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MITACS SKILLS FOR INNOVATION: SHARPENING CANADA'S SKILLS ADVANTAGE

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Mitacs

Mitacs Skills for Innovation

Sharpening Canada's skills advantage

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SHIFT insights

brookfield institute for innovation + entrepreneurship

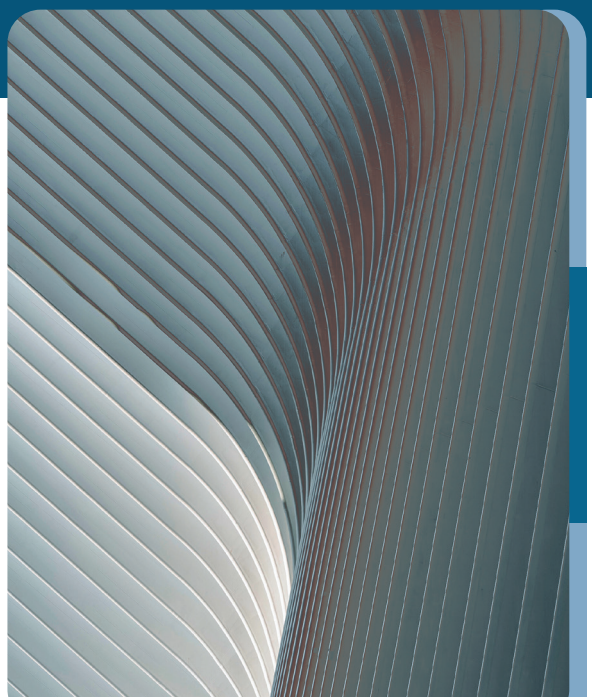
about mitacs:

Founded in 1999, Mitacs builds academic-industry collaborations across Canada, where top talent in Canadian and international post-secondary institutions is brought in to tackle industry challenges. Mitacs's business model is based on a strategy to apply one of Canada's core strengths — the talent and knowledge within its academic community — to an area of weakness: innovation activities in non-academic sectors.

Overall, the Mitacs's network includes:

- **11,165** private sector and not-for-profit organizations since 2008 that have hosted interns and fellows across Canada
- **12,654** university researchers since 2008 across 81 universities
- **94** college, CÉGEP, and polytechnic partners
- **94** memoranda of understanding with partners across the Canadian innovation ecosystem, including other funding agencies such as NSERC, SSHRC, CIHR, Prompt, MEDTEQ+, and Genome Canada
- **52** funding agreements with international partners from **20** countries and the European Commission
- Integration into **14** graduate degree programs across the country
- **10,444** international students have travelled to Canada for internships since 2009
- **$885 million** invested in collaborative research between 2010–11 and 2020–21
- **77,371** internships since 2008
- **37,959** career-ready students since 2008
- **34,701** participants in professional skills courses since 2008

highlights:



- Canada's talent advantage for innovation is strong, but there are opportunities to sharpen Canadians' skills and knowledge to improve our lagging innovation performance.

- We surveyed organizations and interns involved in Mitacs's Elevate and Accelerate programs about the general and specialized skills they needed to innovate.

- **Organizations and interns identified a range of general skills that all types of innovation appear to require, including**:
  - > **Curiosity and creativity**
  - > **Basic data and digital skills** - such as basic statistical literacy, skills to use productivity software, and skills to navigate online research and social media
  - > **Scientific principles and methods** - such as the ability to develop a hypothesis, design experiments to test the hypothesis, gather and interpret data, and conduct literature reviews
  - > **Certain social and emotional skills** including, collaboration, listening, communication and responsibility. However, other social and emotional skills e.g., empathy, emotional control, and tolerance – were rarely mentioned

- **Organizations and interns also identified specialized skills that some, but not all, people on innovation teams must have for the team as a whole to succeed. These include:**
  - > **Advanced data and digital skills** – such as programming, computer science, and statistical analysis. These skills are particularly important for firms engaged in developing technology internally and less so for other kinds of innovation such as process or service innovations.
  - > **Management skills** – such as project, team, and financial management; strategy and planning; and risk assessment, judgment and decision-making.
  - > **Design skills** – including prototyping, testing, and solutions design. However, not all organizations and types of innovation require these skills. Prototyping and testing is especially important in developing technologies for internal use, whereas solution design skills are important across different kinds of innovations.

- Interns' confidence in their skills often lags behind the frequency with which they said they used certain general and specialized skills which points to many areas for improvement in Canadians' skills for innovation.

Introduction

Canada's innovation advantage is its people. We have the world's most highly educated population and a labour force of skilled and motivated people.

Yet, Canada's innovation performance continues to lag behind that of global peers, threatening our longterm prosperity and wellbeing.

Canada's innovation advantage is its people. We have the world's most highly educated population and a labour force of skilled and motivated people. Yet, Canada's innovation performance continues to lag behind that of global peers, threatening our long-term prosperity and well-being. Waning business investment in research and development, ongoing struggles to scale highpotential firms, weak adoption of productivity-enhancing technologies, and limited engagement in global value chains in key sectors are simultaneously symptoms and causes of our innovation weakness.

While Canada's talent advantage is strong,[1] opportunities exist to improve and sharpen the skills and knowledge Canadians need to address innovation challenges and opportunities more effectively. Success in innovation-driven, knowledge-based economies requires more than smart, educated, and highly motivated people; it requires people with specific skills precisely calibrated to address different kinds of innovation and innovation-related activities.[2] And it requires teams of people with different, but complementary, skills and knowledge to complete the full suite of activities and tasks that comprise the full continuum innovation.

Previous studies have identified high-level skills that are necessary for innovation including creativity, critical thinking, problem-solving, communication, and team work.[3] These skills are essential. But innovation is a broad concept, as diverse as the economy itself, and one set of skills is not enough to succeed in all kinds of innovation.[4] Innovation can be product or service development, technology adoption, organizational change, new marketing strategies, social policy and program improvement, better models of healthcare delivery, and improved urban design and traffic management. Given the diversity of kinds of innovation and the variety of tasks and activities they entail, we should expect variation in the specific kinds of skills required.

This report is the first in a series, that will provide clarity around the kinds of skills needed for different kinds of innovation. This and future reports will generate insights to help educators, businesses, students, workers and others build better strategies for developing, recruiting, and harnessing talent for innovation success. Canada has a talent advantage. It's time to sharpen it.

[1] OECD, 2019
[2] Munro & Watt, 2014
[3] Agrawal, Gans, & Goldfarb, 2017; Deming, 2017; Deming & Kahn, 2017; Bakhshi, Frey, & Osborne, 2015; Tambe & Hitt, 2012
[4] Munro & Watt, 2014

Advancing skills for innovation

The first step is developing a clearer understanding of what constitutes a skills advantage for innovation. This requires systematic investigation and thinking about some key questions:

- What is innovation, exactly?
- What are the different kinds, stages, and activities related to innovation?
- What specific skills and knowledge do organizations and individuals use when completing these different kinds, stages and activities related to innovation?
- Is it necessary for every individual involved in innovation to have all or a substantial subset of the relevant skills, or is it enough for the required skills to be found among teams of differently skilled, but complementary, people?

A good way to answer these questions is to observe how innovative organizations work and how the people who work for them behave. When organizations and people generate new value by doing something new or improved - when they innovate - what exactly do they do and what skills and knowledge do they draw on?

Leveraging a unique opportunity to survey employer-organizations and interns involved in Mitacs-supported innovation projects, this report offers granular insights about the specific skills required by individuals and organizations for different kinds, stages, and activities related to innovation.

Mitacs programs involved in the study

Mitacs Accelerate supports collaborative research between between for-profit or approved not-for-profit organizations, interns, and faculty supervisors at Canadian postsecondary institutions.

Mitacs Accelerate	
Objectives	**Tracked results**
• Provide partner organizations with access to cutting-edge research and skills • Provide graduate students and postdocs with applied research experience in a private-sector setting • Provide academic researchers with opportunities to integrate challenges and opportunities from industry into their research programs	• Increased collaboration and knowledge transfer between academia and industry, in various sectors of the Canadian economy • Creating job opportunities for graduate students and postdoctoral fellows in various disciplines • Improved employability of graduate students and postdoctoral fellows in Canada after completing their studies • Increased retention of domestic and international graduate students and postdocs in Canada after completing their studies

Mitacs Elevate builds value for organizations in Canada by training top-ranked postdoctoral fellows to address their complex business challenges. Using the country's only research management training program for postdocs organizations can access specialized business and research expertise through the fellows and faculty supervisors at Canadian universities.

Mitacs Elevate	
Objectives	**Tracked results**
• Support the attraction, training, retention, and deployment of highly qualified postdocs with the goal of strengthening research and innovation results	• Improved employability of postdocs in their field • Increased retention of PhD holders in Canada and creating a highly efficient talent pool ready to lead innovation • Increased opportunities for businesses to identify and engage with postdocs and benefit from the wealth of ideas and solutions these highly qualified people bring • Connected academic researchers to industry partners to develop innovative solutions to Canada's industrial and societal challenges

Approach

To understand what skills and knowledge organizations and individuals need to succeed in different kinds, stages, and activities related to innovation, we executed a multi-faceted research strategy.

To contextualize the work and contribute to survey design and analysis, we **reviewed relevant literature** on skills for innovation, focusing especially on literature and data that offer insights about the specialized skills required for different kinds and stages of innovation. The main data collection instruments were **surveys** of organizations and interns who used Mitacs's Elevate and Accelerate programs.[5] We added detailed innovation and skills-related questions to Mitacs's existing end-of-program surveys and collected results on a two-week rolling basis over four months.

Partner organization survey

We asked partner organizations about the **kind of innovation** they were pursuing; the **stage** it was at; 12 **broad categories of skills and knowledge** and 55 **specific skills and knowledge** they felt it was important to have **on the project team** and for the **student intern specifically to have** (for the full skills taxonomy used for the survey, please see Appendix A). Mitacs's existing survey included tombstone (e.g., sector, firm size, R&D expenditures)

and project results questions (e.g., new innovation, IP, organizational improvements) which we used in analysis.

We collected data from 164 individual companies. Out of these, 70 percent had one to 99 employees, 13 percent had 100 to 499 employees, two percent had 500 to 999, and 12 percent had 1,000 or more employees.

Forty-three percent of companies are in the professional, scientific, and technical services industry, followed by five percent in the religious, grant-making, civic, and professional and similar organizations industry, and three percent in both chemical manufacturing and miscellaneous manufacturing.

Chart 1: Industry composition of companies

3-digit Industry Codes (NAICS)	Proportion of companies
541 – Professional, scientific and technical services	42.7%
813 – Religious, grant-making, civic, and professional and similar organizations	4.9%
325 – Chemical manufacturing	3.0%
339 – Miscellaneous manufacturing	3.0%
611 – Educational services	3.0%
221 – Utilities	2.4%
334 – Computer and electronic product manufacturing	2.4%
518 – Data processing, hosting, and related services	2.4%
522 – Credit intermediation and related activities	2.4%

[5] Mitacs, 2022

Chart 2: Location of companies (province)

Province	Proportion of Companies
ON	29.3%
QC	23.2%
BC	17.7%
AB	9.8%
MB	4.3%
NL	3.7%
SK	1.2%
NB	0.6%
NS	0.6%
PE	0.6%

Chart 3: Location of companies (city)

City	Proportion of Companies
Toronto	12.8%
Montréal	9.8%
Vancouver	7.9%
Calgary	3.7%
Edmonton	3.7%
St. John's	3.7%
Winnipeg	3.7%
Québec	3.7%
Burnaby	3.0%
Ottawa	3.0%

Most companies are located in either Ontario, Quebec, or British Columbia; with the largest proportion located in the three major cities of Toronto, Montreal, and Vancouver.

Student/intern survey

We asked students working with partner organizations how often they used **specific skills** and **knowledge**; how **confident** they are with those skills and knowledge; **other skills they used, acquired or developed** during the internship; and what **skills they felt they lacked** during the internship. The broad categories and specific skills presented to the interns matched the 12 categories and 55 skills presented to the partner organizations, allowing us to get two perspectives on the skills required for innovation projects. We collected data from 608 interns: 50 percent are in the process of completing a doctorate degree, and 21 percent are in the process of completing a research master's.

Our sample of surveyed organizations is not representative of industry in Canada as a whole but skewed towards organizations working at or striving towards the frontier of innovation. This is intentional.

We are not aiming to understand skills needs in the economy generally; rather, we are trying to identify the skills being used by organizations involved in innovation in order to clarify what might be needed by workers and organizations who aspire to work at the innovation frontier.

Organizations' survey responses gave us a picture of the demand for and use of specific innovation skills among a group of innovating firms - disaggregated by innovation type and activity. Students' survey responses gave us a picture of the supply and use of innovation skills among the next generation of innovators - and areas where there are opportunities for further skills development. The current report offers a baseline picture of the skills required and available for innovation at a granular level from both employer and intern perspectives.

How to think about skills for innovation

A skilled workforce is the bedrock of innovation. People generate new knowledge, translate existing knowledge and technology into new or improved products or ways of doing things, disseminate innovations throughout the world, and engage in processes of continuous learning and improvement. Other inputs into the innovation process, like financing and technology adoption, are ultimately tools that enable people to innovate.[6] Whether people have the skills and knowledge to use these inputs effectively determines whether innovation will succeed. In that case, the more we understand about the precise constellations of skills required for different kinds and activities related to innovation, the better positioned we will be to develop and deploy those skills for innovation success.

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What is innovation, exactly?

