# Built to Scale?

## Microcredentials Use Among Digital Professionals

Graham Dobbs, Ibrahim Abuallail, Angus Lockhart | October 2023

Toronto Metropolitan University

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# Acknowledgements


The Dais is Canada's platform for bold policies and better leaders. We are a public policy and leadership think tank at Toronto Metropolitan University, connecting people to the ideas and power we need to build a more inclusive, innovative, prosperous Canada.

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Graph data, as well as the online Appendix in this report, can be found at: **https://github.com/thedaisTMU/Microcredentials**


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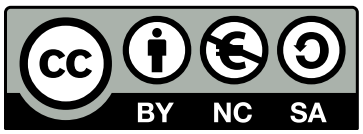




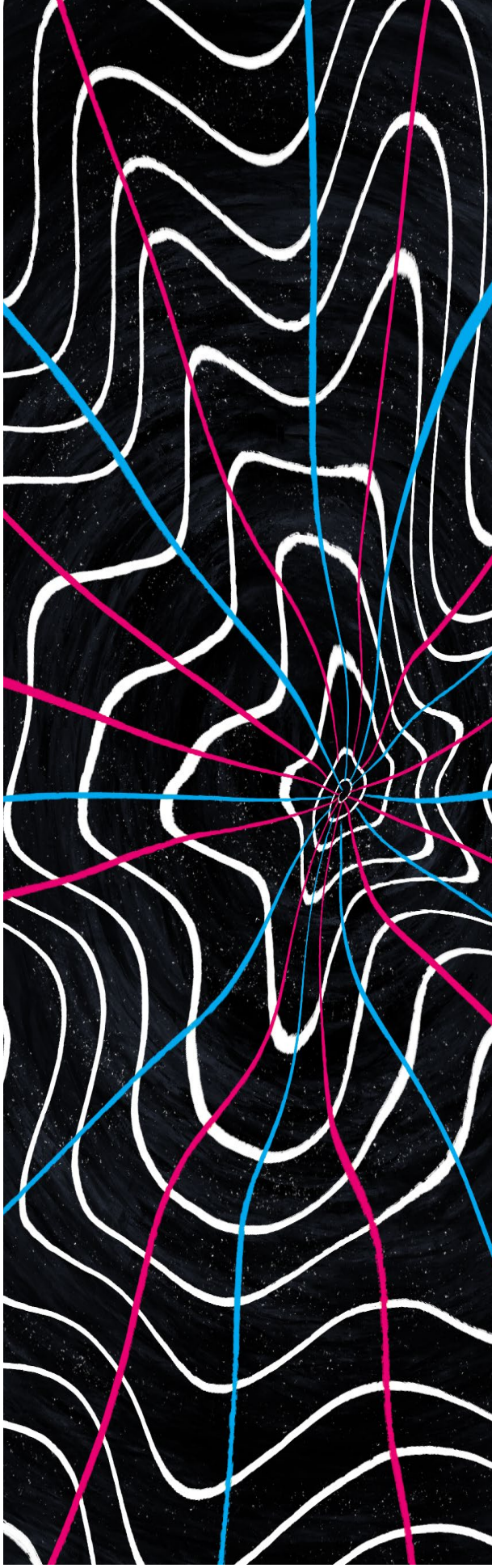

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# Foreword by the Future Skills Centre

In an era defined by rapid technological advancements, the pursuit of knowledge has taken on a dynamic and ever-evolving form. The landscape of education and professional development is shifting, and in this context, microcredentials have emerged as a potential tool for transformation. This research, "Built to Scale: Assessing Microcredentials for Digital Sector Professionals," delves deep into microcredentials, shedding light on their potential significance and implications for policymakers, educators, and professionals alike.

Microcredentials have the potential to be more than mere tokens; they may become powerful instruments that empower individuals from diverse educational backgrounds to hone distinctive and valuable sets of skills and knowledge. This is one of the core appeals – to support inclusive pathways for individuals to reskill and upskill, thereby enabling them to remain agile and adaptive in a rapidly evolving job market.

This research leverages a rich – albeit specific – dataset to explore questions about the use and value of microcredentials. It seeks to uncover how microcredentials can effectively communicate skills to potential employers, their significance in career advancement pathways and the recognition they receive from employers. FSC is keenly committed to exploring these questions and the insights shared in this report will start to inform our collective understanding of the ways in which microcredentials can realize their potential impact, fostering broader recognition of existing skills and targeted acquisition of new skills.

For policymakers and education leaders, this report offers initial insights in how microcredentials figure into the skill development landscape. It calls for a reevaluation of educational fields and attainment, not as barriers but as strategic entry points for acquiring competencies that are vital for the future of work. We know that the pathways to opportunity in the future of work will necessitate us solving these complex skill challenges, and microcredentials are likely to figure prominently in the road ahead.

**Tricia Williams**
Director of Research, Evaluation and Knowledge Mobilization
Future Skills Centre

# 1 Executive Summary

In response to the rapid pace of digitization of the economy, evolving labour market, and changing employer skills demands, public universities, colleges and a litany of for-profit education and training providers are racing to roll out new programs to equip students and workers with in-demand digital skills. In recent years, new types of credentials have emerged. In contrast to comprehensive university or college degree or diploma programs that require substantial time and financial commitments, these credentials are short in duration, tend to focus on a particular skill, and are often comparatively affordable. Alternative credentials, in particular microcredentials, have become a major priority for policymakers, post-secondary institutions and employers, viewed as a solution to upskill, retrain, or formalize competency-based learning.

Given the rapidly changing technical tools and products of the technology economy, microcredentials have potential to support the development of digitally intensive skills and workers. Using a novel labour market information source through LinkedIn profile data, this report assesses the current uptake of microcredentials in two digitally-intensive occupations: data scientists and software professionals. We compare those who have completed microcredentials with those who have not across experience levels, skills profiles, educational attainment, and other characteristics. The report's findings inform both higher education and workforce practitioners who are building microcredentials, and policymakers seeking to understand and support this new form of learning and upskilling.

The study finds that professionals that report microcredentials on their LinkedIn profiles:

- **Represent a small minority of professionals in the two digital occupations,** accounting for just 3.4 percent of data scientists and 3.2 percent of software professionals.
- **Tend to have more professional experience** (i.e., more than five years).
- **Are more likely to list skills, tools, and technologies that are more recent,** such as machine learning, compared to those without, and less likely to list broad knowledge areas such as "software development" and "computer science".
- **More commonly have educational backgrounds outside of STEM fields of study,** in the Business, Humanities, Health, Arts, Social Sciences, and Education (BHASE) fields.
- **Are more than twice as likely to hold an MBA,** the largest difference among types of credentials attained.
- **Report no meaningful differences in their job titles, seniority levels, or industry of employment,** including ICT industries specifically.

Despite the low uptake of microcredentials among the two digital occupations, this study reinforces the thinking that these shorter credentials are being used as an upskilling tool for professionals established in their careers, complementary to existing credentials they hold. Though caution is warranted in extrapolating to other occupations and fields of study, the findings suggest that microcredentials are more often held by digital professionals with non-STEM educational credentials (such as MBAs), potentially as a way to develop complementary digital skills and/or to signal those skills to employers. University degrees develop broadly applicable knowledge, while microcredentials allow a worker to demonstrate competency in a specific skill, application, or technology tool that can leverage the knowledge gained through the university degree.

We offer the following policy recommendations and suggestions for future research:

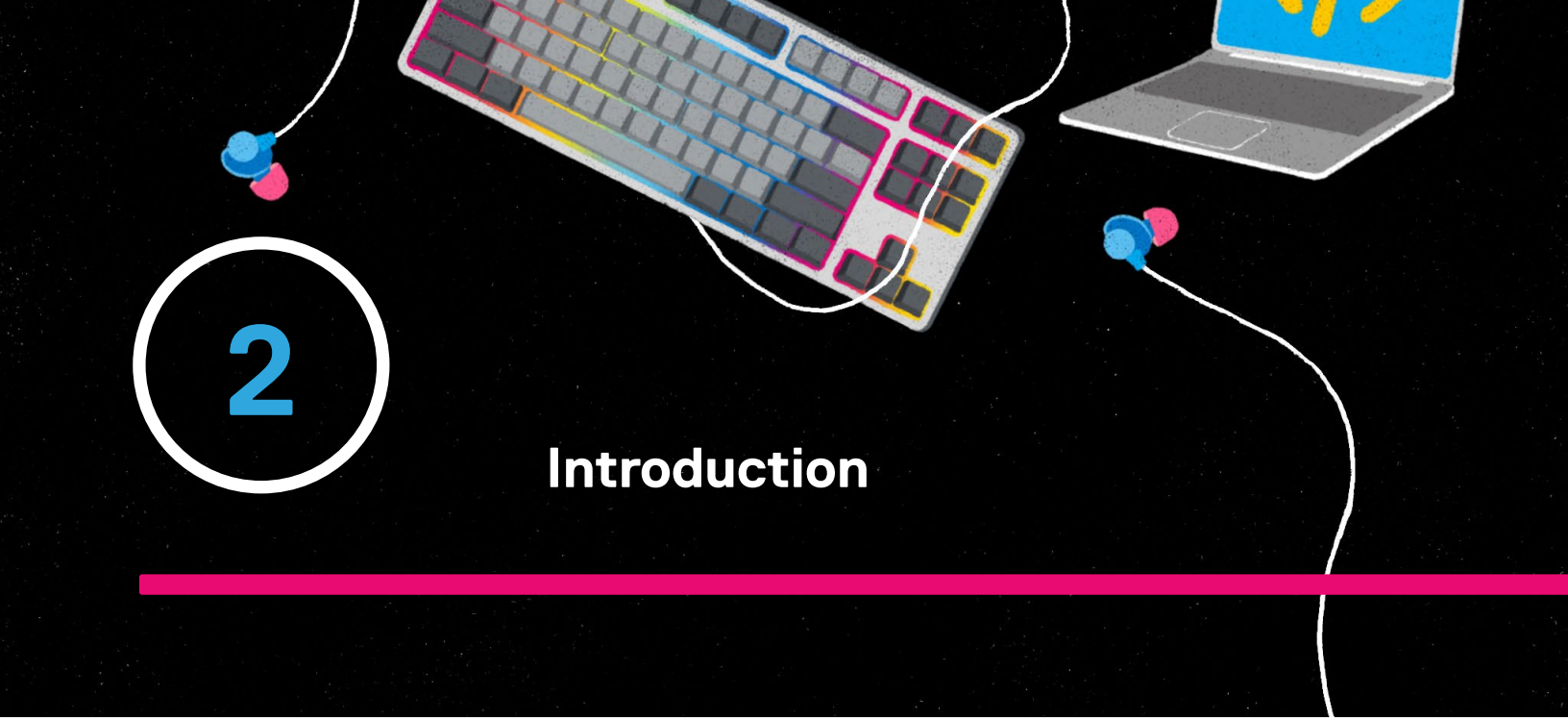
**Better data sources are required to assess the use and value of microcredentials.** Future approaches could explore how private data sources like LinkedIn profiles can be used in conjunction with public data sources collected by Statistics Canada in ways that preserve and protect privacy to improve labour market analysis.

