digital skills; extracurricular curriculums	Public and private primary and secondary schools	Coding; gaming; problem-solving using digital tools; math and digital tools	Children and youth	Embedded in elementary and high school curriculum After-school programming and tutoring, in person and online	Sylvan Learning, Coding for Kids Techy School, Coding and Programming for Kids Grade 6+ online
University degree or college diploma/ formal undergraduate or graduate training	Universities, colleges	Computer science, btm, engineering, information science, digital media degree programs	Youth, undergraduates	Paid Undergraduate 3-4 years Graduate 1-3 In-person and online full time and part time	Queen's MBA in Artificial Intelligence George Brown Bachelor of Digital Experience Design MIT, Bachelor of Science in Computer Science, Economics, and Data Science
Work integrated learning (WIL)	Universities, colleges, public organizations, not-for-profits	Diverse	Youth, mid-career working professionals	Can be part of formal under-graduate training or standalone Sponsored or government-funded work-integrated learning programs	Diversity Institute, Ryerson University, AdaPT NPower Canada Palette TalentX Bridge
Continuing education/ formal post-graduate certification	Universities colleges, innovation centres,	Analytics, Digital Media, Intensive	Working professionals	Continuing education courses in skills training; fee per user	George Brown College, Information and

	professional development programs	Coding, Technology Certifications			Communications Technology program British Columbia Institute of Technology, Web Technologies Harvard, IT Academy
Bridging programs	Public, not-for-profit	Diverse	Internationally trained individuals (ITI) Professionals bridging from one field to another	Online, in person	Humber College, Bridging Programs, ex. IT Infrastructure Calgary Catholic Immigration Society, Information and Technology Bridging Program
Massive open online courses (MOOCs)	Public, private, and not for profit	Diverse	Typically those with existing credentials	MOOCs could be free or fee-based Online multimedia including video and text. Typically, non credit, no grades and no/low costs for the courses. Certification often is for a fee.	LinkedIn Learning Lynda.com Khan Academy edX Coursera FutureLearn Friday Institute, MOOC-Ed EMMA MOOC Aggregator ALISON
Upskilling or training programs	Employers, public and not for profit	Intensive training for coding, analytics, UX etc.	Mainly working professionals Current employees,	Firms providing individuals and corporations with skills courses; fee-based; upskilling and corporate training mainly Delivered in-person and online	Brainstation Bitmaker GA Canada Learning Code Red Academy Hacker U

			interns, candidates	Both nonprofits and for-profit companies are involved in training potential employees in the ICT sector	Lighthouse Labs Udacity Codecademy Galvanize
				Intensive programs (often online) that teach advanced computer skills, e.g. Coding schools/ coding camps	Government of Ontario, Coding in Elementary: A Professional Learning Resource for Ontario Educators
Programs with specific demographic focus	Varied	Diverse	Women, girls, immigrants, other under-represented groups	Online and in-person courses targeted at underrepresented groups in the ICT sector; namely women and girls	Girls who Code Girl Develop It Learn to Code with Me Bridge, Upskilling and supporting women, agender, and non-binary professionals

Appendix C – Assessment Tools

Test for Skills and Competencies	Assessment focus	Method	Use
Self-assessment tests			
PIAAC	Measures key cognitive and workplace skills	Home interviews, computer survey	Understand how education and training systems can nurture skills
OECD ESO (Education Skills Online)	Literacy, numeracy, problem-solving, use of tech	Online test	Benchmarks test-takers against global demographic
Lumina Spark	Psychometric	Online questionnaire	Self-knowledge, fit within work teams
Standardized tests to measure essential skills			
ESDC Essential Skills Indicator	Numeracy, document use, reading,	Online pre- and post-tests up to 3 levels	Individual skill assessment, identify skill and improvement levels
Towes	General, sector, domain-specific, web-based	Paper-based and online	Employers assess workers' skills Employees, students and job-seekers identify and develop skills Trainers develop strategies
ESKARGO Initial Skills Assessment	Skills, Knowledge and Attitudes		Adult and continuing ed practitioners
Canadian Adult Reading Assessment (CARA)	Reading patterns	Print	Diagnostic tool for adult literacy education
CABS: Common Assessment of Basic Skills	Reading, writing, numeracy, technology (basic computer skills)	Online	Adult learners and career practitioners
The Essential Skills Group	Three online assessments (reading, document use, numeracy) for numerous occupations	Online Tests	Occupational fit
Tests to Measure Specific Tools or Techniques			
Pega CSA Exam	Knowledge of Pegasystems platform	Online	Used by Pegasystems to grant certification
Salesforce	Salesforce platform	Online through Pearson Vue	Certification
Criteria Pre-employment testing	Skills tests on MS Office programs, basic computer literacy, typing, etc.	Web-based	Employers for screening applicants

TOSA Digital Solutions	Adobe Creative Suite, OS skills	Web-based platform	Assessment tests for HR, certification tests for individuals

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