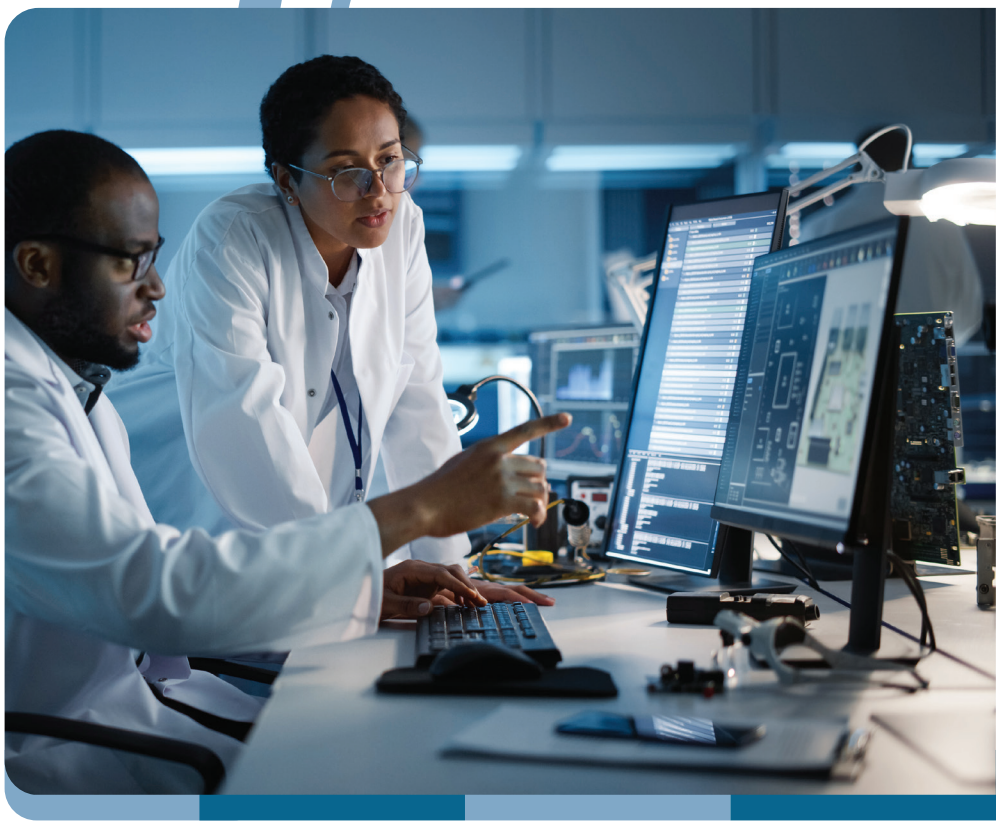
Innovation is the development, diffusion, or implementation of new or improved products, services, processes and/or capabilities that generate economic or social value for people, organizations, communities and/or economies and societies as a whole.[7] For something to count as innovation, it must be novel and it must generate value. Novelty need not be seen simply as introducing something new or improved to the world as a whole; rather, it can involve introducing something new or improved to a sector or single organization. Someone or some organization must be doing something that is new to them. Value can be economic (e.g., revenue, GDP growth) or social (e.g., health improvements, environmental benefits, strong communities) and can accrue to individuals, organizations, sectors, or the economy or society as a whole.

While the basic idea of innovation is relatively clear, we need more than an umbrella concept to help us identify the skills required to succeed. We need a better understanding of the qualitatively different kinds of innovation, different activities or stages of innovation, and how teams rather than lone individuals are the relevant agents of innovation.

[6] Munro & Watt, 2014; Breznitz, 2021
[7] Munro & Zachariah, 2021; OECD, 2018

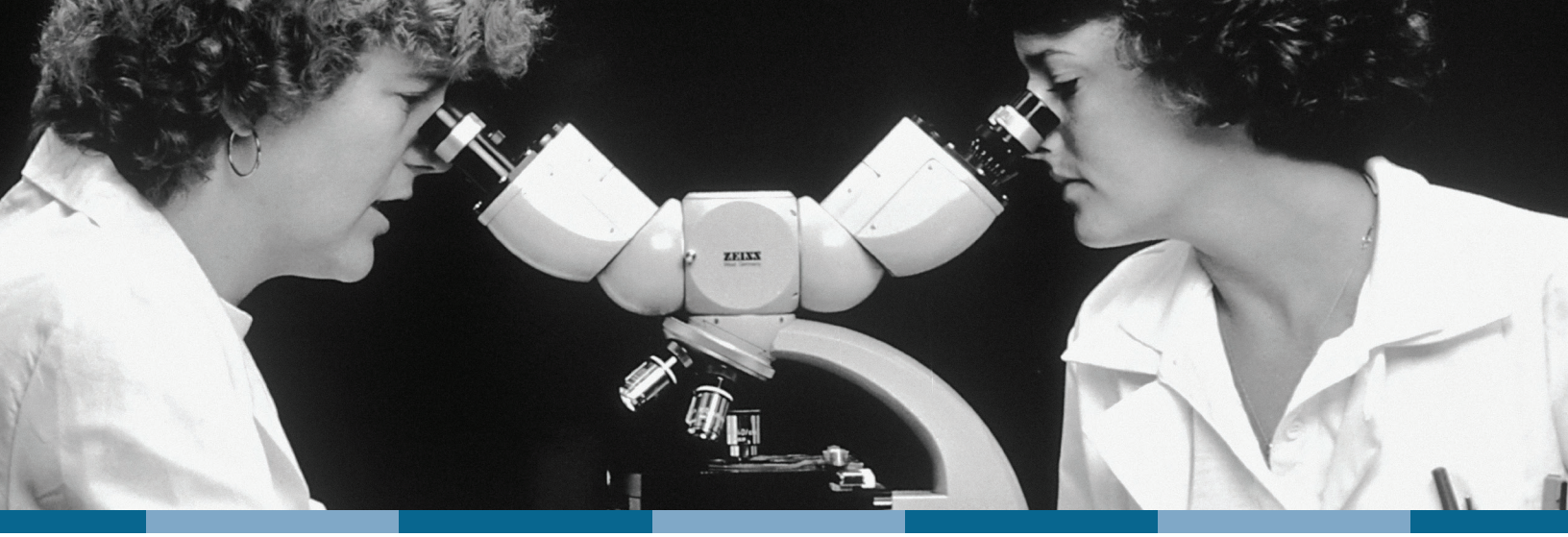
1 Kinds of Innovation

There are different kinds of innovation. The OECD's Oslo Manual identifies four categories, each of which may require different skills.[8]



- **Product/service innovation** is focused on the development or improvement of a good or service. This might include new technologies or software, components and materials for other products and technologies, new flavours of BBQ sauce, or the drive-thru window. The specific skills required for product and service innovation might include design skills, science and engineering expertise, and, increasingly, digital skills.[9] The exact mix will depend on the exact nature of the product or service innovation.
- **Process innovation** is focused on the introduction of new or improved production techniques, delivery methods, or organizational procedures. This might include the adoption and use of new machinery, equipment or software in production; the design and implementation of more efficient booking systems for healthcare appointments and services; or the use of more sophisticated supply chain tracking tools. While product and service innovation is often about tech-making, process innovation is often about tech-taking. Process innovation might require skills in operations logistics; IT and machinery implementation, use, and maintenance; procurement; and change management and leadership.[10]
- **Marketing innovation** is focused on changes in how products and services are packaged, presented and sold to customers. This might include packaging design, product placement, advertising and promotion, or pricing models. The specific skills required in marketing innovation might include advanced creativity, graphic design, web design, and communications. Because marketing innovation involves collecting, analyzing, and using data about consumer preferences and behaviours, it likely also requires or would benefit from people with expertise in web and data analytics, psychology, and the use of digital technologies and social media.[11]
- **Organizational innovation** is focused on new methods in business practices, workplace organization or external relations. This might include the introduction of new organizational structures and reporting lines, advanced management techniques, new corporate strategies, or new stakeholder engagement strategies. While the OECD recognizes that organizational innovation is widespread and generates value, it acknowledges that it is harder to pin down and measure.[12] Nevertheless, the skills required to support organizational innovation likely include opportunity recognition, management and leadership, communication, and technical skills for system design.[13]

[8] The Oslo Manual is published by the OECD and Eurostat to facilitate the coordinated collection and presentation of comparable innovation statistics based on common language, definitions and approaches.
[9] Muro, Liu, Whiton, & Kulkarni, 2017
[10] Brynjolfsson, Rock, & Syverson, 2021; Villeneuve, 2019; Watt and Munro (2014)
[11] Munro & Watt, 2014
[12] OECD, 2018
[13] Ibid.



2 Innovation activities

In addition to distinguishing among different kinds of innovation, it is important to distinguish among different activities that occur at different times in innovation. While innovation tends to be more fluid, porous and iterative than linear, there are activities that cluster at different points during innovation.[14] [15] Activities like gathering information about opportunities and problems, identifying and analyzing customer preferences and behaviour, and assessing market gaps tend to occur in the early stages of innovation.[16] Idea and solution generation, design, prototyping and testing, and production tend to occur in the middle stages of innovation. Later stages involve activities like implementation, marketing and sales, delivery logistics, and customer service, as well as continuous improvement based on user experience and feedback.[17]

Again, innovation is rarely linear. The point is that just as there are distinct kinds of innovation that require different mixes of skills, there are different innovation activities that require different skill mixes at different times - from early-stage design-oriented skills to later-stage management, sales and marketing skills.

3 Innovation agents

A final consideration in thinking about innovation and its implications for skills is agency, or who innovates. Innovation is a team sport, not an individual event. People who work in organizations know that there are various functions that require specific skills - such as human resources, sales, information technology support, and design - and, critically, that these functions are performed by different people in the organization. No one person can one person can have all the skills needed to make an organization function.[18] Similarly, no one person can have all the skills needed to innovate. Much research on innovation neglects this insight and assumes that everyone involved in innovation must have all the innovation skills.

Innovation happens when groups of people with different but complementary skills and knowledge work together. There are general skills that all team members need to contribute as part of a team - including critical thinking, problem-solving, creativity, and especially communication and listening skills. Teams also need people with certain specialized skills and knowledge to perform specialized innovation activities, but not all team-members need to have all the specialized skills. In that case, we need to think not only about skills for innovation, but the *mix* of general and specific skills required on teams to execute different kinds of innovation and innovation-related activities.

General and specific skills for innovation

Thinking about innovation as a multi-faceted, multi-activity phenomenon advances our thinking about the skills required to support it. While there are some general skills that all people involved in innovation require, there are also specific skills that distinct individuals require for different kinds of innovation and for different innovation activities.

Previous work has highlighted the importance of **general skills for innovation**. The Conference Board of Canada's *Innovation Skills Profile* identifies the skills, attitudes

[14] Salerno, Augusto de Vasconcelos Gomes, Oliveira da Silva, Barros Bagno, & Lara Teixeira Uchôa Freitas, 2015
[15] Munro & Watt, 2014; Micaëlli, Forest, Coatanéa, & Medyna, 2015
[16] Munro & Watt, 2014
[17] Ibid.
[18] Breznitz, 2021

> Thinking about innovation as a multi-faceted, multi-activity phenomenon advances our thinking about the skills required to support it. While there are some specific skills that all people involved in innovation require, there are also specific skills that distinct individuals require for different kinds of innovation and for different innovation activities.

and behaviours people need to participate in and support innovation generally. These include **creativity**, **problem-solving**, and **continuous improvement skills**; **risk assessment and risk-taking skills**; **relationship-building** and **communication skills**; and **implementation skills** - that is, the general skills needed to turn ideas into new or improved strategies, capabilities, products, processes, and services.[19] Other research emphasizes the importance of **social and emotional skills**, including skills to understand and work with others, empathize with co-workers and clients, and otherwise attend to the human dimensions of innovation.[20] [21]
have all the skills needed to make an organization function. Similarly, no one person can have all the skills needed to innovate. Much research on innovation neglects this insight and assumes that everyone involved in innovation must have all the innovation skills. technology becomes increasingly ubiquitous and more
job tasks are automated, the importance and value of critical thinking, creativity, human judgment and decision making increases.[22] [23] [24]

There is also accumulating evidence that basic **digital literacy** and some **STEM skills** are needed by all people involved in innovation.

- A recent Brookfield Institute report on digital skills that examined 7 million job postings from 2012 to 2018 found that the ability to use standard software - like Microsoft Excel and the rest of the MS Office suite - is the most in-demand skill in the labour force and that basic digital literacy and skills are increasingly prerequisites for entering the workforce and moving into more technical, innovation-focused roles.[25]
- Similarly, the Council of Canadian Academies' Expert Panel on STEM Skills for the Future notes that fundamental STEM skills - including basic numeracy, computational and critical thinking, and problem solving - are necessary (though not sufficient), for innovation and economic growth.[26] More applied STEM skills (like coding, prototype testing, and manufacturing) and advanced STEM skills like training and expertise in specific STEM disciplines such as software engineering, chemistry, neuroscience, or materials science) are associated with high-value innovation, but are the kinds of STEM skills needed on teams and not by all members of a team.[27]

If the picture of general skills needed for innovation is fairly clear, the picture of specific skills for different kinds of innovation and innovation activities, and the right mix of skills in teams, is much less so. Our surveys of Mitacs's partner organizations and interns helps to clear some of the fog.

Of course, the skills needed for innovation are not static and evolve over time, just as innovations evolve over time. For example, a US study showed that between 2002 and 2016 the share of occupations requiring a high degree of digital skills and knowledge more than tripled from 4.8 to 23 percent of the labour market, mostly due to changes in the digital content of existing occupations.[28] While this report will help to clarify the skills required for various innovation activities today these skills demands will evolve over time.

For a full skills taxonomy, please see Appendix A

[19] Conference Board of Canada, 2014
[20] Giammarco, Higham & McKean, 2020
[21] Deming, 2017
[22] Agrawal, Gans, & Goldfarb, 2018
[23] Bakhshi, Frey, & Osborne, 2015
[24] Vu, Lamb, & Willoughby, 2019
[25] Ibid.
[26] The Expert Panel on STEM Skills for the Future, 2015
[27] Ibid.
[28] Muro, Liu, Whiton et Kulkarni, 2017

Organizations' perspectives on skills for innovation

Organizations involved in innovation make important decisions about what skills they need, how to put together teams with the right mix of skills, and what skills they might need to find among new hires or consultants to fill gaps.

Organizations involved in innovation make important decisions about what skills they need, how to put together teams with the right mix of skills, and what skills they might need to find among new hires or consultants to fill gaps. To be sure, organizations might be wrong about what they think they need. In that case, examining survey responses requires a sharp critical lens. Still, because human resource decisions have financial implications for organizations, they provide good signals about what thoughtful innovators regard as necessary. Examining exactly which skills individual organizations enlist for their innovation projects is thus a useful way to gain clarity about skills for innovation.

General skills for innovation

A majority of the organizations involved in Mitacs's Elevate and Accelerate programs that we surveyed said they needed science-related skills for their innovation projects (60 percent), while large proportions said they needed critical thinking and creativity (49 percent), design thinking and experimentation (44 percent), and engineering and digital skills (43 percent).