**Quality assurance of microcredentials in Canada should be a priority for education leaders and policymakers.** While these new alternative credentials hold promise, the absence of common definitions and quality frameworks across Canada limit their growth potential for learners and employers—the ultimate arbiters of microcredential value.

**Further research should extend this analysis to adjacent occupations and fields of study.** While this study focused on specific digitally-intensive roles (given that the data from online job platforms is most relevant for digitally intensive careers), several adjacent roles can be examined.

**Further research should explore the benefits of microcredentials to different populations and learners.** A critical study would be to dive deeper into the general applicability of microcredentials and their impacts on specific demographic groups.

In conclusion, this study pioneers a novel source of Canadian labour market information and underscores the potential of microcredentials as a complementary tool for career development. Rather than replacing traditional degrees, microcredentials can augment Canada's existing educational infrastructure. However, addressing data limitations and quality assurance challenges will be essential to fulfilling their potential for digital skill adoption. As the digital landscape evolves, microcredentials offer a promising path forward for Canada's education institutions, helping professionals stay competitive and adaptable in an ever-changing digital world.



# 2 Introduction

In response to the rapid pace of digitization of the economy, the evolving labour market, and changing employer skills demands, public universities, colleges and a litany of for-profit education and training providers are racing to roll out new programs to equip students and workers that directly address labour market needs. Microcredential providers typically promise applied curriculum, convenient hybrid or online learning platforms, and outcomes that include higher wages and career advancement opportunities. A particular focus has been responding to the need for digital skills in software development, data science, and artificial intelligence, among others, to respond to industry demands. Yet for Canadian learners and upskilling workers (and, indeed, government funders), there is still significant uncertainty about this new marketplace of programs and their effect on learning pathways, skills development, and career trajectories.

In recent years, new types of credentials have emerged. In contrast to comprehensive university degrees, or college degree or diploma programs that require substantial time and financial commitments, these credentials are short in duration, tend to focus on a particular skill, and are often comparatively affordable. These alternative credentials, in particular microcredentials, have become a major priority for policymakers, post-secondary institutions, and employers, viewed as a novel solution to upskill, retrain, or formalize competency-based learning.[1] While some provinces[2] [3] and institutions have introduced microcredential frameworks, Canada still lacks a standardized definition and quality assurance framework for this new category of credentials. Consequently, the debate continues about how microcredentials are categorized within the extensive postsecondary-credentials universe, and their overall value and outcomes for learners and the labour market.

Given the rapidly changing technical tools and products of the technology economy, microcredentials have strong potential to support the development of digitally intensive skills and workers. The supply of digitally-intensive labour is a relatively new market and fast-moving industry for skill and concept adoption. Microcredentials could be both a time- and cost-effective option for professionals trying to adapt to a constantly shifting demand for new skills and technologies. Using a novel labour market information (LMI) source, this report assesses the current uptake of microcredentials within digitally-intensive industries in Canada and the profile and career trajectories of those who earn microcredentials in the tech labour market. The findings should be important to inform both higher education and workforce practitioners building microcredentials and policymakers seeking to support this new form of learning and upskilling.

# 3 Microcredentials in Context

## Summary

Microcredentials have gained attention in their emergence to address the evolving needs of the labour market and provide learners with targeted skills and competencies. In this section, we scan existing research on microcredentials, exploring the labour market impacts and implications for microcredential policy. We focus our search on English-language studies, and include grey literature and non-peer-reviewed journal articles. The studies provide insights into the benefits, challenges, and potential impacts of microcredentials on workforce development and employability.

The literature review finds that these credentials offer potential solutions to the rapidly evolving digital economy's challenges. Microcredentials may enhance labour market value for workers who hold them, provide support for lifelong learning and retraining, and shape employer perceptions of skill competency. The studies also provide glimpses into the future of microcredentials, which offer the potential to bridge skill gaps, help learners adapt to emerging job roles, and support employers to embrace competency-based hiring. Despite these opportunities, challenges and gaps remain, necessitating further research and evaluation to fully harness the potential of microcredentials in transforming the landscape of digital labour markets.

**Microcredentials may enhance labour market value for workers who hold them, provide support for lifelong learning and retraining, and shape employer perceptions of skill competency. Despite these opportunities, challenges and gaps remain, necessitating further research and evaluation to fully harness the potential of microcredentials in transforming the landscape of digital labour markets.**

# Microcredentials in the Canadian education and skills development system

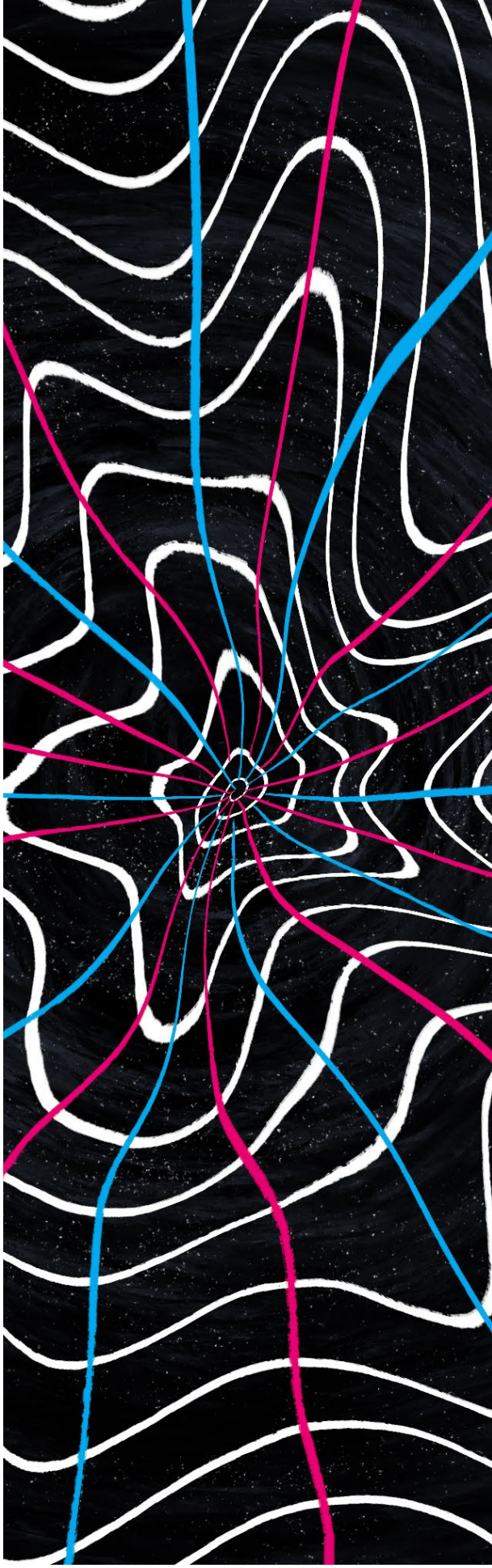
Investments in education are widely recognized as one of the critical drivers of societal progress and economic growth. Years of research have established a link between education (seen as an investment in human capital) and income growth.[4] Furthermore, studies have shown that human and non-human capital investments account for an overwhelming proportion of postwar growth in the United States.[5] Research linking education and economic growth have typically used postsecondary credentials (such as a bachelor's degree) as the measure of educational attainment. An important debate has centred on the function of formal credentials, and whether they accurately reflect knowledge and skills acquisition, or represent a way to signal one's abilities to employers or within society.[6] Without delving into this debate, the practical assumption is that credentials likely do both.

This report looks to identify microcredential holders in highly technical digital occupations, to better understand the competencies they seek to acquire and signal to employers, and how they fare relative to the rest of the professionals in these occupations. In scanning the literature, a systematic review of microcredentials in higher education, conducted in the US, reaffirms their early stage of development.[7] The review found only two empirical studies, published in 2020 and 2021. Its major conclusions were that challenges remain with microcredentials, and that they should primarily be a complement to traditional higher education programs, rather than a replacement. Still, despite the limited academic research and evaluation, microcredentials have attracted attention from governments and international organizations; some countries include them in their national qualification frameworks.[8] In Canada, a number of education and skills institutions and research centres have undertaken analysis of microcredentials. The Future Skills Centre identifies microcredentials as quick training programs that rapidly develop specific skills,demonstrating certified competency upon completion.[9] They highlight that, while Canadian postsecondary institutions are increasingly offering microcredentials via online courses geared to addressing lifelong learning and career advancement goals, employers need to become more familiar with these credentials. An adjacent report from the Diversity Institute finds microcredentials have the potential to bridge skills gaps and address future labour market needs in Canada.[10] However, their nascency presents challenges in widespread adoption. The authors of these studies find microcredentials are valued for workplace-related skills, agility, flexibility, and collaborative development. Their recommendations aim to advance micro-credential adoption, enhance their value, and strengthen collaboration within the ecosystem.

Colleges and Institutes Canada (CICan) conducted a scan to define and understand the landscape of microcredentials in Canada.[11] This report briefly examines international microcredential trends and explores Canada's microcredential developments and research initiatives. They suggest microcredentials can address demand for upskilling and reskilling in the Canadian labour market, in response to technological changes and pandemic-induced job losses. They call for collaboration to establish a national consensus on microcredential characteristics.

Higher Education Strategy Associates (HESA), a consultancy based in Toronto, reports that integrating microcredentials in Ontario is hindered by the existing education system's inability to integrate these credentials into degrees and diplomas, especially when earned from different institutions.[12] This limitation reduces their value in a labour market that primarily recognizes diplomas and degrees. The issue stems from a need for standardized, verifiable information about the learning outcomes of micro-credentials. This lack of data makes it challenging for learners seeking advanced standing in a degree or diploma, resulting in high information costs. The study proposes solutions, including providers transparently stating the industry value of micro-credentials, third-party assessments, and creating a provincial bank of assessments to address the integration problem.