Despite increasing attention to social and emotional skills in the literature, only 17 percent of the organizations we surveyed said that these skills were required to complete

Figure 1
Science skills are top of mind for Mitacs' innovating firms
Proportion of Responses; n=164

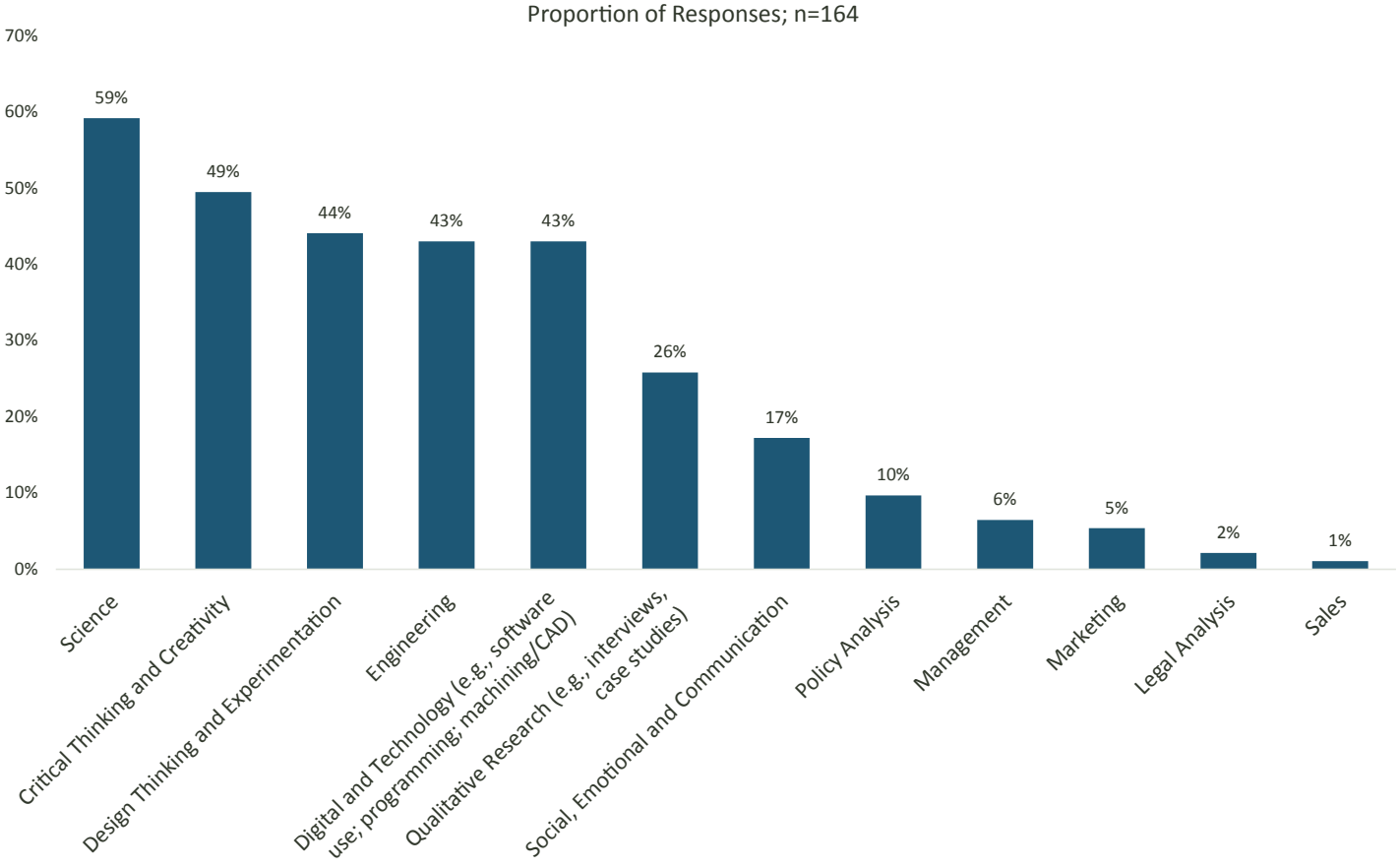
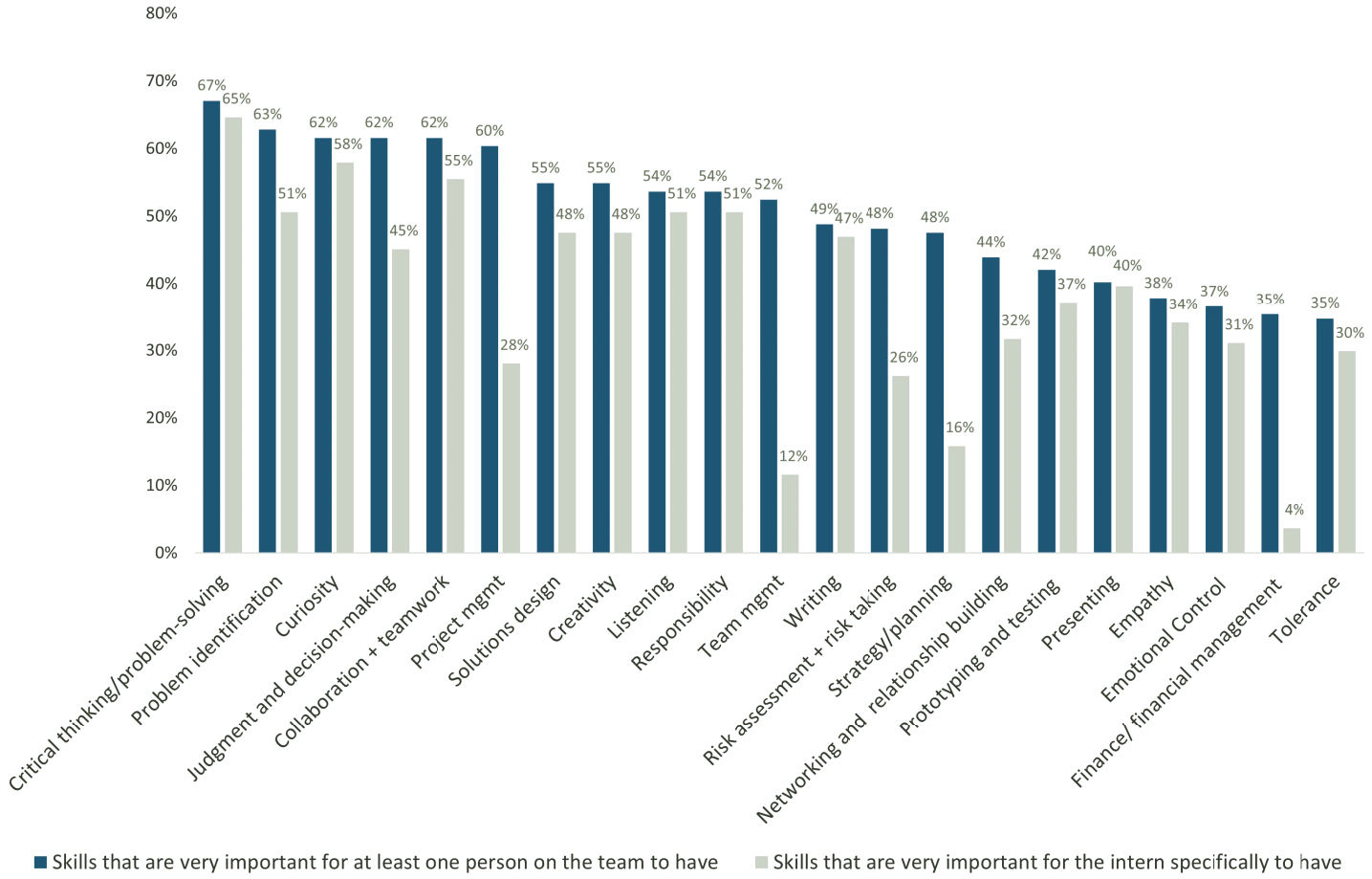


Figure 2
Innovation requires critical thinking, problem identification and curiosity
Proportion of employers; n=164



their innovation project. But we need to take these results with a grain of salt. Our sample is skewed towards organizations involved in science- and engineering-related innovation, for whom the language of social and emotional skills might have less resonance. It may also be the case that social and emotional skills are important to these organizations but not always top of mind because they rarely experience social and emotional skills shortages in ways that could upset their innovation activities in the way that they experience gaps in technical skills. Still, these are high-level results. The terrain is more nuanced and interesting when we look through the lenses of innovation types and activities.

Technical skills

The specific **technical skills** most frequently cited by organizations as very important to their innovation projects include scientific methods and principles, basic data skills, computer science, advanced data skills, productivity software, and programming and software. These results confirm the sense that digital skills - both basic and advanced - are increasingly important for innovation. Indeed, respondents were about as likely to say that they needed their Mitacs intern to have these digital and data skills as they were to say they needed these skills on their teams more generally.

The ability to conduct literature reviews was also frequently cited as very important for the innovation projects being pursued. In this case, respondents were somewhat more interested in ensuring the intern had this skill than someone on their team more generally, which may speak to a specific need at a certain phase in the innovation process. Nearly half of all projects in our sample were characterized as being in the problem identification stage of innovation, making the ability to identify, analyze and communicate insights from existing knowledge particularly important.

Complementary skills

Many respondents said that it was important for their team to have critical thinking/problem solving, problem

identification, curiosity, judgment and decision-making, and collaboration and teamwork skills. Notably, while large proportions of respondents said that it was very important for at least one person on their innovation team to have problem identification, judgement, decision-making, and project management skills, they were less likely to say their Mitacs intern needed these skills. It seems many firms believe that the innovation management function can be performed by a subset of team members, which reflects our expectation that innovation teams can be composed of individuals with different specialized but complementary skills.

While "social and emotional skills" as a skills *category* received very little attention from respondents, specific social and emotional skills were flagged as important by innovating organizations. Sixty-two percent said that collaboration and teamwork - key social and emotional skills - were very important to the innovation project. Similarly, more than half said that listening and responsibility were very important both for their team and the Mitacs intern to have. By contrast, other social and emotional skills - empathy (38 percent), emotional control (37 percent) and tolerance (35 percent) - were less frequently flagged as very important. Again, it seems that organizations view *specific* social and emotional skills as more important to innovation than others, while they find the category or label "social and emotional skills" less relevant or recognizable. When talking about innovation skills, specificity and granularity are critical.

Figure 3
When employers require technical skills for innovation, they frequently need complementary skills as well
Proportion of employers; n=164

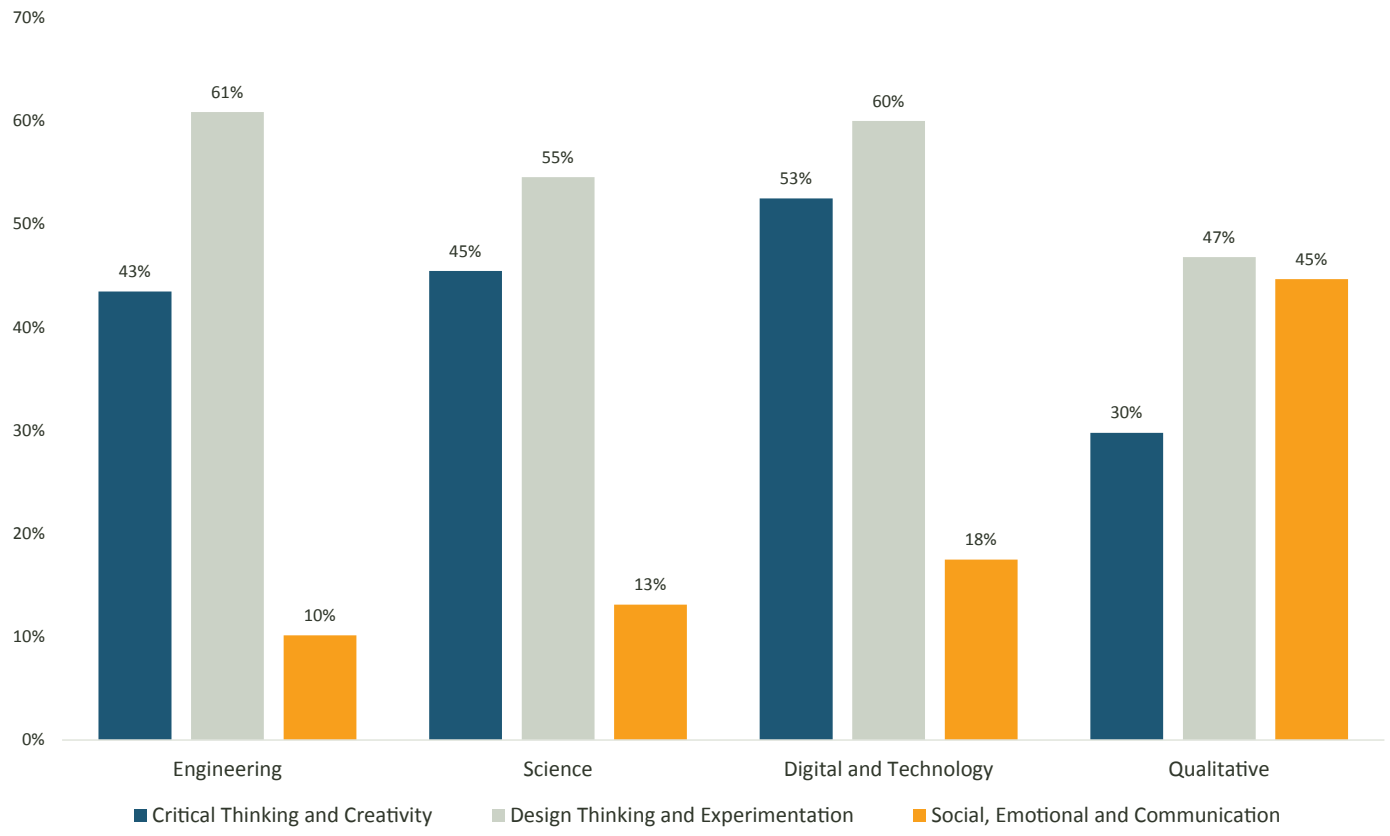
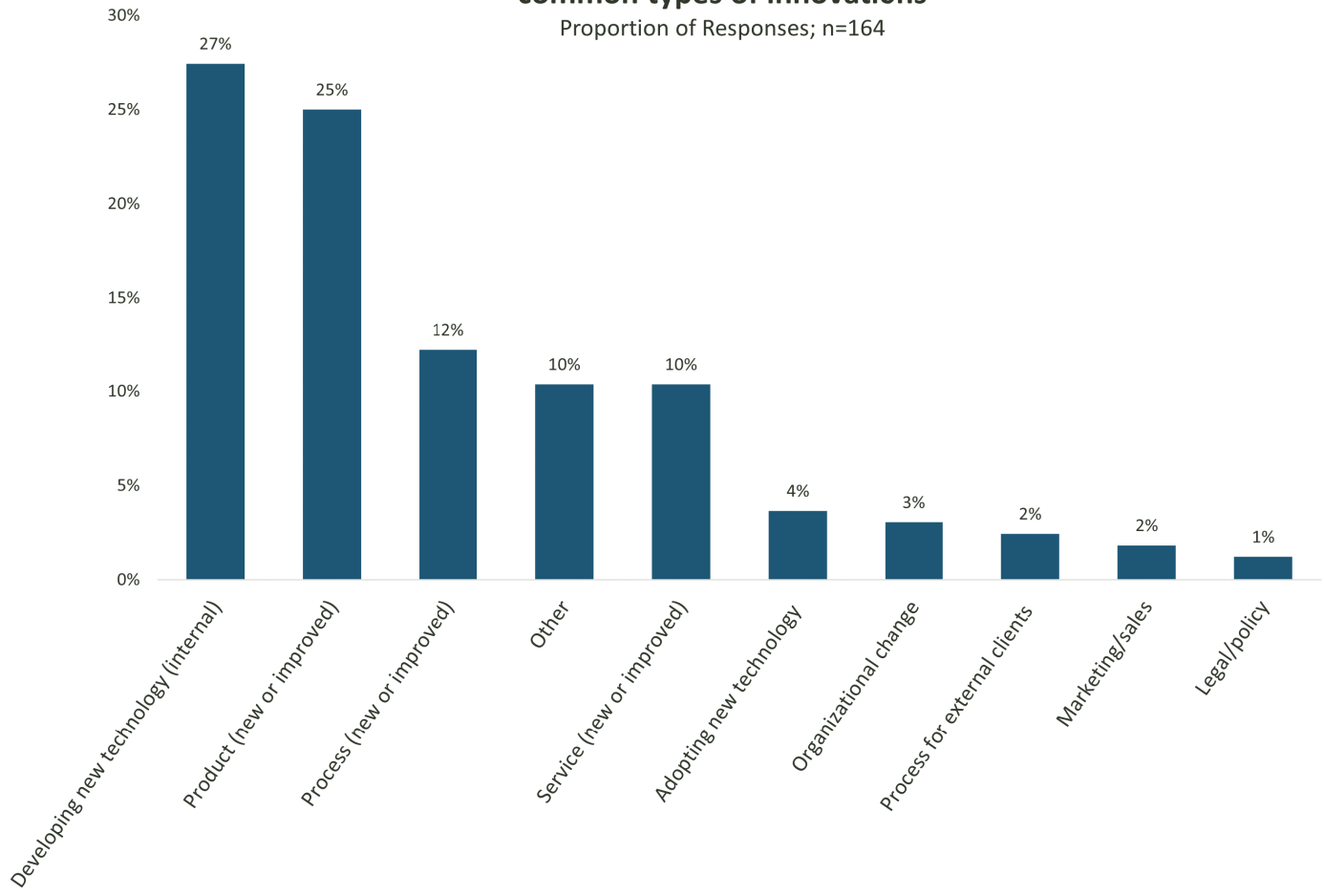


Figure 4
Internal technology and new or improved products were the most common types of innovations
Proportion of Responses; n=164



Skills complementarities

Numerous studies have shown that demand for certain technical STEM skills is associated with demand for certain non-technical complementary skills such as judgment, creativity, social and communication skills.[29] Our survey offers additional confirmation of skills clustering. Of those organizations that needed engineering, science, or digital and technology skills for their innovation project, between 43 and 53 percent also needed critical thinking and creativity skills (versus only 30 percent of those who required qualitative skills). Similarly, while only 10 to 18 percent of organizations that needed engineering, science, or digital and technology skills also needed social, emotional and communication skills, the demand for social, emotional and communication skills rises to 45 percent among those that said they need qualitative skills.

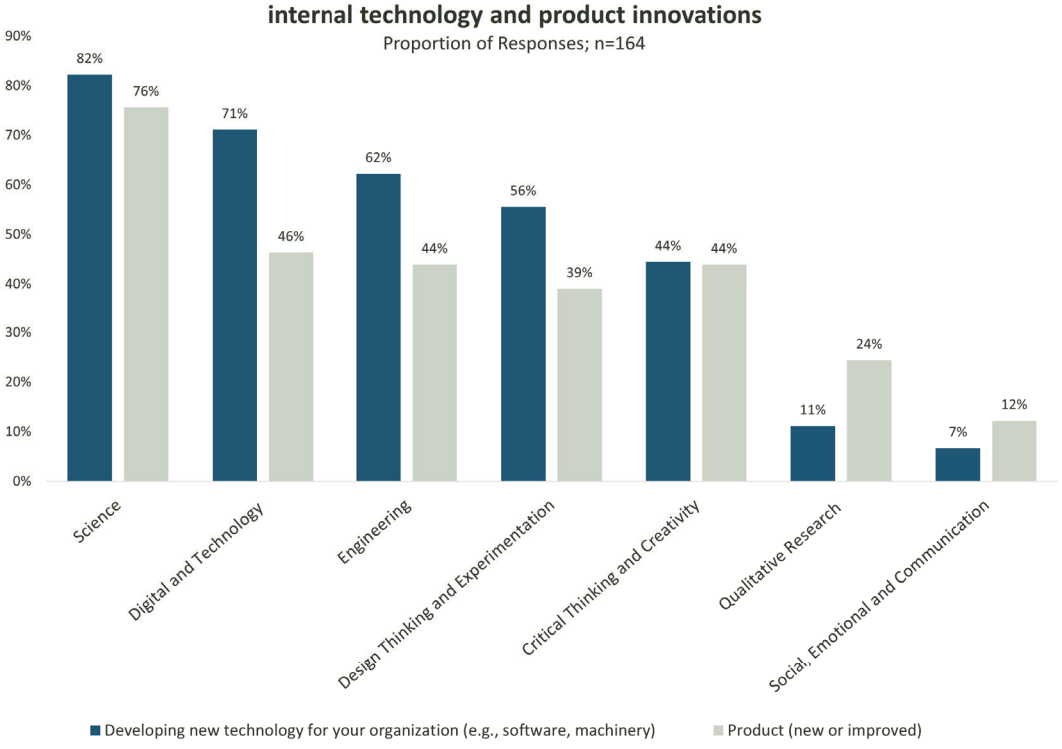
[29] Agrawal, Gans, & Goldfarb, 2017; Deming, 2017; Deming & Kahn, 2017; Bakhshi, Frey, & Osborne, 2015; Tambe & Hitt, 2012

Skills for different kinds of innovation

There are different kinds of innovation. Do organizations involved in innovation have preferences for different skills for the different kinds of innovation?

We asked organizations to identify which kind of innovation their Mitacs-supported project was focused on when the intern joined and offered 10 options, including product, service, process, marketing, and organizational innovation.[30] Many organizations said their innovation project was focused on **developing a new technology for their organization** (27 percent) or **product innovation** (25 percent), followed by **process innovation for their organization** (12 percent), and **service innovation** (10 percent). The results are sufficiently robust to allow us to identify specific skills requirements for these four types of innovation, but not others. Future reports on skills for innovation within this research project will have access to more survey responses and should be able to identify skills required for other kinds of innovation.

Figure 5
High-level technical skills are most frequently required for internal technology and product innovations
Proportion of Responses; n=164



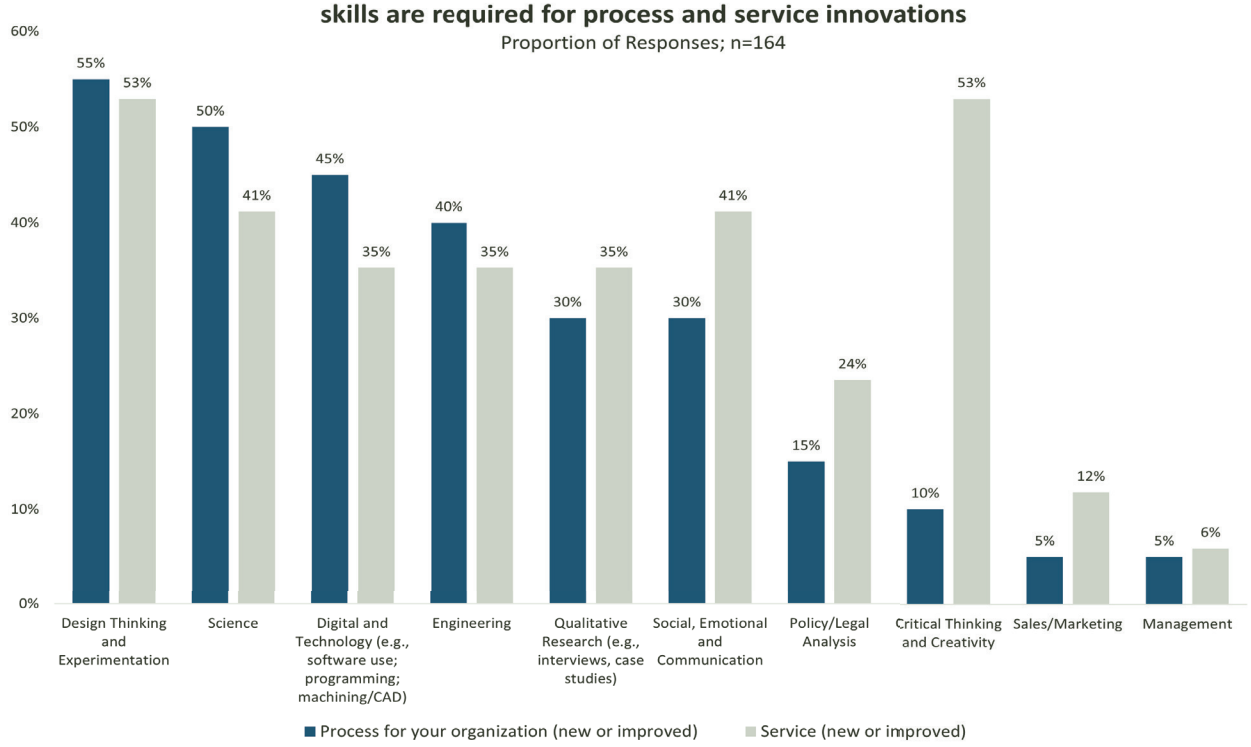
Firms **developing new technologies for their own organizations** said they needed broad technical skills, including science skills (82 percent), digital skills (71 percent), and engineering skills (62 percent). Design thinking and experimentation were very important for 56 percent of respondents developing new technology for their organization, while just under half (44 percent) said that critical thinking and creativity skills were important for their innovation. This suggests that while technical skills are must-haves, certain complementary skills are also very important for technological innovation, while social and emotional skills - as a category - are not top-of-mind for these organizations.

Organizations involved in **product innovation** also gave prominence to technical skills categories, but not as frequently as internal technology innovators. Seventy-six percent said they needed science skills. Digital and technology (46 percent) and engineering (44 percent) skills were also important for many organizations in product innovation, but fewer said these skills were more important than those involved in developing internal technologies. Complementary skills categories - like design thinking and experimentation (39 percent) and critical thinking and creativity (44 percent) were important to many product innovators, while social and emotional skills as a category were largely off their radar.

Organizations engaged in **process** or **service innovation** were much less likely than technology innovators to say that skills in the science category (50 percent and 41 percent versus 82 percent) and the digital technology and software category (45 percent and 35 percent versus 71 percent) were important for their innovation project.

[30] The full set of options included product (new or improved); service (new or improved); process for your organization (new or improved); process for external clients (new or improved); marketing/sales (new or improved strategies, methods, etc.); adopting new technology in your organization (e.g., software, machinery); developing new technology for your organization (e.g., software, machinery); organizational change; legal/policy innovation; and other (with a write-in option).

Figure 6
Technical and complementary design, critical thinking, and social and emotional skills are required for process and service innovations
Proportion of Responses; n=164



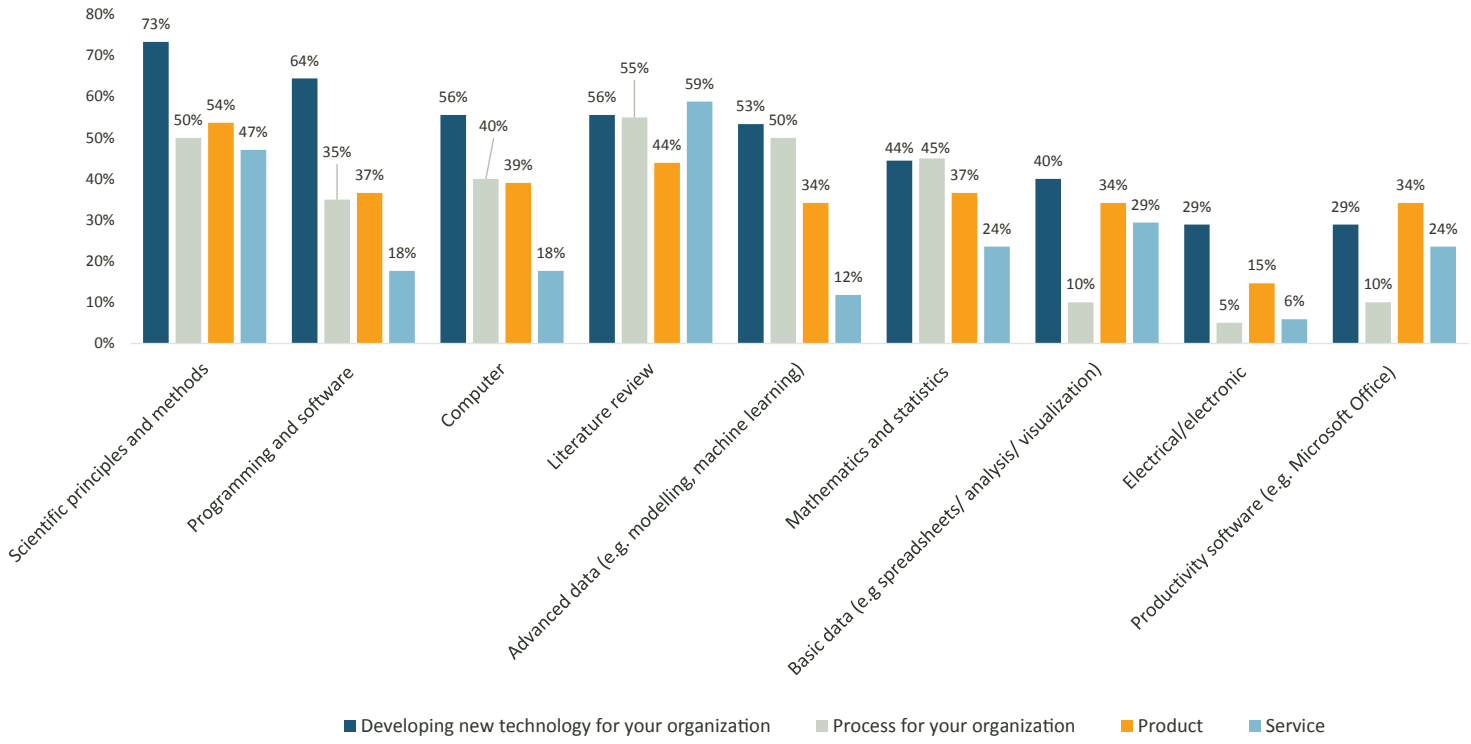
The most important skills category for process and service innovators is design thinking and experimentation (55 percent and 53 percent, respectively) though, interestingly, the same proportion of internal technology innovators cited this skills category as important (56 percent).

Notably, critical thinking and creativity skills are largely absent from process innovators' skills needs (10 percent), while over half (53 percent) of service innovators cited this skills category as very important. Among internal technology and product innovators, critical thinking and creativity skills were regarded as very important by 44 percent. Social and emotional skills are much more prominent among process and service innovators skills needs (30 percent and 41 percent, respectively) than technology and product innovators (seven percent and 12 percent, respectively). This likely reflects the fact internal process changes are largely about organizational culture, behaviour, and/or process flows, and that much service innovation likely requires interaction with, and an understanding of, client behaviour.