At the provincial level, a survey conducted by the Higher Education Quality Council of Ontario (HEQCO), found that 75 percent of respondents displayed interest in this type of professional development.[13] The study highlighted that awareness and understanding of microcredentials were limited across all groups surveyed. Employers expressed uncertainty about the term itself, while prospective students sought affordability and employer recognition. The report recommended that institutions emphasize the alignment of microcredentials with quality markers, including stackability, flexibility, assessment, accreditation, and standardization. Another study led by the Northern Alberta Institute of Technology (NAIT), in collaboration with Bow Valley College (BVC) and the Southern Alberta Institute of Technology (SAIT), employs grounded theory to understand the value of microcredentials among Alberta employers and individuals (earners) compared to traditional credentials.[14] They similarly find that awareness needs to improve, and propose measures to enhance adoption including targeted marketing and leveraging standardizing microcredential metadata to address employer concerns.



# Labour market impact and equity considerations

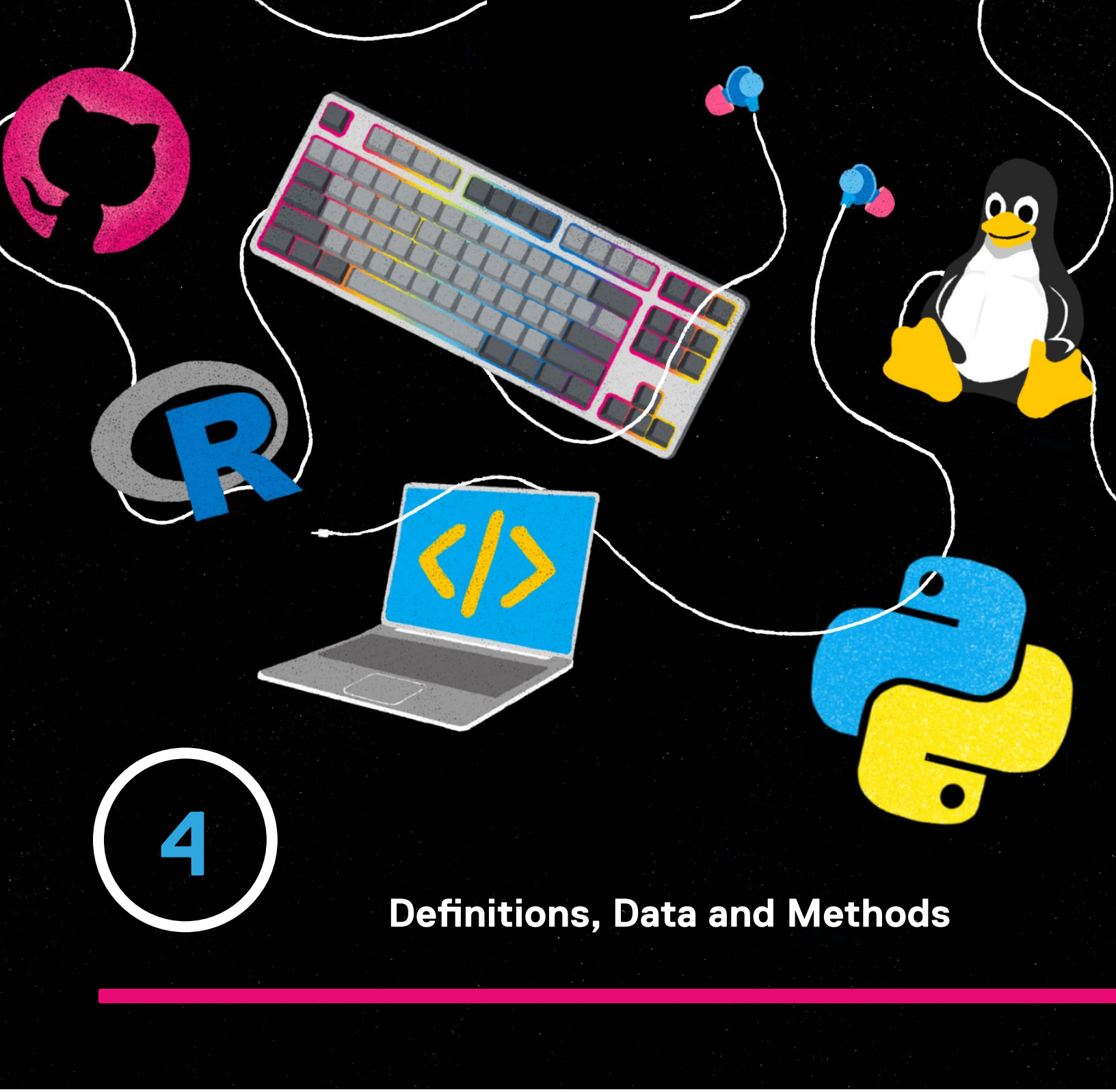
Frenette & Handler have conducted the only notable empirical study in Canada to date, exploring the impacts of short post-secondary education programs following job loss. After a permanent layoff, workers often face financial challenges, with research consistently revealing that post-layoff earnings decline sharply and remain below pre-layoff levels for years.[15] To address this, some invest in education before rejoining the workforce. However, recent evidence shows that only a small number of laid-off workers enroll in post-secondary education, often choosing short-term, career-focused programs or taking individual credits. The findings indicate that individuals who obtained college or CEGEP certificates or diplomas after a layoff experienced substantial increases in annual earnings, particularly those in STEM or healthcare fields. In contrast, non-STEM programs or microcredential graduates experienced no earnings gains.

There has been more research in other jurisdictions. A Brookings Institution report sheds light on several insights about FastForward programs in Virginia.[16] These programs attract a diverse student population, including more Black students, males, and older individuals. Enrollment patterns between FastForward non-credit and credit-bearing programs are distinct, with limited student flow from non-credit to credit programs. Despite this finding, completion rates and industry credential attainment in FastForward programs are high. The unique attributes of non-credit continuing education programs, such as their diverse enrollment and high completion rates, suggest that they provide an alternative pathway to skills and workforce opportunities for traditionally underrepresented populations.

A Columbia University study investigates the labour market returns of stackable credentials in the United States, analyzing various data sets and applying novel empirical approaches due to the scarcity of data.[17] The findings suggest that while the earnings gains for degrees are robust and certificates generally yield positive results, there needs to be clear evidence of the specific earnings gains from stacking these credentials. Additionally, the report notes combining traditional degrees and microcredentials can provide a synergistic effect, complementing each other to better prepare individuals for the labour market. The future value of stackable credentials may increase as labour market trends shift toward a more educated workforce, providing opportunities for marginalized workers to augment their skills.

A study by the Lumina Foundation finds that a majority of Americans aged 25 to 64 lack qualifications beyond high school, limiting their job prospects.[18] This report explores outcomes for adults who secure non-degree post-secondary credentials, like certificates, within two years. Drawing from seven studies involving 49 community and technical colleges, the findings reveal that such credentials enhance employment prospects and, to a lesser extent, earnings. Across data sets, holding a non-degree credential corresponds to a 5 to 15 percent higher employment likelihood. Even brief credentials (under six months) yield a four to seven percent employment boost. The report recommends integrating short-term credentials into longer pathways and revising financial aid programs accordingly.

In the United Kingdom, a report from Oxford University examines the impact of digital microcredentials on worker earnings in an online tasked-based labour market.[19] The study finds that acquiring additional microcredentials leads to an average earnings increase of 8.9 percent. The most plausible explanation is that microcredentials reduce employers' uncertainty about worker abilities, therefore demonstrating microcredential completion provides a signalling effect for employers. The research rules out alternative explanations, such as worker productivity or effort changes. The study emphasizes the potential for microcredentials to aid skilled individuals facing discrimination in the labour market or help match skills to rapidly changing demands.



# 4 Definitions, Data and Methods

## Defining microcredentials in Canada

While some provinces (British Columbia, Ontario) and other jurisdictions (New Zealand, Singapore) have proposed or established quality assurance frameworks for microcredentials, or regulated them as qualifications within their post-secondary system, its important to note that microcredentials are not universally defined, recognized, or standardized educational credentials in Canada or internationally. Table 1 lists several international and Canadian definitions of microcredentials.

## Table 1

| Source | Definition |
|---|---|
| **Future Skills Centre** | Focused certification issued by a recognized institution conferring some measure of competence in a given area. |
| **Colleges & Institutes Canada** | Certification of assessed competencies that is additional, alternate, complementary to, or a component of a formal qualification. |
| **eCampusOntario** | Certification of assessed learning associated with a specific and relevant skill or competency. Microcredentials enable rapid retraining and augment traditional education through pathways into regular postsecondary programming. |
| **British Columbia Ministry of Advanced Education and Skills Training** | Microcredentials recognize stand-alone, short duration learning experiences that are competency-based, align with industry, employer, community and/or Indigenous community needs and can be assessed and recognized for employment or learning purposes. |
| **Higher Education Quality Council of Ontario** | A microcredential is a representation of learning, awarded for completion of a short program that is focused on a discrete set of competencies (i.e., skills, knowledge, attributes), and is sometimes related to other credentials. |
| **New Zealand** | A microcredential certifies achievement of a coherent set of skills and knowledge; and is specified by a statement of purpose, learning outcomes, and strong evidence of need by industry, employers, and/or the community. They are smaller than a qualification and focus on skill development opportunities not currently catered for in the regulated tertiary education system. |
| **European Commission** | A microcredential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Microcredentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards. |
| **The United Nations Educational, Scientific and Cultural Organization** | A microcredential is a record of focused learning achievement verifying what the learner knows, understands or can do, includes assessment based on clearly defined standards and is awarded by a trusted provider, has standalone value and may also contribute to or complement other microcredentials or macrocredentials, including through recognition of prior learning, and meets the standards required by relevant quality assurance. |
| **National Education Association** | A microcredential is a short, competency-based recognition that allows an educator to demonstrate mastery in a particular area. |

Despite the variability and inconsistency in these microcredential definitions, they commonly include the following themes and characteristics:

- Short duration
- Emphasis on skill or competency development[20]
- Stackability with other microcredentials (or other alternative credentials)
- Recognition, validation, and portability of the microcredential to other institutions or with conventional credentials
- Mode of delivery often incorporating an online or hybrid component
- Assessment for demonstrating achievement of the skill or competency
- Partner endorsement, typically by employers or industry

**For purposes of this study, reflecting the characteristics and limitations of the available dataset (to be described below), we define microcredentials as:**

- Offered by Canadian public and private providers, and global education platform (e.g., Coursera, edX), as programs that do not confer academic credit
- Delivered through either hybrid or online program models
- Less than 12 weeks of full-time study in duration
- Developing competencies in skills, tools and technologies

Microcredential programs were identified in the LinkedIn profile data based on extensive manual review of skills and competencies offered by program providers (see Table B for full identified list). The next section describes the methodological rationale for this approach.