The importance of specific *technical skills* varies depending on the kinds of innovation projects being explored. Advanced digital skills were most important for organizations developing new technology for internal purposes, including programming and software, computer science, and advanced data skills. Scientific principles and methods skills were also most important for organizations engaged in internal technology development. Literature review skills were emphasized as important regardless of the innovation activities being undertaken.

There is considerably less variation across, and more importance attributed to, specific **complementary skills**, which suggests that many of these skills act more like general skills for innovation. Employers engaged in product innovation and developing new technology internally highlighted the importance of prototyping and testing skills much more frequently than process or service innovations. However, solutions design skills were important across innovation activities. Employers also highlighted the importance of project and team management skills, as well as foundational curiosity and risk taking and assessment skills.

Figure 7
Technical Skills for Different Innovations
Proportion of employers that that deem these very important for at least one member of the team to possess



Skills for different innovation activities and stages

Innovation involves different clusters of activities at different times or stages. Do innovators state preferences for different skills for different activities and stages?

We asked respondents to select the stage their innovation project was at when the Mitacs intern joined from the following options: problem identification and exploration; solution design, building and/or testing; implementation; marketing, sales or distribution; or another stage (with a write-in option). Only two stages featured prominently in the responses: problem identification and exploration (48 percent) and solution design, building, and/or testing (39 percent). Eight percent said they were at the implementation stage, which offers us only a small sample to analyze and therefore results in this category should be treated with caution. This distribution likely reflects focus of the Mitacs Accelerate and Elevate programs included in the study.

Looking at the responses from organizations focused on the three different stages or clusters of activities, we see both similarities and differences in the skills required - which maps onto our expectations about high-level general skills and more specialized activity-focused skills. Organizations that characterized their innovation projects as being at a solutions design, building and testing stage were more likely than those focused on problem identification and exploration or implementation to say they needed science skills (69 percent, 60 percent, and 46 percent respectively) and engineering skills (50 percent, 37 percent, and 38 percent, respectively).

Organizations focused on *problem identification and exploration activities* were more likely than those at a *solutions design* or *implementation stage* to require critical thinking and creativity skills (60 percent, 50 percent, and 23 percent, respectively). Social and emotional skills were more important for those focused on *implementation* (31 percent) than those focused on *problem identification* (23 percent) or *solutions design* (16 percent). Notably, the need for digital skills was about the same for all three stages of innovation, confirming the increasingly general importance of digital skills for innovation. The differences in skills required at each innovation stage are not especially stark across all skills categories, so the best conclusion might be to say that different stages and activities have varying skills *emphases*.

Figure 8
Complementary Skills for Different Innovations

Proportion of employers that that deem these very important for at least one member of the team to possess

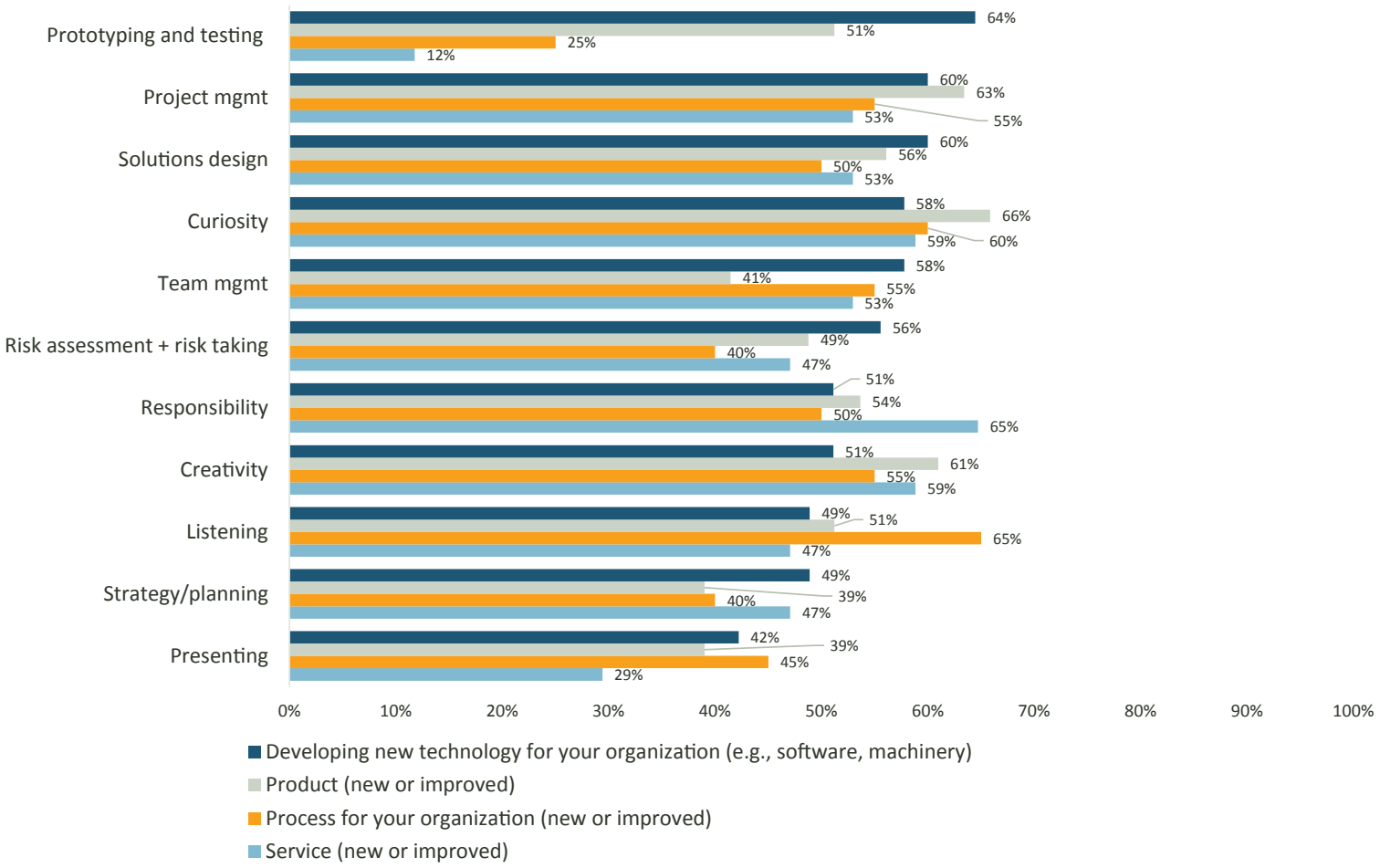


Figure 9
Problem identification and solutions design the most common stages
Proportion of Responses, n=164

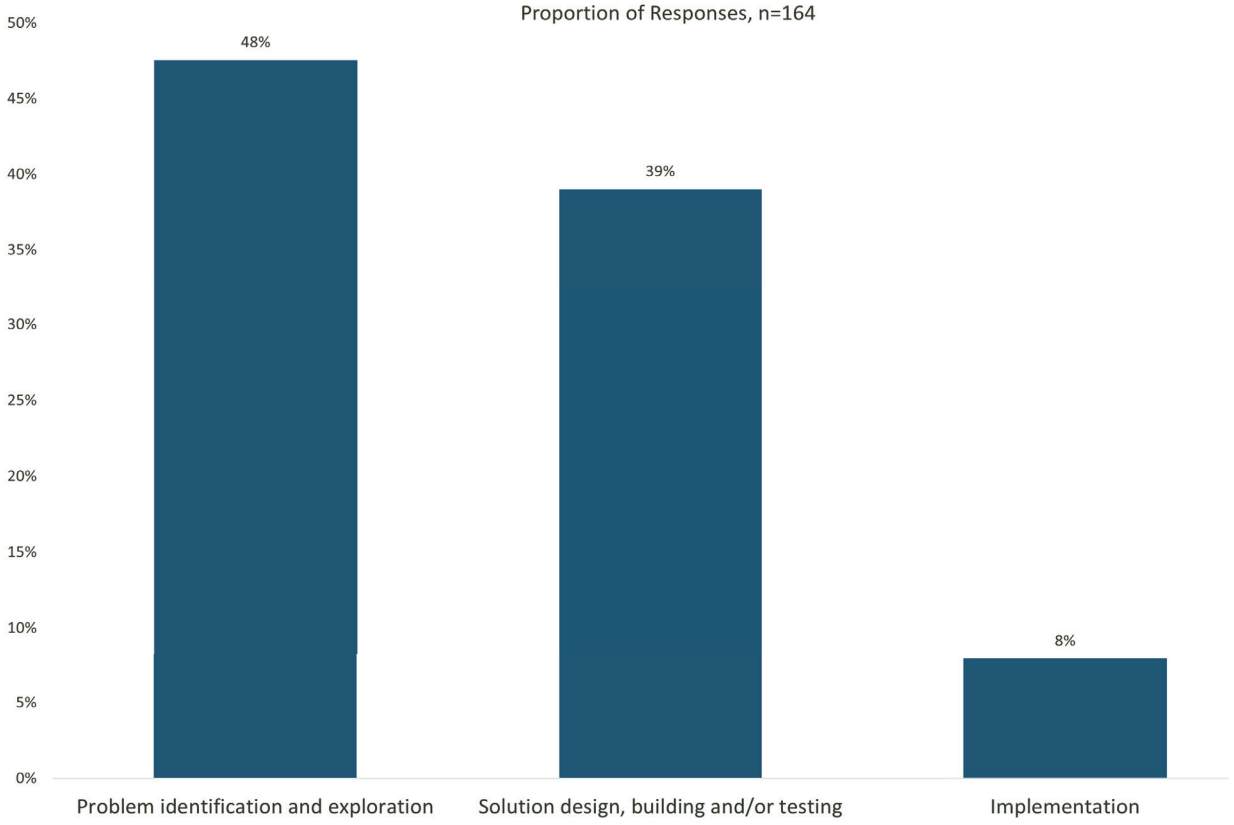
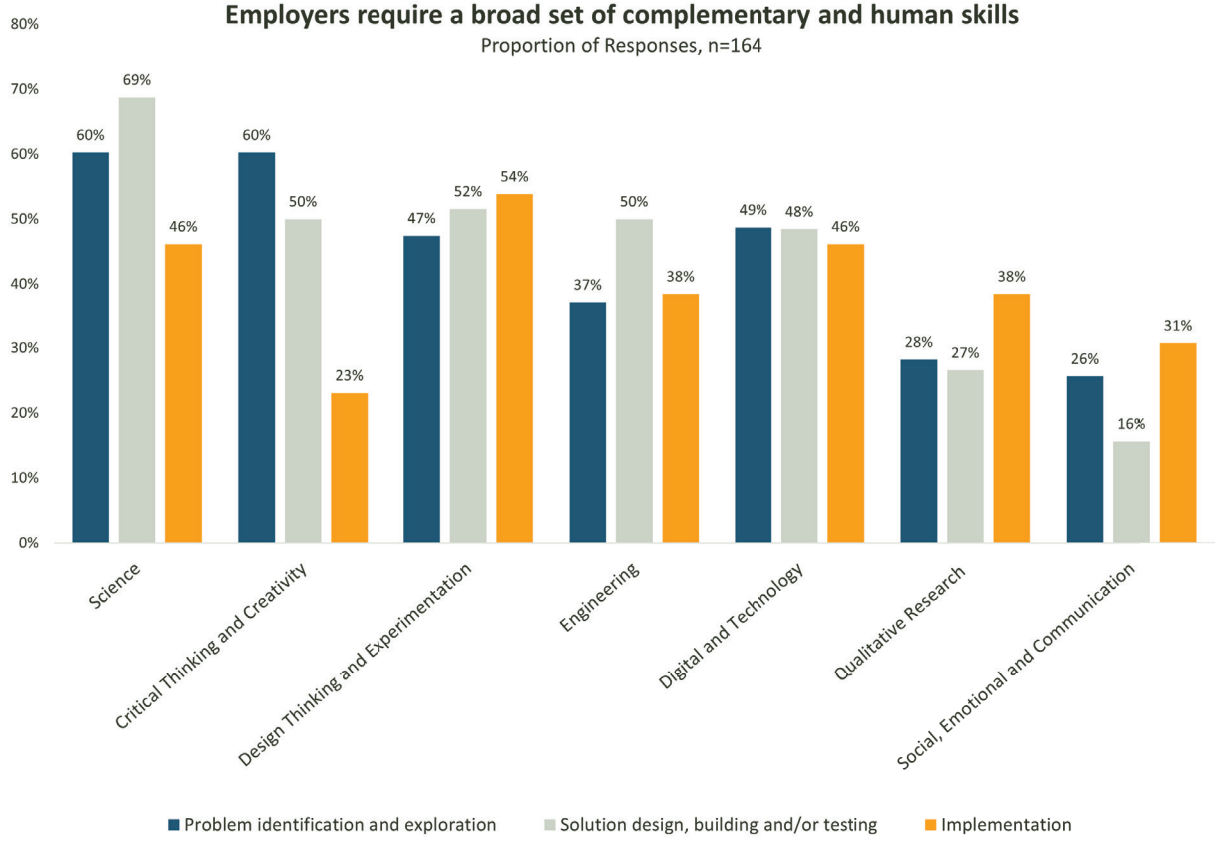


Figure 10
Employers require a broad set of complementary and human skills
Proportion of Responses, n=164



Innovation agents: Individuals and teams

Innovation is a team sport, not an individual event. Do survey responses reveal distinctions among general innovation skills - i.e., skills required by all members of an innovation team - and specialized innovation skills - i.e., skills required by only a subset of innovation team members? When asking organizations to rate the importance of skills for their Mitacs-supported innovation project we prompted them to distinguish between skills they needed in at least one member of their innovation team and skills they needed from the Mitacs intern specifically. The responses revealed some interesting insights about individual and team skills.

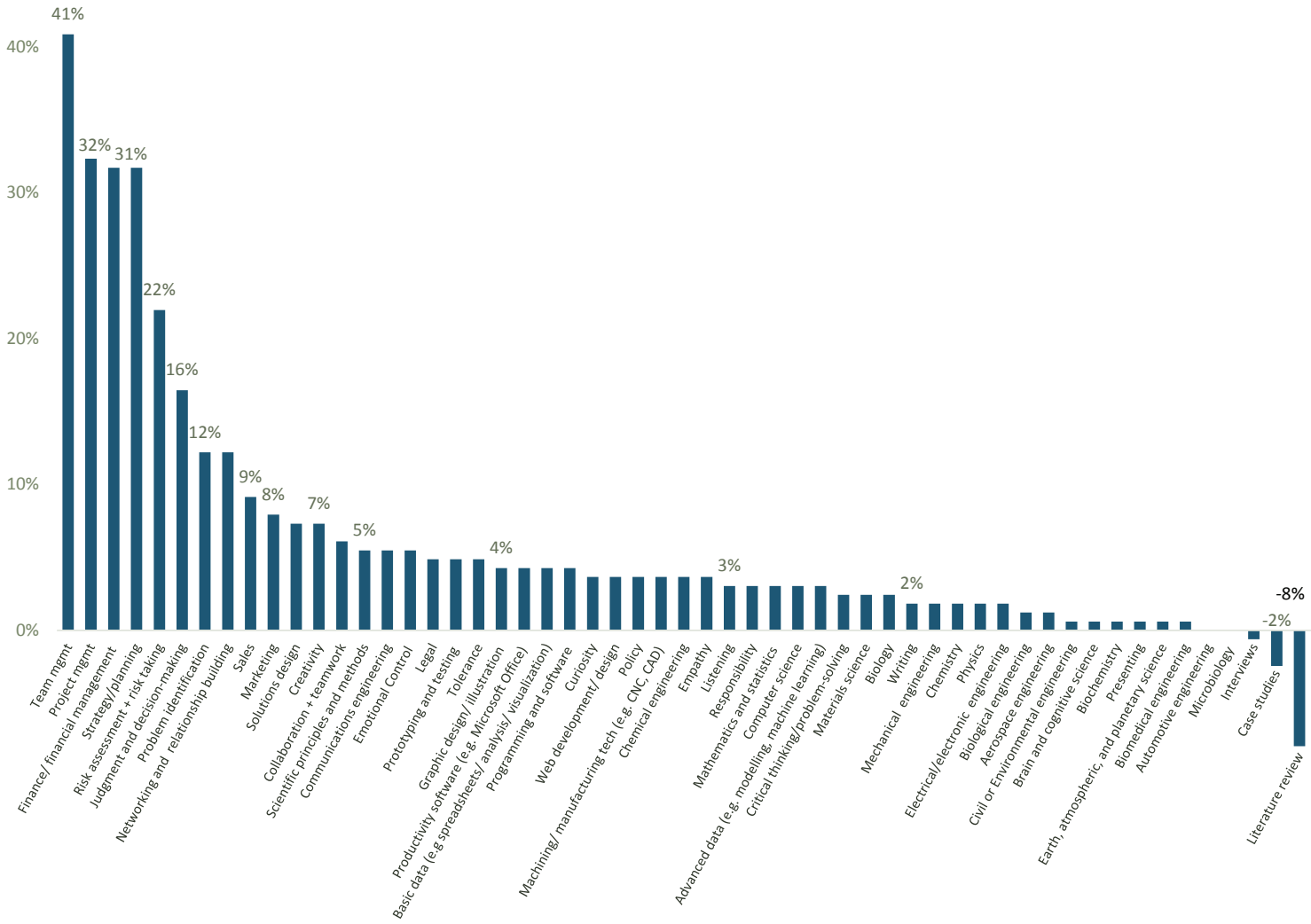
Various management and sales skills stand out quite starkly as skills organizations need on their teams, but not by their Mitacs intern - or, presumably, other new employees - specifically. We see a 41 percentage point difference between the proportion of organizations who said team management skills were important for the team as a whole versus important for their Mitacs intern specifically, as well as 32 percentage point differences for project management, financial management, and strategy and planning skills. A 12 percentage point difference between team versus intern need for networking and relationship building, and nine percentage points for sales were also reported. Simply put, there are skills for many management and leadership functions that respondents need in their organizations, but only among key employees.

Interestingly, there was an eight percentage point difference in the proportion of organizations stating that literature reviews were 'very important' for interns specifically versus the team as a whole to have - which suggests that some innovators view some skills as not only important and specialized, but also not necessary on their teams generally. These are skills they can pull in as necessary through internships and/or external procurement and contracting.

Meanwhile, we see little difference in the share of organizations who view a range of technical and complementary skills as important for their teams and interns specifically. The level of importance attached to these skills varies by type and stage of innovation, but when an organization flags a skill as important, they see it as universally required.

Figure 11
Management skills critical for innovation - but not everyone needs them

Percentage point difference between skills deemed 'very important' for the team and intern specifically



Interns' perspectives on skills for innovation

Over the course of their education and careers, students and workers are prompted to make a number of difficult choices about which skills to develop, including skills for innovation. The choices are difficult because skills development requires investments of time and resources, often with an uncertain return. Reducing that uncertainty - and thereby enabling more informed choices - is an ongoing challenge. Information from employers about their innovation skills needs is an essential input. Just as valuable to reducing uncertainty and improving decision-making are students' and workers' own insights gained from internships and employment about what skills they use and what skills they lack.

Over the course of their education and careers, students and workers are prompted to make a number of difficult choices about which skills to develop, including skills for innovation. The choices are difficult because skills development requires investments of time and resources, often with an uncertain return.

Our survey of Mitacs interns prompted them to reflect on the skills they used in their innovation internships and their sense of whether they have developed the necessary skills sufficiently. When considered together, responses on use and confidence reveal important and instructive insights about what skills are required for innovation and how much room there is for students and workers - with employers, educators, and other organizations' support - to improve those skills. Additionally, when we compare organizations' responses about their need for certain skills with interns' self-reported confidence in those skills, we gain another set of signals about the skills that might need further development.

Use of and confidence in skills for innovation

Looking at technical skills, intern responses reveal many gaps between frequency of use and confidence. Consistent with organizations' insights, interns reported frequent use of basic data and digital skills, including productivity software (65 percent) and spreadsheets and visualizations (62 percent). Yet, interns' self-reported confidence in those skills reached just 54 and 51 percent, respectively. Similarly, 64 percent of interns reported being involved in literature reviews as part of their innovation project, but only 44 percent said that they felt very confident about their literature review skills. In fact, there are gaps between use and confidence rates across almost all the technical skills we asked interns to consider.

The most frequently used complementary skill in innovation, according to interns, was critical thinking and problem-solving. Seventy percent of interns said they frequently used this skill, but only 43 percent feel very confident in this skill. The pervasiveness of critical thinking and problem-solving is across innovation activities and stages; improving confidence is an imperative for innovation skills development. Interns also reported frequently using many social and emotional skills - such as listening (61 percent), curiosity (58 percent), responsibility (58 percent), and collaboration and teamwork (56 percent). Yet, again, for all these skills, confidence lags significantly behind frequency of use.

Interestingly, some of the lowest levels of confidence are seen in two of the management skills - team management (19 percent) and project management (24 percent). For team management, this does not appear to be an especially big problem since only 26 percent of students said that they used team management skills during their internship, but as 43 percent said they used project management skills, there may be a need for skills development in these management-specific skills. Overall, there are many areas for improvement in students' skills development.

Organizations' need for and interns' confidence in skills for innovation

There are also discrepancies between organizations' stated skills requirements and interns' confidence in their ability to put these skills to use. In this case we compare the share of organizations who said it was very important for the intern specifically to have a skill with the share of students who said they felt very confident in that skill.

For *technical skills*, the largest gaps emerge in literature review skills (60 percent importance versus 44 percent confidence), scientific principles and methods (48 percent importance versus 34 percent confidence), advanced data (33 percent importance versus 21 percent confidence), and mathematics and statistics (32 percent importance versus 22 percent confidence).

By contrast, there are some basic data and digital skills in which students' confidence outpaces employers' stated need. Interns are very confident with their basic data skills (51 percent) and use of productivity software (54 percent), but only 40 percent of organizations said it was very important for interns to have basic data skills and 31 percent said productivity software skills were very important. This is not evidence of a skills surplus, but instead a good sign that many students are ready to use skills that organizations need.

The 10 technical skills that are most important for employers directly matched the 10 skills students were most confident using, albeit in a very different order. This suggests that there is considerable overlap in the supply and demand for skills. However, there is also room for improvement when it comes to skills development.

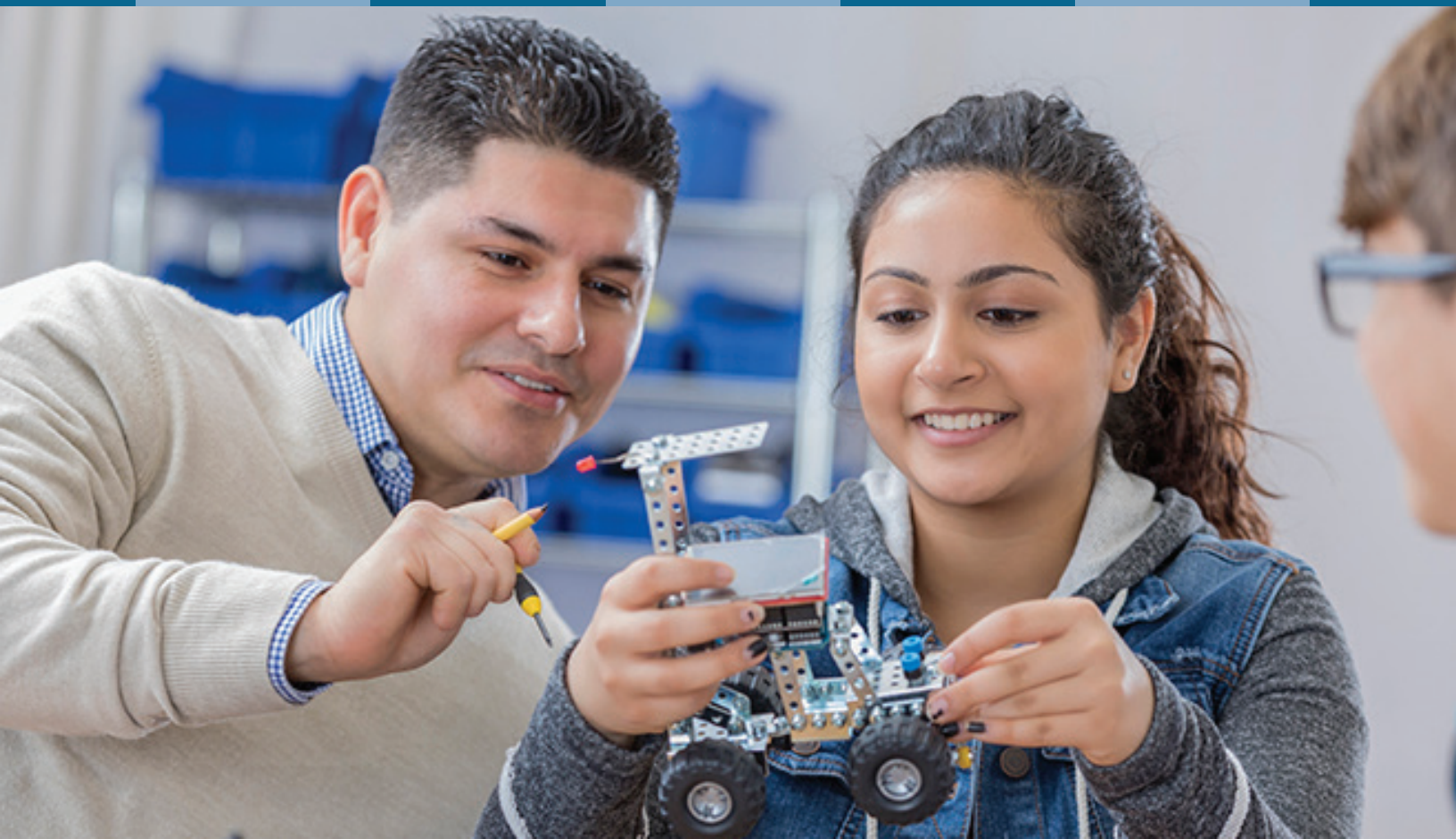
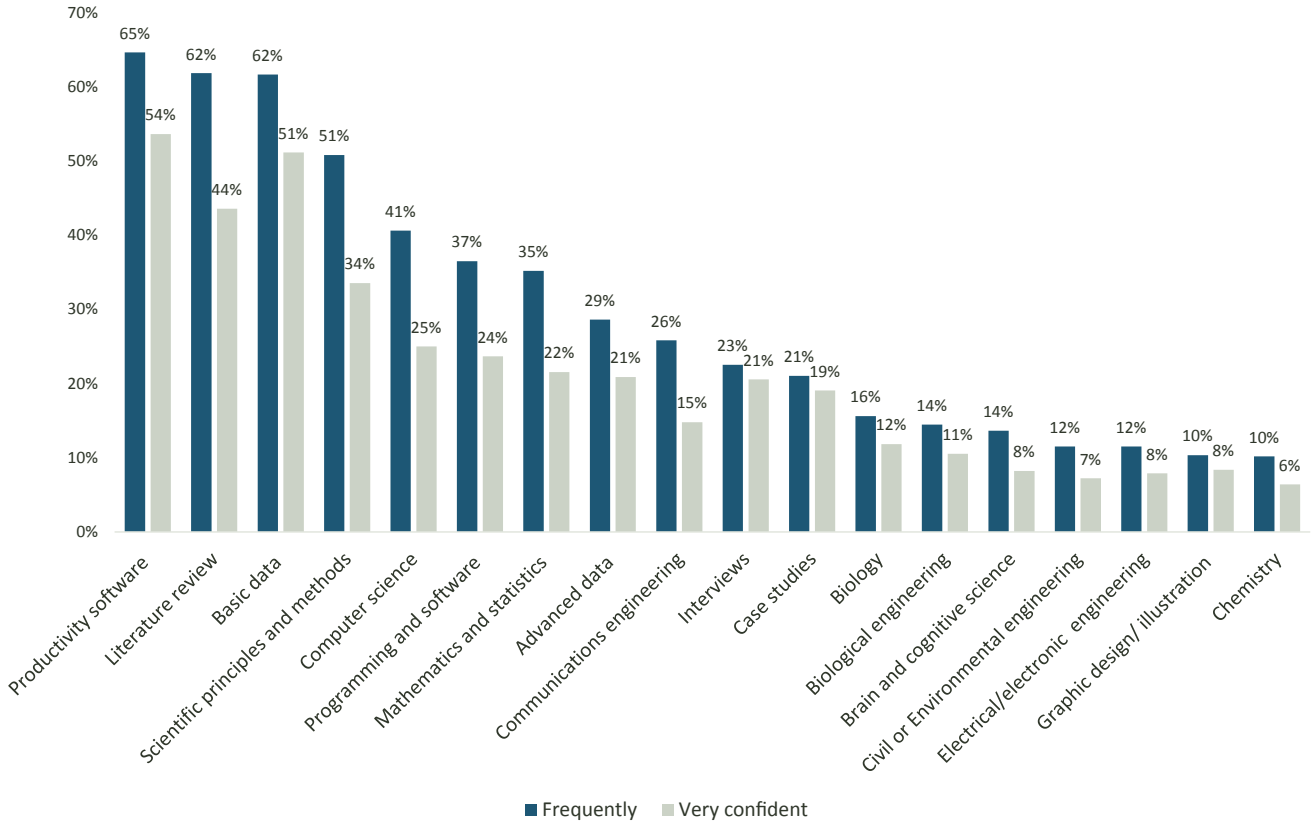


Figure 12
Students' use vs confidence in technical skills
Proportion of students; n=608



In terms of complementary skills, the largest gaps between organizations' needs and student confidence emerge in critical thinking and problem-solving skills (65 percent importance versus 43 percent confidence), and a number of design thinking skills – including solutions design (48 percent importance versus 26 percent confidence), problem identification (51 percent importance versus 40 percent confidence), and prototyping and testing (37 percent importance versus 19 percent confidence). Collaboration and teamwork also show a significant gap (55 percent importance versus 42 percent confidence).