# Defining digital sector professionals

In this study, we focus on two occupational groups: data scientists (NOC 21211) and software professionals (which combines Software Engineers and Designers (23231) and Software Developers and Programmers (23232). These occupations are relatively under-studied and rapidly changing occupations in the current labour market climate. We combine software engineers and designers with developers and programmers for a number of reasons:

1. The tasks and responsibilities of these occupations are fairly close, and it is hard to decompose this at the level of job titles.
2. O*NET only has one occupation, Software Engineer, which makes skills comparisons smoother.
3. Combining both occupations allows a better representation of the total supply for the software labour market and is less comparable to web and computer developers.

We compare professionals within these occupations to better understand how microcredential holders are faring in the job market. We identify our study sample groups as follows:

**Table 2**

| Occupation | Definition | Comparison Group |
|---|---|---|
| **Data Scientists (NOC 21211)** | Professionals who hold microcredential(s) | Professionals without microcredentials |
| **Software Professionals (NOC 23231 & 23232)** | Professionals who hold microcredential(s) | Professionals without microcredentials |

This report's focus on data science and software professionals is motivated by the coverage of job data for those roles and the frequency of microcredentials used in these positions. Official statistics tend to have particular trouble capturing emerging occupations, as occupational taxonomy used by the government prioritizes long-term consistency in the definition that allows for longitudinal analysis of the labour market. As a result, occupational classifications such as the National Occupational Classification (NOC) used by most researchers and governments in Canada often do not capture occupational dynamics that have only recently emerged. Until the most recent (2021) version of the NOC, Data Scientist and Software Developers/Programmers was added as a distinct occupational group from the 2016 NOC classification.

Data for this study was accessed through LinkedIn Talent Insights (LTI), a data visualization and aggregation platform for LinkedIn profile data that enables researchers and human resource professionals to understand labour market information that is self-reported by LinkedIn users. Job title, industry, skills, years of experience, educational degree and field of study, company, location, and spoken language can stratify aggregate profile data. In essence, LTI enables analysis of labour trends among LinkedIn users.

# Suitability of LinkedIn profile data for labour economics analysis

LinkedIn profiles provide deeper information on professionals' educational, skills, and occupational histories than conventional LMI sources for government surveys and census accounts. This data source is more timely and frequent as it provides near-instant data on reported information from LinkedIn users. It is more accessible as it can aggregate and provide insight into the change in trends among professionals by several factors. Profile data is not weighted and provides accessibility in aggregated table exports. Another interesting factor is that the data taxonomy is uniform across regions and countries, allowing for international trends for workforce research.

Data science and software professionals are rapidly changing occupations in the labour market. The cadence of new skills, technologies and tools for these professions is changing faster than most of the labour market. Combining the demand for these professionals, rapidly changing skills, and representation on online job platforms, LinkedIn profile data may provide a new way of understanding trends in the digital labour market. Given the integration between the sector and job platforms, workers in data science or software engineering are highly likely to include any digital skills and credentials.

There are limitations to using self-reported data, particularly for research,[21] [22] as it has been shown that professionals often report false or out-of-date information on social media, resumes and job applications. Despite this limitation, it is important to note that the digital workforce is more likely to accurately represent themselves on online job platforms from an education, occupation, and skills-based approach.[23] A 2019 report by LMIC finds that almost 80 percent of regional online job postings for natural and applied science occupations are representative of job vacancies from public data sources. With these two findings in mind, we infer that professionals and employers leveraging the platform for job opportunities and hiring will likely self-report their career experience reasonably accurately.

# Extracting LinkedIn profile data using the LinkedIn Talent Insights platform

We use LTI, a query-based data access point, to extract our data. It has boolean filters for job title, location, skills, education, and years of experience, amongst other worker attributes. We extracted our data by identifying the total population of professionals within the two occupation groups of interest (using a list of job titles as described above). We then extracted those professionals in those occupations who report holding a microcredential and analyzed the data.

We restrict the sample to be new entrants of the labour market to those with up to fifteen years of experience who live in Canada. In the verification section only, we extend the sample to include those with up to thirty years of experience. To identify microcredential holders, the same filters are selected as the total occupation sample, but we filter for those who report holding a microcredential as a separate sample. We subtract the counts of our professionals who complete microcredentials to remove duplicates from the total occupation sample.

# Verifying LinkedIn data against the 2021 census and O*NET skills data

To test the representativeness of the LinkedIn data versus traditional LMI sources, we compare the LinkedIn profile of data scientists and software professionals by employment counts, education, skills, and wages against other sources of labour market data. Table 3 shows the employment totals of occupations from the LinkedIn profile data at up to fifteen and thirty years of experience and the 2021 Canadian Census of Population total employment and full-time employment totals. LinkedIn profile data closely matches employment counts for data scientists with up to 15 years of experience and software occupations with up to 30 years of experience. Since software occupations have been pervasive over a more extended period, it is expected that Linked profile data counts would be more representative with up to 30 years of experience compared to the census. Data scientists are slightly overrepresented in the LinkedIn profile data as compared to the Census (+3.7 percent). In contrast, software professionals with up to fifteen years experience are underrepresented compared to the Census. Comparing LinkedIn profiles with software professionals with at least 30 years of experience results in a slight overrepresentation as compared to the Census (+4.4 percent). However, if we consider only full-time software professionals, there is insignificant underrepresentation compared to the Census (-1 percent).

**Table 3**

| Employment Counts | 2021 Census Employed Full-time | Total Linkedin (0-15 Years Of Experience) | 2021 Census Total Employed | Total Linkedin (0-30 Years Of Experience) |
|---|---|---|---|---|
| **Data Scientists (NOC 21211)** | 10,500 | 16,000 | 15,420 | 19,500 |
| **Software Professionals (NOCs 21231 + 21232)** | 133,375 | 132,000 | 185,790 | 194,000 |

Table 4 shows the highest level of educational attainment among self-reported LinkedIn data and the 2021 Census professionals at the Bachelor's level or higher. LinkedIn profile data only captures formal education degrees at the three-year post-secondary bachelor's degree or higher. This does not imply that those with less than a bachelor's degree are excluded in the data, but it is not displayed in the LinkedIn Talent Insights platform. Among both professions, LinkedIn profile data include proportionally higher master's degree holders and proportionally fewer with only a bachelor's degree.

**Table 4**

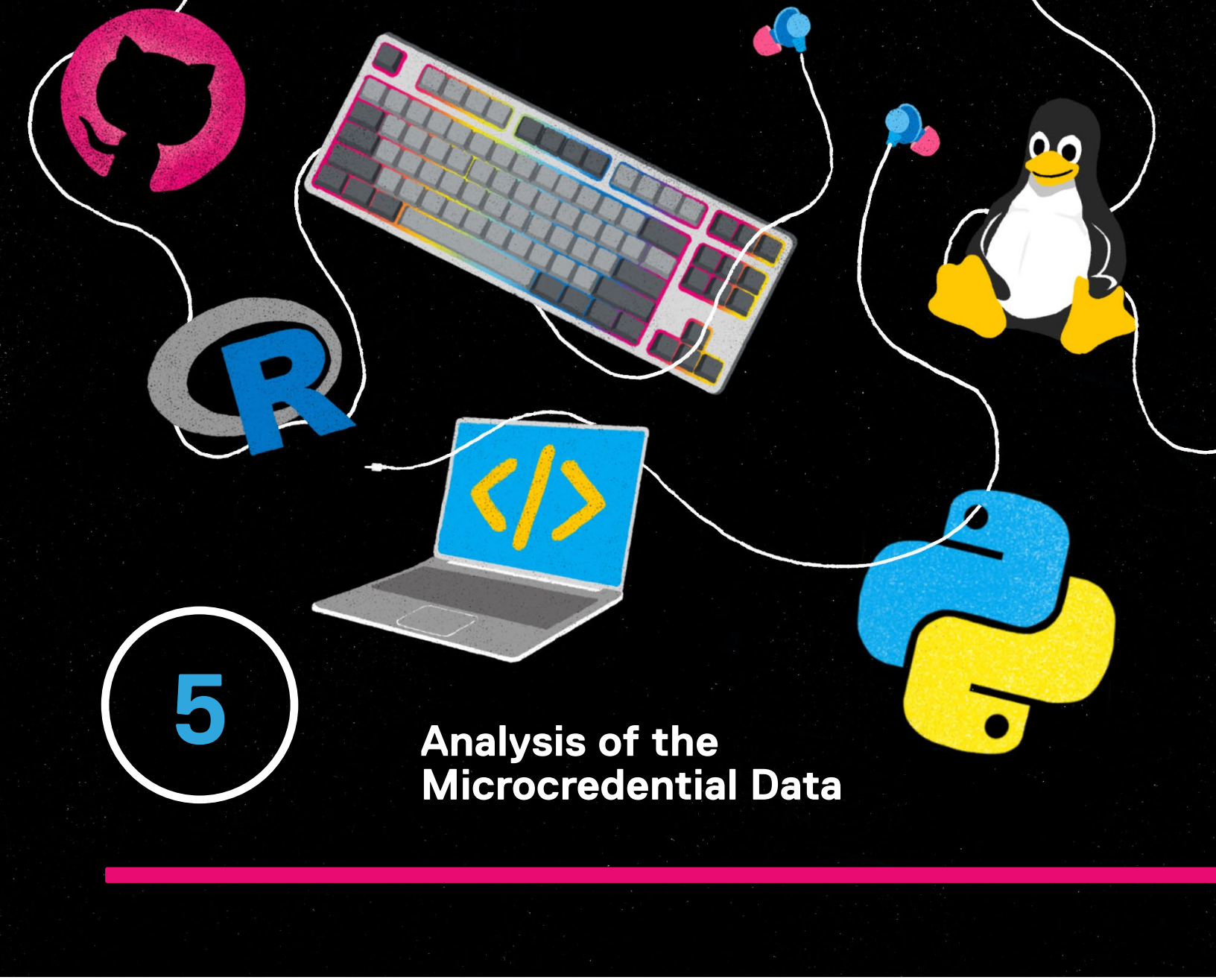
| Highest Educational Attainment (Bachelor's Degree Or Higher) | Data Scientists | | Software Professionals | |
|---|---|---|---|---|
| **Education level** | **LinkedIn** | **Census** | **LinkedIn** | **Census** |
| **Bachelor's degree** | 29% | 38% | 60% | 68% |
| **Master's degree** | 57% | 46% | 38% | 29% |
| **PhD** | 14% | 15% | 2% | 3% |
| **Total** | 100% | 100% | 100% | 100% |

To see more information on skill reporting, please see the Appendix for more details. In summary, our analysis compares the skills among Data Scientists and Software professionals that match the in-demand skills for their respective occupations in O*NET. The LinkedIn profile data rank is based on the percentage of professionals who report this skill on their profile, while the O*NET ranking is based on the percentage of online job postings that mention the skill. For data scientists, 23 of 25 in-demand O*NET skills reported in the top 100 skills in LinkedIn Profile data, only NoSQL (a type of database for large data storage needs) and Microsoft Excel (spreadsheet software) is not reported in the top 100 skills reported by Data Scientists at LinkedIn. For software professionals, 34 of the 35 in-demand skills from O*NET appear for software professionals in LinkedIn profile data. Apache Kafka (a platform for streaming data in real-time) is not reported among the top 100 self-reported skills in LinkedIn profile data. There is also a less similar ranking between skill reporting and online job posting skill mention for software professionals. The limited variability between in-demand O*NET skills and skill reporting by LinkedIn professionals may validate that LinkedIn profile data offers reasonably comparable representation of data scientist and software occupations for the purpose of this study.

Table 5 displays the annual base compensation data scientists and software professionals report among LinkedIn and Census data sources. LinkedIn data scientists report substantially higher wages than the 2021 Census, whereas software professionals report similar wages.

**Table 5**

| Employment Income | Data Scientist | Software Professionals |
|---|---|---|
| **2021 Census** | $89,600 | $97,700 |
| **LinkedIn** | $97,700 | $101,000 |



# 5 Analysis of the Microcredential Data

As noted above, data science occupations have only been reported for about 15 years; therefore, our methodological approach is to segment digital professionals by years of experience across three tiers, to assess differences-based variables including seniority, skills, industry and education. We categorize years of experience as such:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

**0-5 years**
**in occupation**

**6-10 years**
**in occupation**

**11-15 years**
**in occupation**

# Microcredential reporting among digital sector professionals

Table 6 details the proportions of digital sector professionals who hold microcredentials by years of experience. The LinkedIn data indicates that approximately 1 in 29 data scientists (3.4 percent) and 1 in 31 software professionals (3.2 percent) report a microcredential on their profile. Professionals with more experience (six or more years in the occupation) are more likely to report completion of a microcredential.

**Table 6**

| Share Of Professionals Holding Microcredentials By Years Of Experience | Data Scientists Who Report Microcredentials As A Share Of Their Occupation | Software Professionals Who Report Microcredentials As A Share Of Their Occupation |
|---|---|---|
| **Total** | **3.4%** | **3.2%** |
| **Zero to five years** | 2.2% | 2.7% |
| **Six to ten years** | 3.8% | 3.6% |
| **Eleven to fifteen years** | 3.9% | 3.2% |

While overall microcredential uptake appears to be very low today, this data allows for deeper analysis of this group of microcredential holders against their peers. The next section analyzes the differences between data science and software professionals to understand how microcredential holders fare relative to the rest of the professionals in their respective fields.

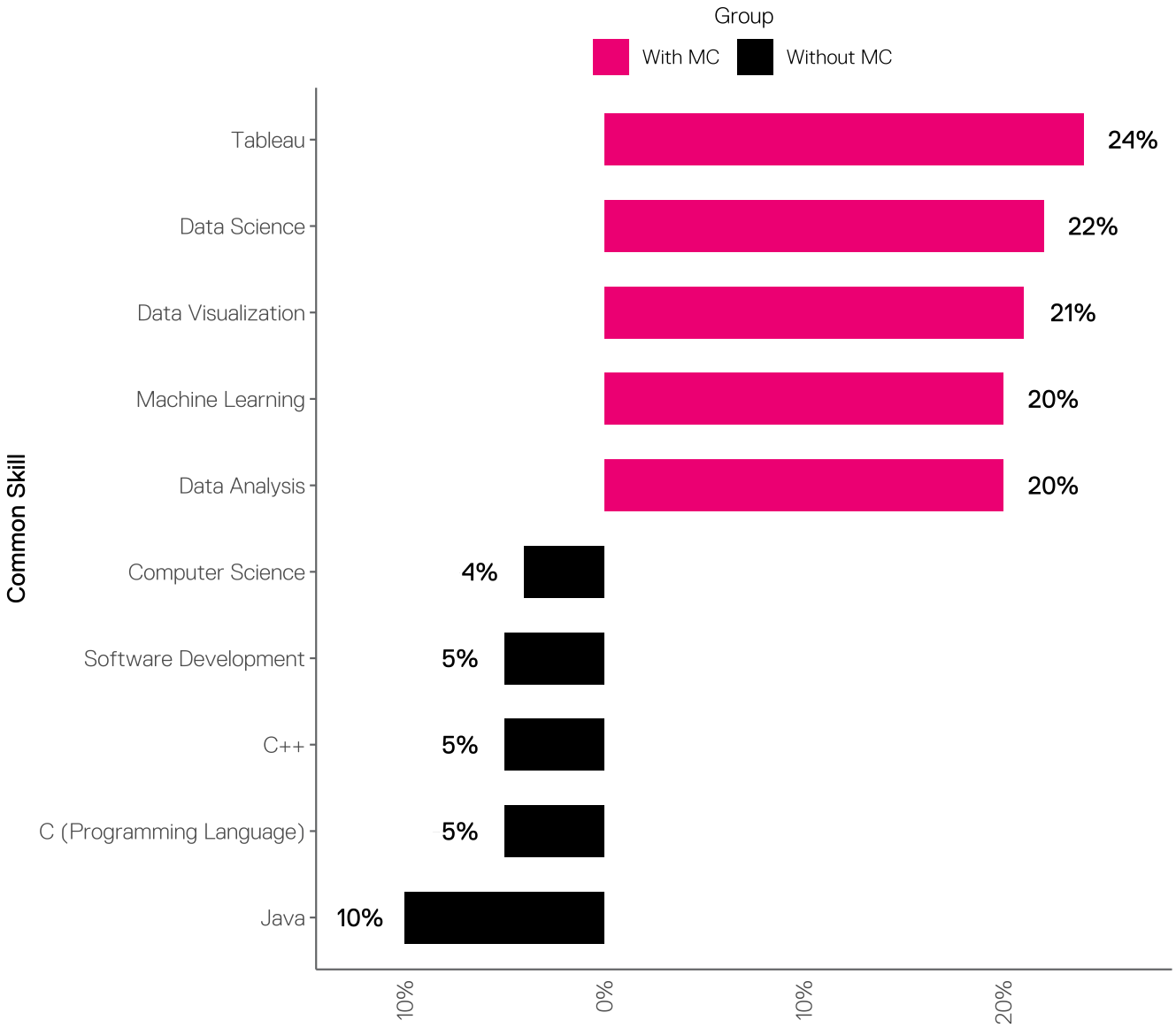
# Examining differences among digital sector professionals who report holding microcredentials

The primary focus of our analysis is to discern potential disparities among professionals who hold microcredentials relative to the rest of their respective professions. Simply put, we look at how a worker listing a microcredential on their LinkedIn profile impacts their stated skills and career. We also look at differences in career background between those with microcredentials, and those without. To do so, we calculated the normalized proportions of skills reported among those holding microcredentials to compare against the larger sample of professionals who do not hold microcredentials.

We first compared how **skill disclosure** differed between those who hold microcredentials compared to those without. Figures 1 and 2 show both the five skills that microcredential holders were more likely to list (compared to non-microcredential holders), and five skills that they were least likely to list. Notably, Figure 1 underscores that data science professionals with microcredentials tend to report skills and tools that have only emerged in popularity in the past 10 years, such as machine learning and Tableau (a data visualization program). Similarly, Figure 2 shows a larger proportion of microcredential holders in software professions report having skills in React.js, Node.js, Express.js, which tend to be a design and user experience-oriented set of skills compared to the rest of the profession. In contrast, there were proportionally more professionals without microcredentials reporting skills such as software development, Java, C, and C++ in both professions. This difference in reported skills suggests data scientists and software professionals with microcredentials are trained in more modern front-end development skills and tools, whereas professionals without microcredentials report more traditional software and operating system development skills. The following section examines the field of study among digital sector professionals.

## Figure 1

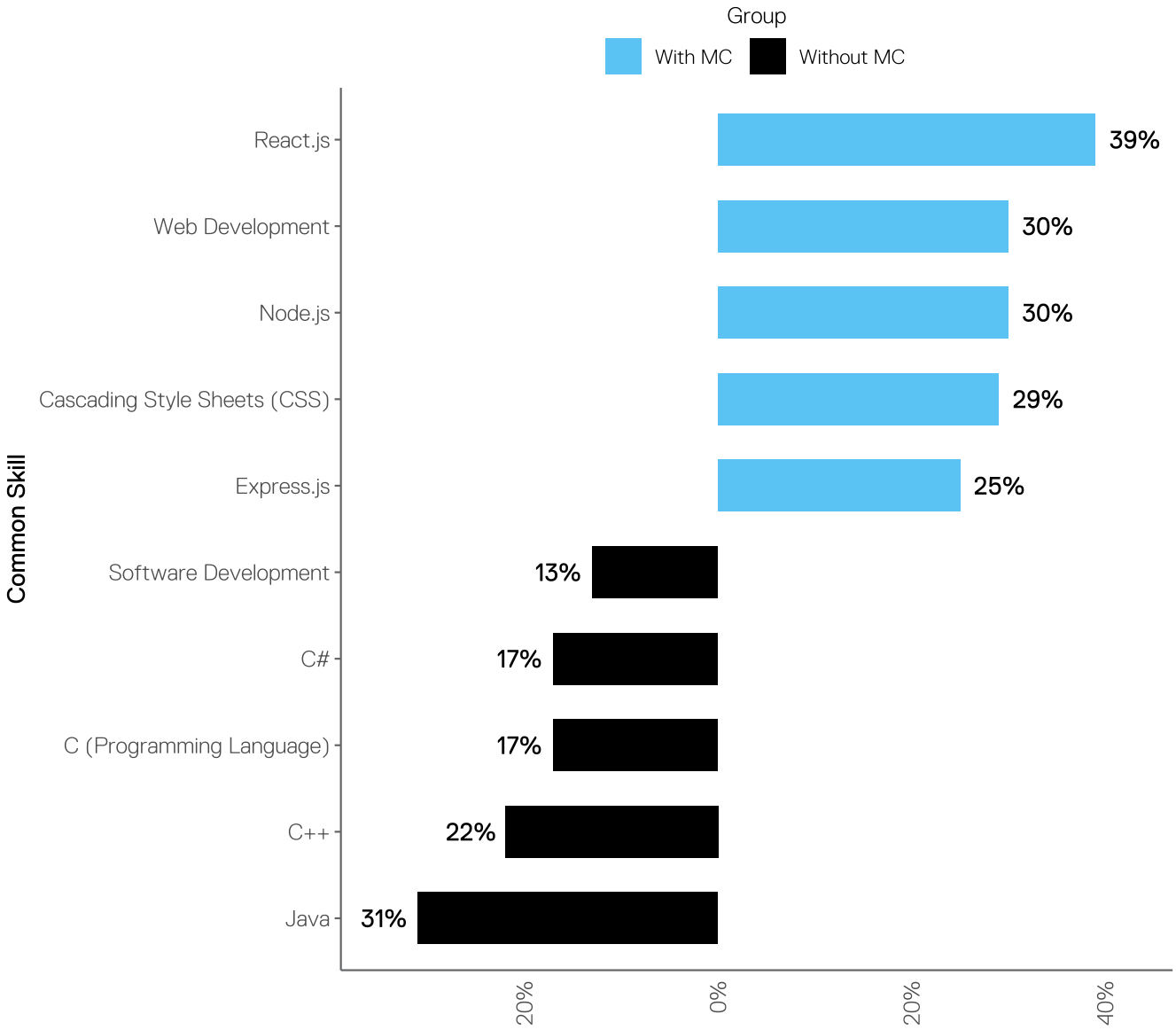
Data Scientists: Skills Reporting Differences Based on Microcredential Completion