Notably, while students' confidence in key social and emotional skills could be higher, there are few noticeable gaps between the share of organizations flagging certain social and emotional skills as very important for the intern to have and interns self-reported confidence in those skills. This is most evident in empathy (34 percent importance versus 38 percent confidence), emotional control (31 percent importance versus 32 percent confidence), and tolerance (30 percent importance versus 35 percent confidence).

Figure 13
Students' use vs confidence in complementary skills
Proportion of students; n=608

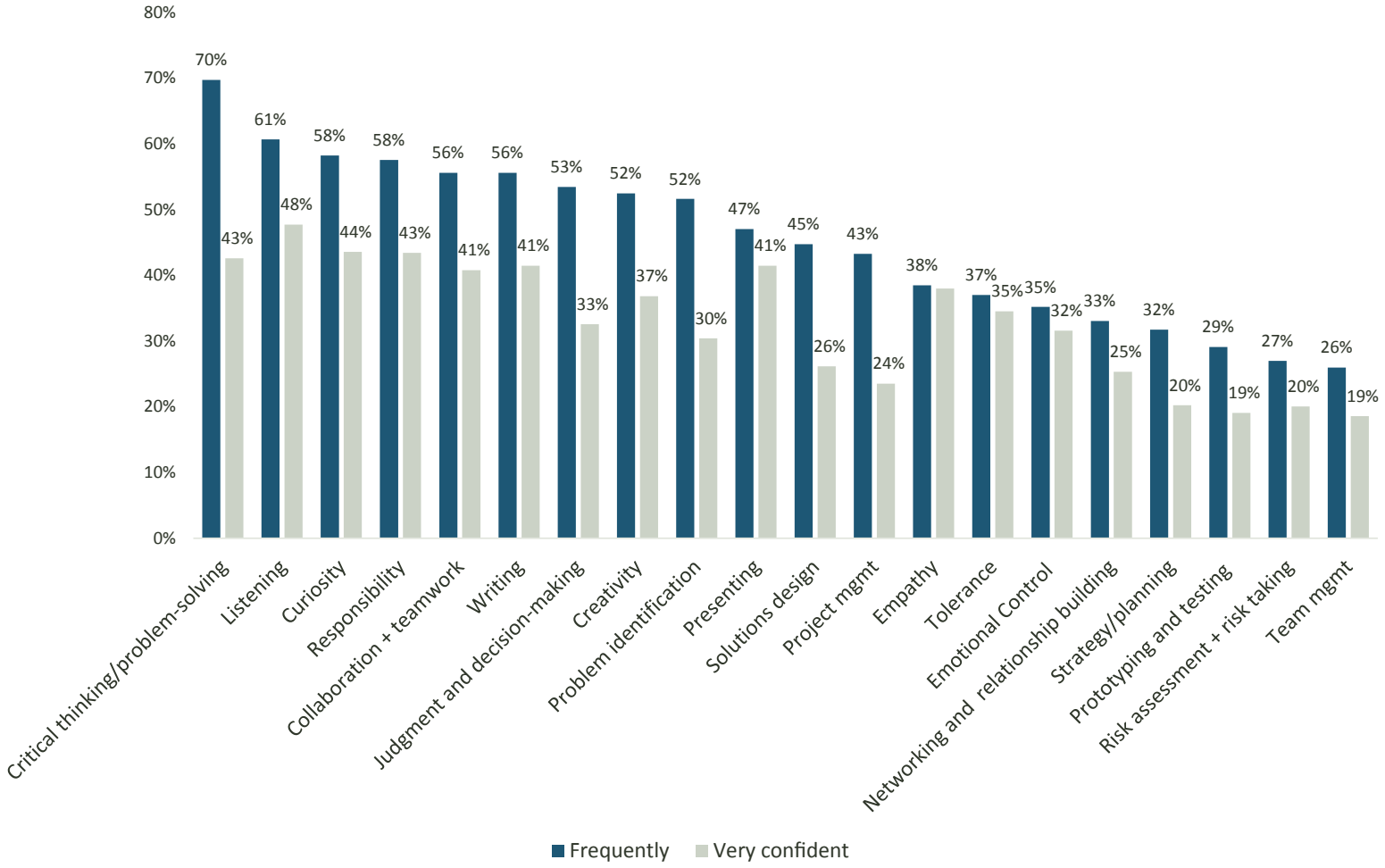


Figure 14
Confidence in Key Technical Skills Lags Organizations' Needs
Proportion of employers (n=164) and proportion of students (N=608)

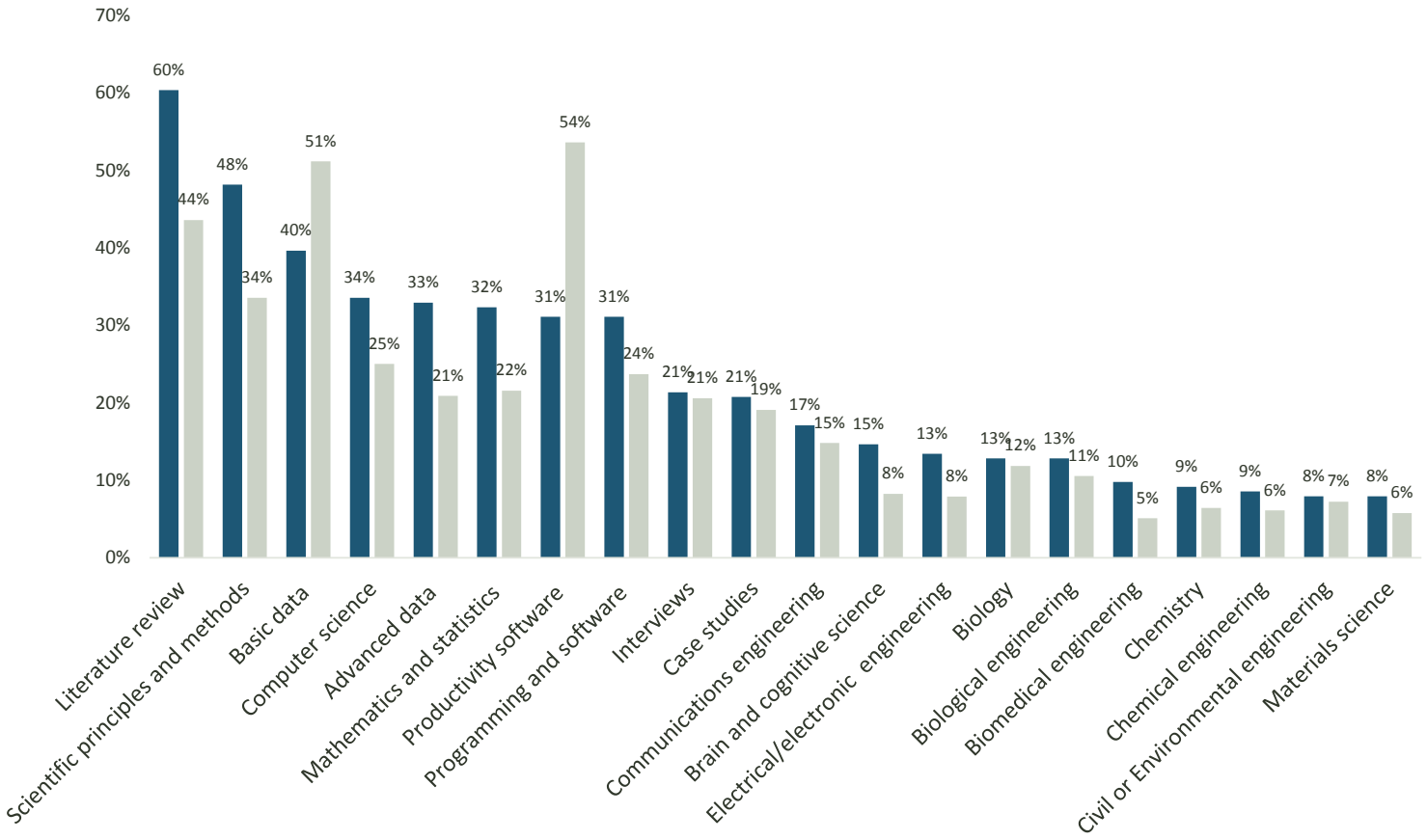


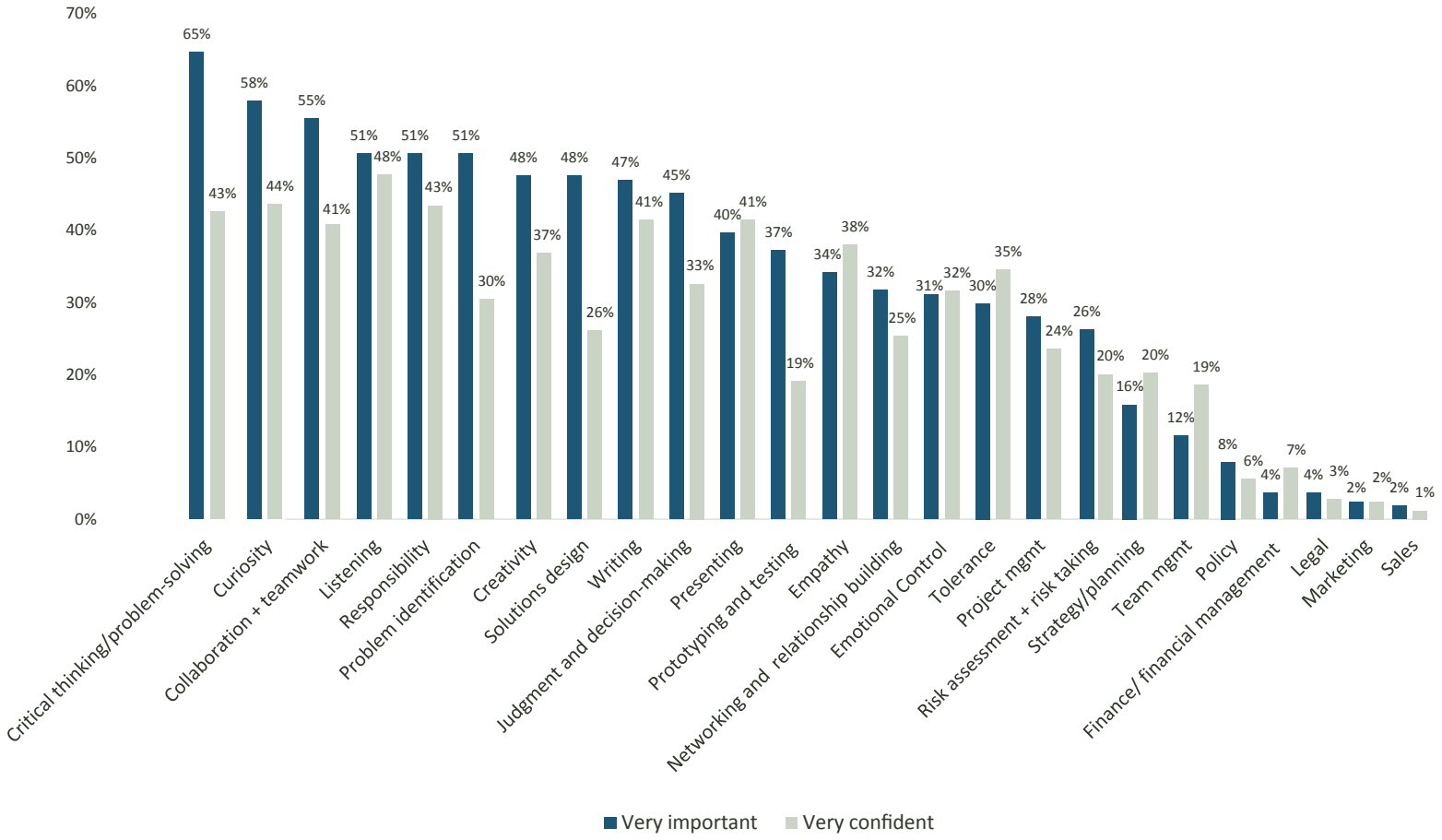
Chart 4: Comparing top 10 most frequently selected technical skills

Employers: Very important	Students: Very confident
Literature review	Productivity software (e.g. Microsoft Office)
Scientific principles and methods	Basic data (e.g spreadsheets/ analysis/ visualization)
Basic data (e.g spreadsheets/ analysis/ visualization)	Literature review
Computer science	Scientific principles and methods
Advanced data (e.g. modelling, machine learning)	Computer science
Mathematics and statistics	Programming and software
Productivity software (e.g. Microsoft Office)	Mathematics and statistics
Programming and software	Advanced data (e.g. modelling, machine learning)
Interviews	Interviews
Case studies	Case studies

Figure 15

Room for Improvement in Students' Complementary Skills Confidence

Proportion of employers (n=164) and proportion of students (N=608)



Like technical skills, there is considerable overlap in the 10 complementary skills that are most important for employers and the 10 skills students are most confident using. However, there is once again room for improvement in key areas. For example, employers' emphasis on the importance of judgment and decision-making, problem solving and identification, and teamwork (to name a few) far exceeds students' confidence in using these skills.

Chart 5: Comparing top 10 most frequently selected complementary skills

Employers: Very important	Students: Very confident
Critical thinking/problem-solving	Listening
Curiosity	Curiosity
Collaboration + teamwork	Responsibility
Problem identification	Critical thinking/problem-solving
Listening	Writing
Responsibility	Presenting
Solutions design	Collaboration + teamwork
Creativity	Empathy
Writing	Creativity
Judgment and decision-making	Tolerance

Again, while the questions posed to interns about use and confidence, and to organizations about importance, of certain skills are not directly aligned, viewing results from these questions adjacently reveals some gaps worth thinking about. Clearly, there is room for improving a number of skills among interns and students to sharpen Canada's innovation skills advantage. The best skills development plans likely start with students' own experiences and are individualized to their needs and aspirations in innovation.

Implications for innovation skills development

Identifying the skills needed for innovation is not straightforward. There are *general* skills that all people involved in innovation require and play a role across all kinds and stages of innovation - including critical thinking, problem-solving, communication, and teamwork. There are also *specialized* skills needed among some, but not all, people on innovation teams and required at different times and for different kinds of innovation and innovation activities. This more granular understanding of innovation skills has implications for how innovators, educators, and other organizations think about, plan for, and execute skills development.