Source: LinkedIn Talent Insights Data, July 2023

## Figure 2

Software Professionals: Skills Reporting Differences Based on Microcredential Completion

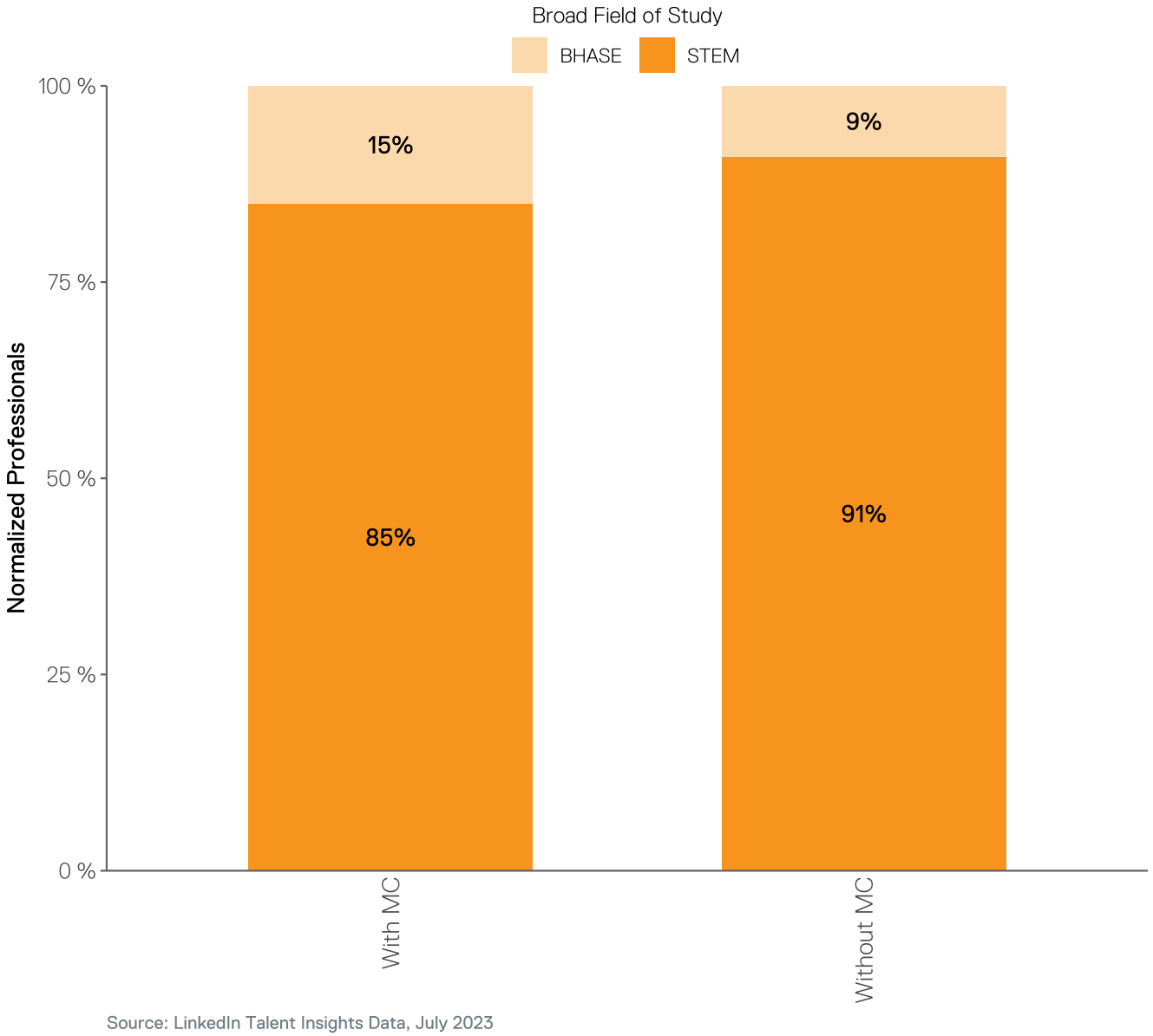



Source: LinkedIn Talent Insights Data, July 2023

To compare by reported **educational field of study**, Figures 3 and 4 differentiate for two categories: in STEM (Science, Technology, Engineering, and Mathematics) and BHASE (Business, Humanities, Health, Arts, Social Sciences, and Education). While both professions reported a strong preponderance in STEM qualifications, microcredential holders were more likely to report a non-STEM field of study among both professions by notable margins.

**Figure 3**

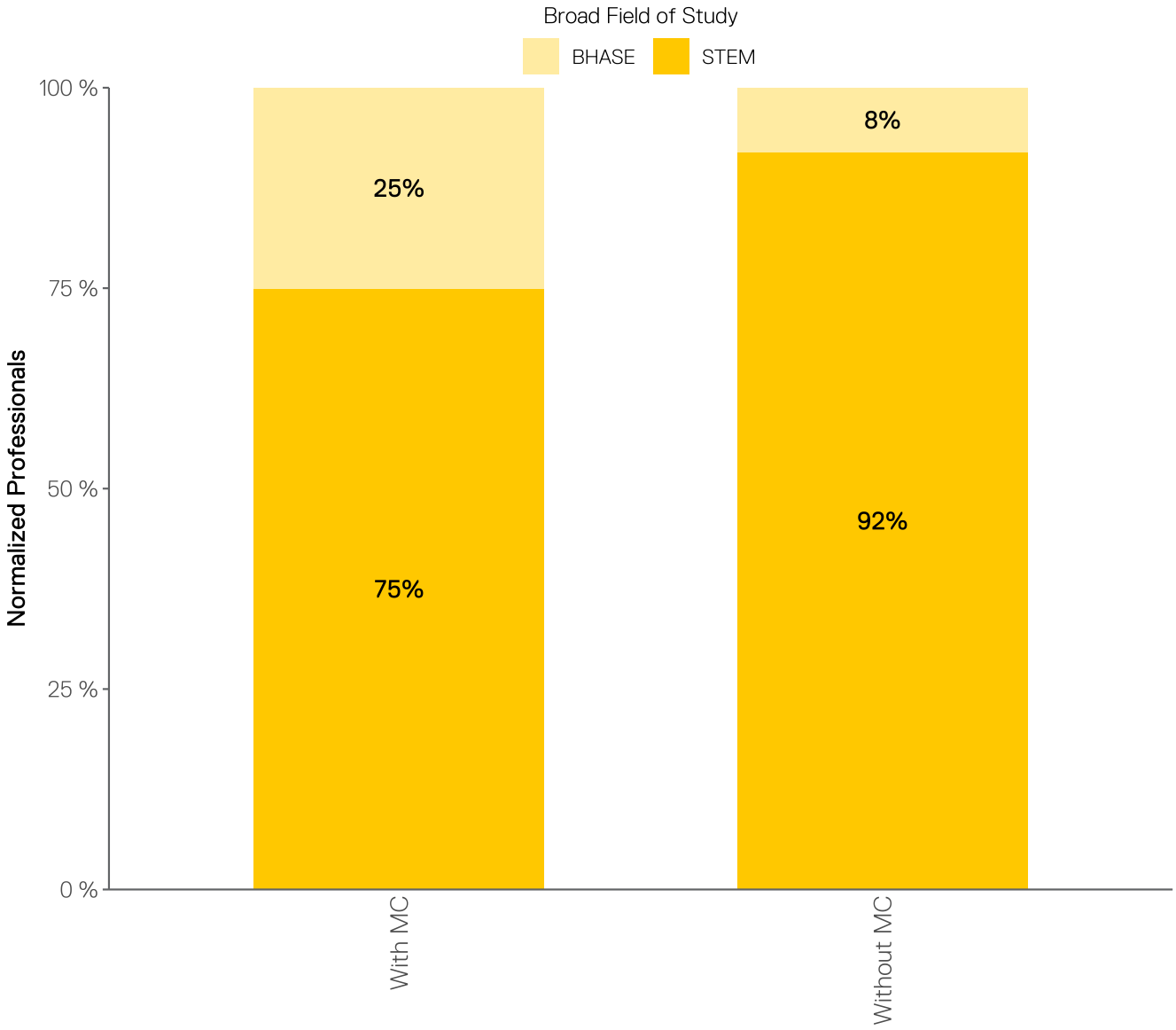
Data Scientists: Normalized Professionals In STEM and BHASE