General skills for innovation

Individuals and organizations aiming to innovate will need a certain set of general skills to succeed. Our survey and analysis confirm some key insights from existing literature about what those skills are, while also revealing some new insights. To contribute to innovation, individuals and organizations will want to focus on the development of creativity, communication, and teamwork skills to ensure a good flow and exchange of ideas and insights that contribute to innovation success. Additionally, skills like critical thinking, problem-solving, curiosity, judgment and decision-making are important for all innovating organizations and individuals. These are the foundational, general skills for innovation. But there are two other kinds of general skills for innovation that are increasingly important - basic data skills and digital literacy, and certain social and emotional skills.

Basic data skills and digital literacy

Across all kinds and stages of innovation, basic data skills and digital literacy are essential. Organizations and interns involved in innovation frequently note that using basic productivity software, understanding and interpreting data-based insights, and navigating online research, social media, and other digital tools are now standard innovation activities for which all employees must have the skills and knowledge to perform. Advanced data and digital skills - such as programming, computer science, and advanced statistical analysis - are more likely to be seen as specialized skills required of some, but not all, people involved in innovation and with more relevance to some kinds and stages of innovation than others.

Social and emotional skills

Some skills that have been classified under the umbrella category “social and emotional skills” are general, universally required skills for innovation, including collaboration, teamwork, listening, and responsibility. Future innovators will want to hone these skills to ensure they have the full suite of foundational skills for innovation. At the same time, other social and emotional skills are less likely to be seen as important to innovators - including empathy, emotional control, and tolerance. This is not to say that these skills are not important for employment and healthy organizations more broadly, but they tend not to be flagged by innovators as very important for innovation per se.

Moreover, even while innovators regard certain social and emotional skills as important, the category or label “social and emotional skills” has little resonance for them. This suggests that students, workers, educators, and other stakeholders might need to adopt different ways of talking about social and emotional skills when interacting with industry and other employers.

Specialized skills for innovation

As we discovered in our surveys of innovators and have emphasized throughout the report, beyond the general foundational skills that all innovators require, there are certain specialized skills that differ across different kinds and stages of innovation. This presents both opportunities and challenges for those developing innovation skills. On the one hand, with a more granular, context-specific understanding of the skills needed for

innovation, individuals and organizations can develop more precisely calibrated education and recruitment plans for certain kinds of innovation. On the other hand, the fragmentation of skills for innovation across innovation types and stages means that skills for innovation curricula may be more difficult to develop and deliver in ways that are relevant to all students/workers and organizations.

Skills for different kinds of innovation

Organizations involved in new technology or product development indicate greater need for broad and specific technical skills - such as scientific principles and methods and myriad advanced data and digital skills - while those engaged in process or service innovations indicate greater need for broad design thinking and experimentation skills. Although employers involved in technology development and product innovations emphasize the importance of prototyping and testing skills. To be sure, the different technical skills required in different kinds of innovation is more a matter of emphasis than a dichotomous required/not required. Moreover, there is less variation in emphasis on complementary skills across different kinds of innovation - such as critical thinking, judgement, curiosity, and writing. Still, students and workers who want to be involved in specific kinds of innovation - or who want to be employed by organizations who emphasize some kinds of innovation over others - will want to emphasize development of certain technical skills over others.

Skills for different stages and activities

Generally speaking, organizations whose innovation projects are at the problem identification and exploration stage are more likely to need critical thinking and creativity skills, as well as certain social and emotional skills, while those whose innovation projects are at the solutions design, building and testing stage are more likely to need science and engineering skills. This tracks a general distinction between skills needed to collect and analyze information about problems and opportunities – i.e., diagnostic skills – and skills to build solutions – i.e., design and engineering skills. In many cases, good engineering/design will require good diagnostic skills in the same person – in which case the differences in skills needed for different stages does not imply that distinct individuals should develop subsets of skills. Rather, it implies only that people and teams likely require different skills at different stages, which could have management implications but not necessarily skills development implications.

Innovation management

Innovation happens in teams, and not every member of the team needs to possess every skill required for the team as a whole to succeed. This is clear in the case of management skills. The organizations we surveyed consistently cited a range of management skills as very important to their innovation activities - including project management, team management, and financial management - but not important for their entry-level Mitacs interns to possess.

Much has been written about the importance of management to innovation, and about Canada's challenges in these areas, leading some observers to conclude that innovation management ought to have a more prominent place in training and educating future managers. Our findings suggest this recommendation should be nuanced in two ways: First, while management is critical, not every future innovator needs to become a management expert. We should be careful not to insert management training into every future innovator's education and training experience. Second, management responsibilities appear to rest mainly with those with experience rather than with new employees and teammates. We should be careful, then, not to assume that management education - even for those specializing in management functions - will be sufficient to take on innovation management roles.

Recommendations

The insights from the survey and subsequent analysis lead us to a set of recommendations for employers, students and workers, skills training and development organizations, and researchers examining skills for innovation. Because this report is the first in an ongoing series, we expect that these recommendations will evolve and be refined as new insights emerge. Still, there are some actions that stakeholders can take now to improve Canada's talent advantage for innovation.

Recommendations for employers

1 Systematically identify the general and specialized skills required for the specific kinds of innovation and innovative activities pursued by the organization.

- Different innovation types, stages, and activities require different specialized skills. In consultation with current employees, organizations should closely audit their innovation activities and the skills needed to execute them successfully.
- General skills are critical but often overlooked. Employers should complement their focus on specialized skills by identifying the general skills needed for innovation, including basic data and digital skills, research skills, knowledge of scientific principles, and certain social and emotional skills, such as collaboration, listening, communication, and responsibility.

2 Create skills recruitment, development, and procurement strategies that ensure necessary specialized and general skills for innovation are available as needed.

- Some required skills can be found through recruitment processes, while others can be developed among existing employees. After identifying exactly the specialized and general skills needed for innovation in the organization, employers should review existing hiring and recruitment practices to ensure they are effectively sourcing candidates with the requisite skills.
- Employers should also invest in skills training and development for both new and current employees. Because innovation tools and techniques change over time, and no employee has all the required skills at any given time, strategies for continuous learning and skills development are critical.

3 Take a team-focused approach to recruiting for, developing, and procuring skills for innovation.

- Innovation teams require a wide variety of specialized skills, but not all members of a team require or have all the specialized skills. Employers should distinguish between skills that are required on the team, but not by every member of the team - such as financial management, advanced coding, or specialized sales - and skills that are required by every member on the team - such as communication, teamwork, and project management skills.

Recommendations for students and workers

4 Systematically identify the specialized and general skills required for the kinds of innovation pursued by those industries and employers with whom you hope to work.

- Different innovation types, stages, and activities require different specialized skills. Students and workers should think about exactly what kinds of innovation they want to contribute to and the skills that will be needed to do so successfully.

- General skills are critical but often overlooked. Students and workers should complement their focus on specialized skills with a focus on general skills, including basic data and digital skills, research skills, knowledge of scientific principles, and certain social and emotional skills, such as collaboration, listening, communication, and responsibility.

5 Create a skills development plan that ensures you will have the necessary specialized and general skills required for innovation.

- A skills development plan will identify the skills required in the short, medium and long term, and consider practical ways to acquire them.
-

Recommendations for skills development organizations

6 Build and/or identify skills development opportunities, courses, and teaching materials that distinguish among specialized and general innovation skills needs.

- All students/workers will require general skills to contribute to innovation and development opportunities and should provide these. But because different specialized skills are required for different kinds and stages of innovation, students/workers should also have streamed skills development paths.
- Work with employers, post-secondary institutions, and other training providers to develop skills upgrading and training programs to meet employer and student needs.

7 Assist employers in identifying and articulating the innovation skills required in different industries, roles, and kinds of innovation.

8 Assist students/workers in developing precise and practical innovation skills development plans that focus on both specialized and general innovation skills requirements.

9 Ensure that the language used to articulate skills aligns with the language used by employers.

- For example, while employers recognize that certain social and emotional skills are essential, few appear to use the specific phrase "social and emotional skills" to describe those skills. In that case, resumes, course descriptions, and other skills signalling materials that use terms like "social and emotional skills" might fail to resonate with employers even as the skills they are attempting to signal are, in fact, important to employers.

Recommendations for researchers

10 Collect and analyze innovation skills data from more and different kinds of employers to enhance understanding of the specialized and general skills required for innovation.

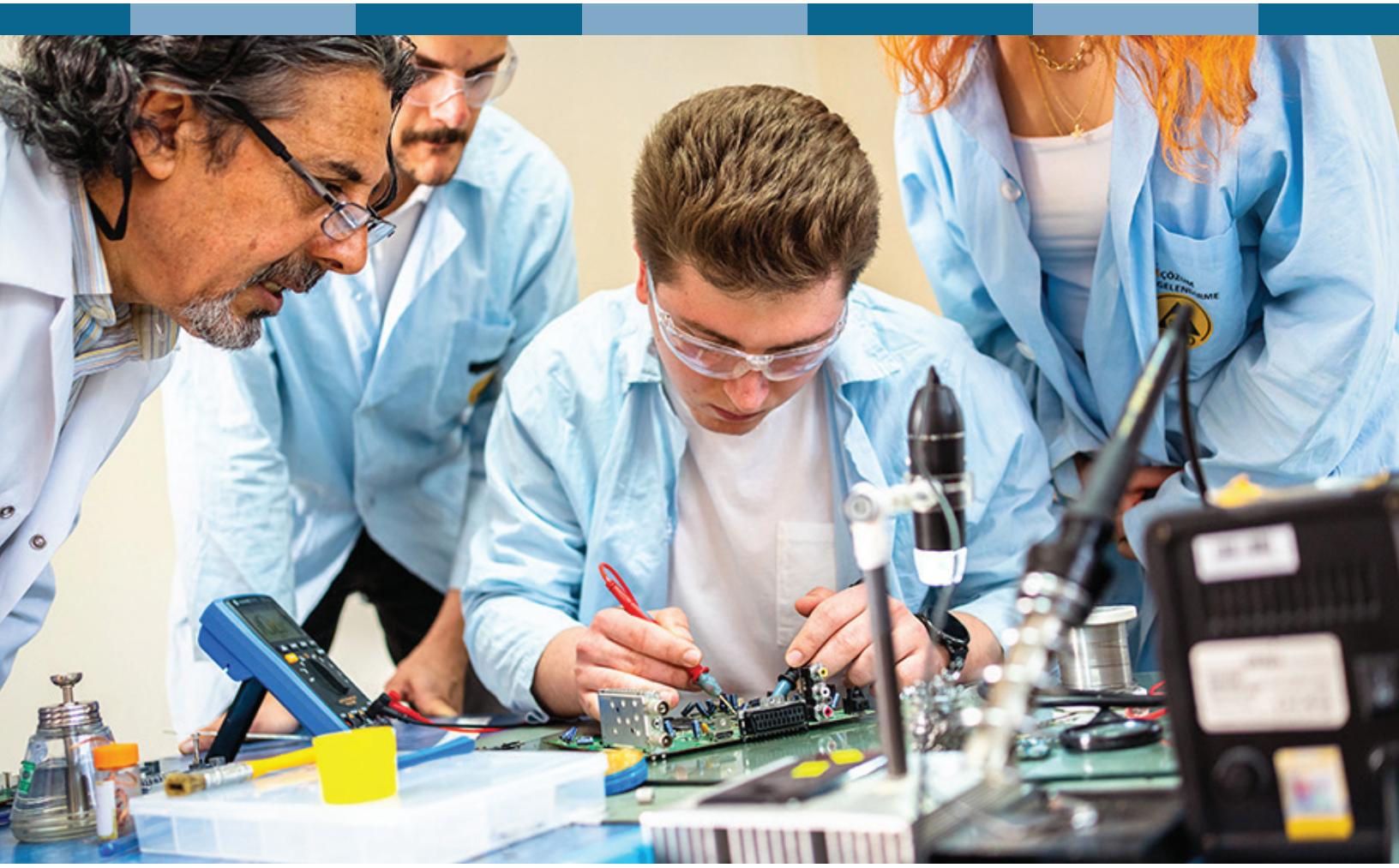
- There is a growing awareness of the kinds of skills needed for innovation in STEM fields and industries, but less is known about the innovation skills needed in social science and humanities (SSH) fields and industries, as well as industries that operate at the intersection of STEM and SSH.

11 To more precisely identify the specialized and general skills used in innovation, develop and execute more direct observational studies to complement survey-based studies.

- Organizations tend to know what they are doing and what they need, but not always how to clearly articulate what they are doing and what they need. Observational studies would allow researchers to see what skills are used even if organizations and workers are not aware – or not able to articulate – that they are using them.

Skills plans for innovation success

The main contribution of this report is a clearer, more granular view about the skills required for innovation. Innovation is about generating value through the application of new ideas and knowledge, but this can be done in different ways, in different contexts, and with different activities performed at different stages. Moreover, innovation is a team sport, not an individual event. In that case, while there are general skills that all innovators require, there are also specialized skills that some, but not all, innovation team members require to be used in different kinds and at different stages of innovation. By offering clarity about the general and specialized skills involved in innovation - and indicating their practical importance among organizations and self-reported confidence in those skills among interns - the report provides a foundation for better innovation skills development plans.



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Appendix A

High-level skills categories	Specific skills
Engineering	Aerospace engineering
	Automotive engineering
	Biological engineering
	Biomedical engineering
	Chemical engineering
	Civil or environmental engineering
	Communications engineering
	Electrical/electronic engineering
	Mechanical engineering
	Other
Science	Materials science
	Scientific principles and methods
	Mathematics and statistics
	Brain and cognitive science
	Biology
	Chemistry
	Biochemistry
	Microbiology
	Computer science
	Earth, atmospheric, and planetary science
	Physics
	Other
Digital and Technology (e.g., software use; programming; machining/CAD)	Productivity software (e.g. Microsoft Office)
	Basic data (e.g. spreadsheets/ analysis/ visualization)
	Advanced data (e.g. modelling, machine learning)
	Programming and software
	Web development/ design
	Graphic design/ illustration
	Machining/ manufacturing tech (e.g. CNC, CAD)
	Other
Qualitative Research (e.g., interviews, case studies)	Case studies
	Interviews
	Literature review
	Other
Design Thinking and Experimentation	Problem identification
	Solutions design
	Prototyping and testing
	Other

Appendix A (continued)

High-level skills categories	Specific skills
Sales and marketing	Sales
	Marketing
Management	Project management
	Team management
	Finance/ financial management
	Strategy/planning
Social, Emotional and Communication	Networking and relationship building
	Collaboration + teamwork
	Presenting
	Listening
	Writing
	Responsibility
	Empathy
	Tolerance
	Emotional control
Critical Thinking and Creativity	Critical thinking/problem-solving
	Creativity
	Curiosity
	Judgment and decision-making
	Risk assessment + risk taking
Policy and Legal Analysis	Policy analysis
	Legal analysis