Source: LinkedIn Talent Insights Data, July 2023

## Figure 4

Software Professionals: Normalized Professionals
In STEM and BHASE



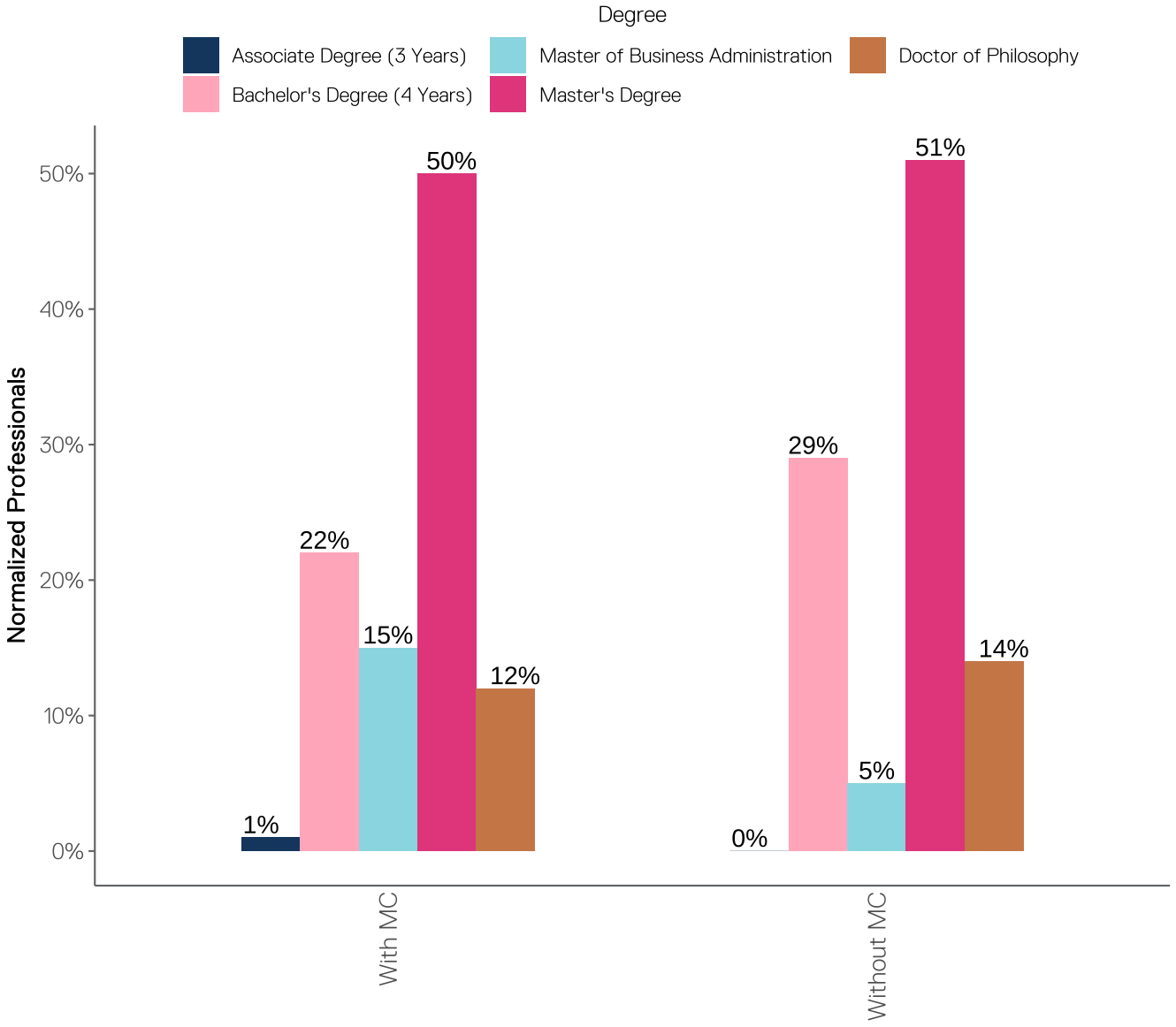

Source: LinkedIn Talent Insights Data, July 2023

**While both professions reported a strong preponderance in STEM qualifications, microcredential holders were more likely to report a non-STEM field of study among both professions by notable margins.**

Figures 5 and 6 show differences among microcredential holders with respect to their highest **educational attainment**. Professionals in both occupations report relatively advanced levels of educational attainment, with more than half of professionals reporting a graduate degree. Most notably, a higher prevalence of Master of Business Administration (MBA) graduates are observed among professionals with microcredentials. MBA holders are more than twice as prevalent among those with microcredentials in both professions.

**Figure 5**

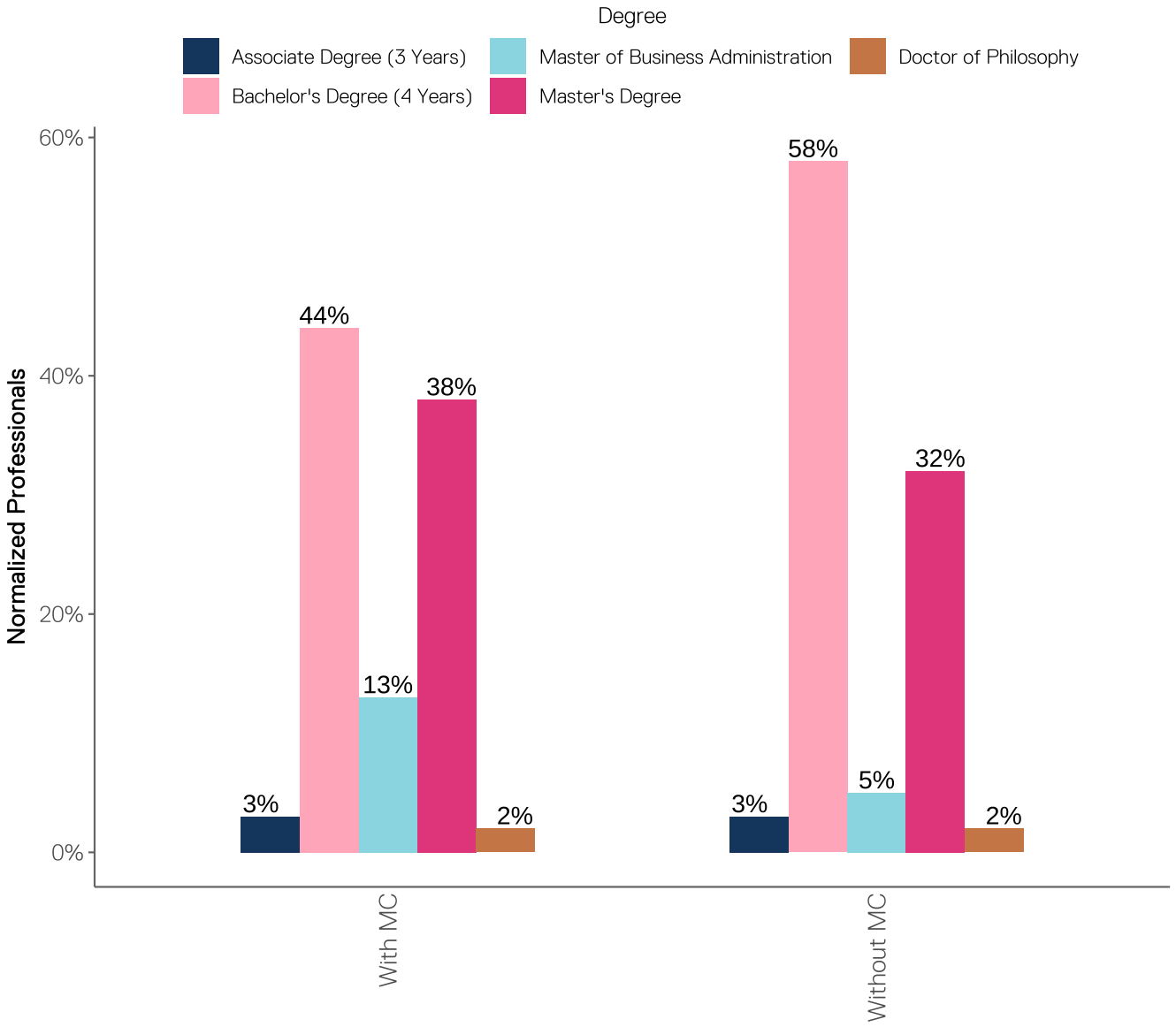
Data Scientists: Normalized Professionals By Degree




Source: LinkedIn Talent Insights Data, July 2023

## Figure 6

Software Professionals: Normalized Professionals By Degree



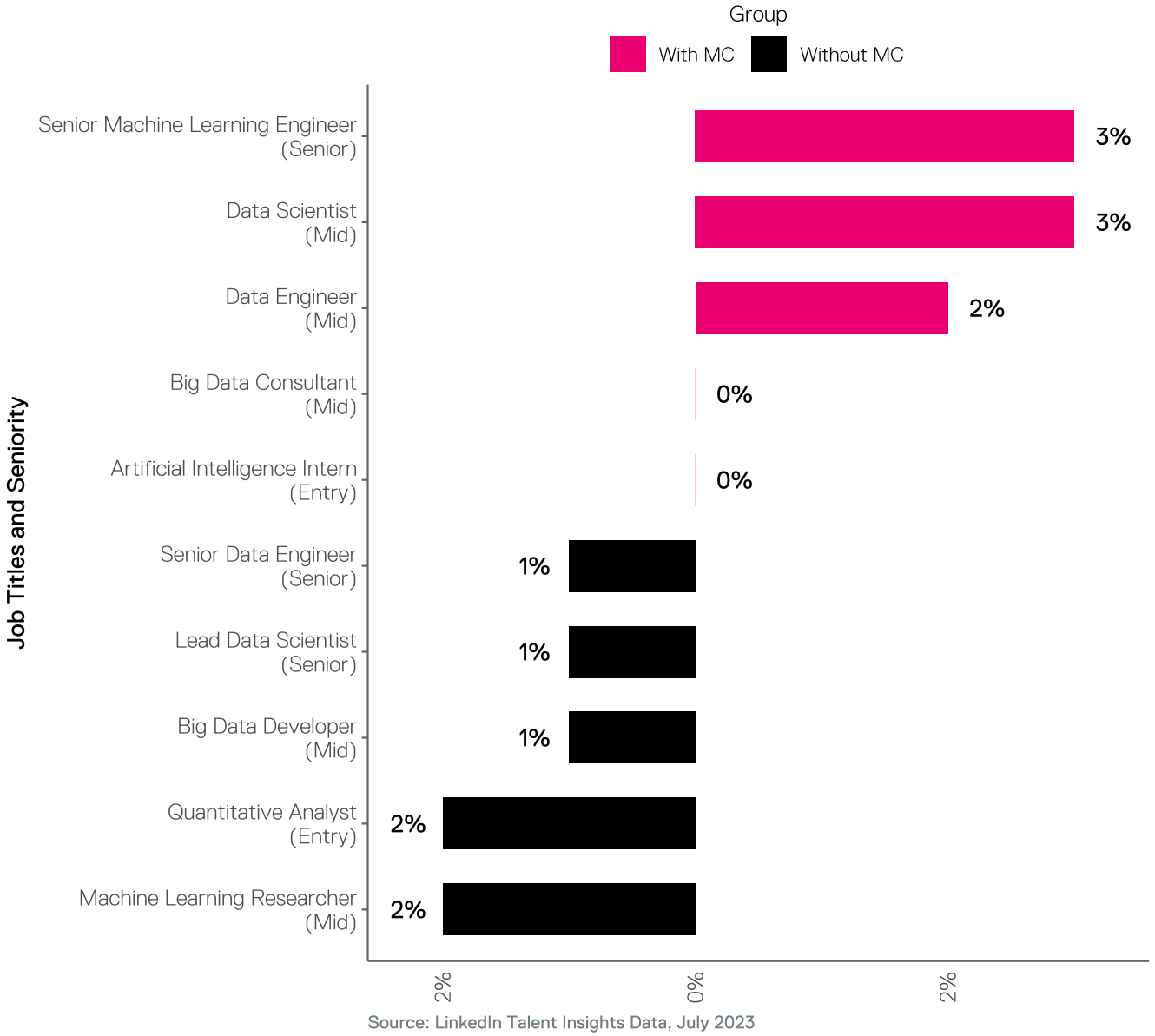

Source: LinkedIn Talent Insights Data, July 2023

**Most notably, a higher prevalence of Master of Business Administration (MBA) graduates are observed among professionals with microcredentials. MBA holders are more than twice as prevalent among those with microcredentials in both professions.**

We examine differences in reported **current job titles** between those with microcredentials and those without in Figures 7 and 8. There are no significant differences in job titles among data scientists, with differences in the low single digits. Among software professionals, differences are more pronounced, with microcredential holders more likely to report job titles such as user experience designer, full-stack engineer, and front-end developer. Conversely, software professionals without microcredentials report more software engineering positions.

**Figure 7**

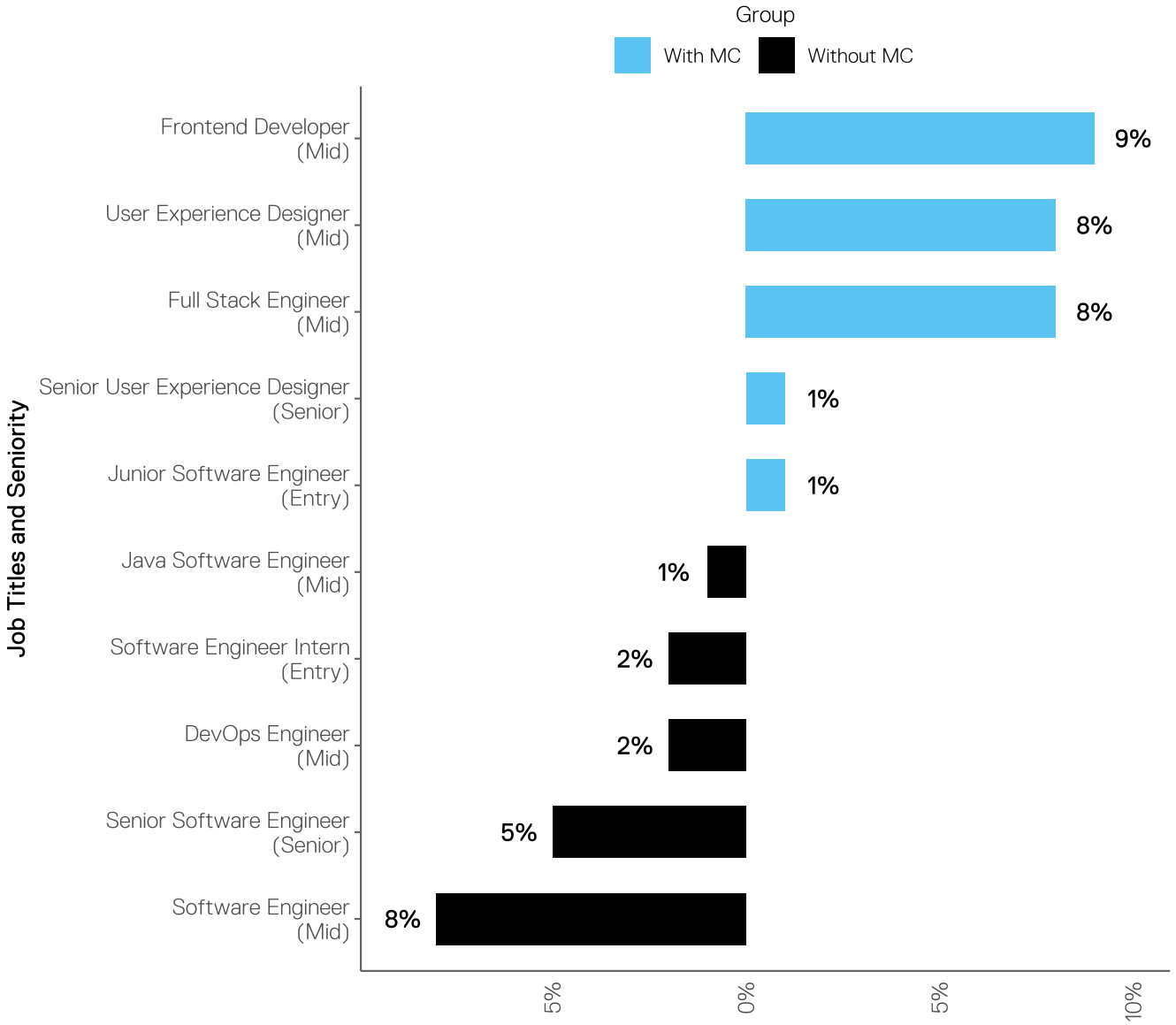
Data Scientists: Job Title Differences Based on Microcredential Completion




Source: LinkedIn Talent Insights Data, July 2023

## Figure 8

Software Professionals: Job Title Differences Based on Microcredential Completion




Source: LinkedIn Talent Insights Data, July 2023

We next examined whether microcredential holders were employed at higher or lower levels of **seniority**. For this analysis, we classified job titles into entry, middle, or senior categories using the prefix or suffix denoting an occupational hierarchy. For example, entry positions were categorized as intern, junior, or analyst, whereas middle position titles are categorized as having no affixes, and senior positions are categorized with title affixes such as senior, lead, manager, director, or head. Figures 9 and 10 show small differences in job title seniority among data scientists with and without microcredentials. Figure 10 shows that software engineers with more seniority were less likely to report microcredentials, though the statistical analysis (Tables 7 and 8) again found no statistical significance in the difference between the two groups. These statistical findings suggest that microcredential holders have similar levels of seniority relative to the rest of their respective professions.

### Table 7

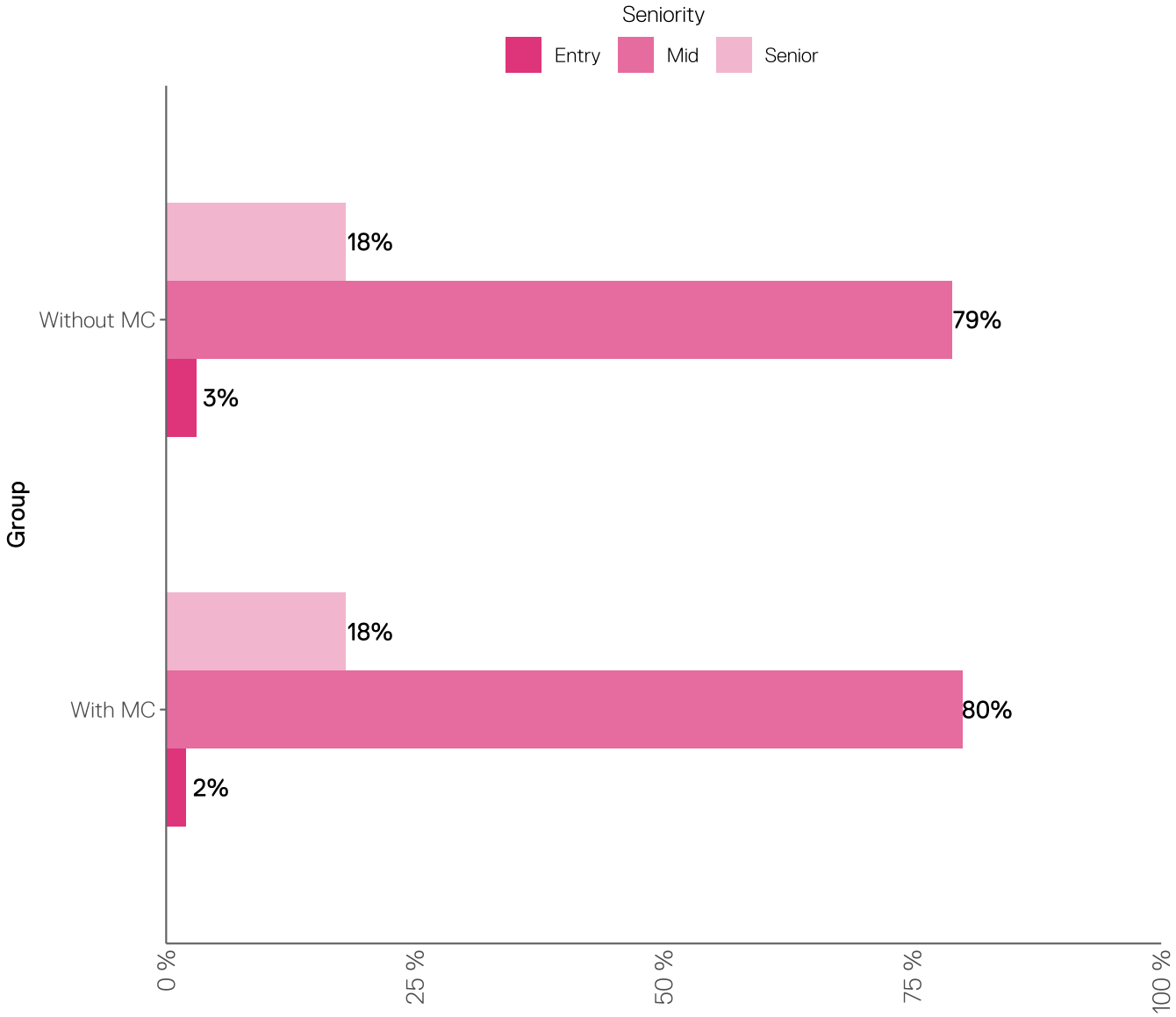
| Welch T-Test For Entry Level Differences | Data Scientist- Without Microcredentials | Data Scientist - With Microcredentials |
|---|---|---|
| **Mean** | 0.007 | 0.004 |
| **t-stat** | 0.932 | |
| **p-value** | 0.399 | |

### Table 8

| Welch T-Test For Mid-Level Differences | Software Professionals - Without Microcredentials | Software Professionals - With Microcredentials |
|---|---|---|
| **Mean** | 0.019 | 0.028 |
| **t-stat** | -0.515 | |
| **p-value** | 0.609 | |

## Figure 9

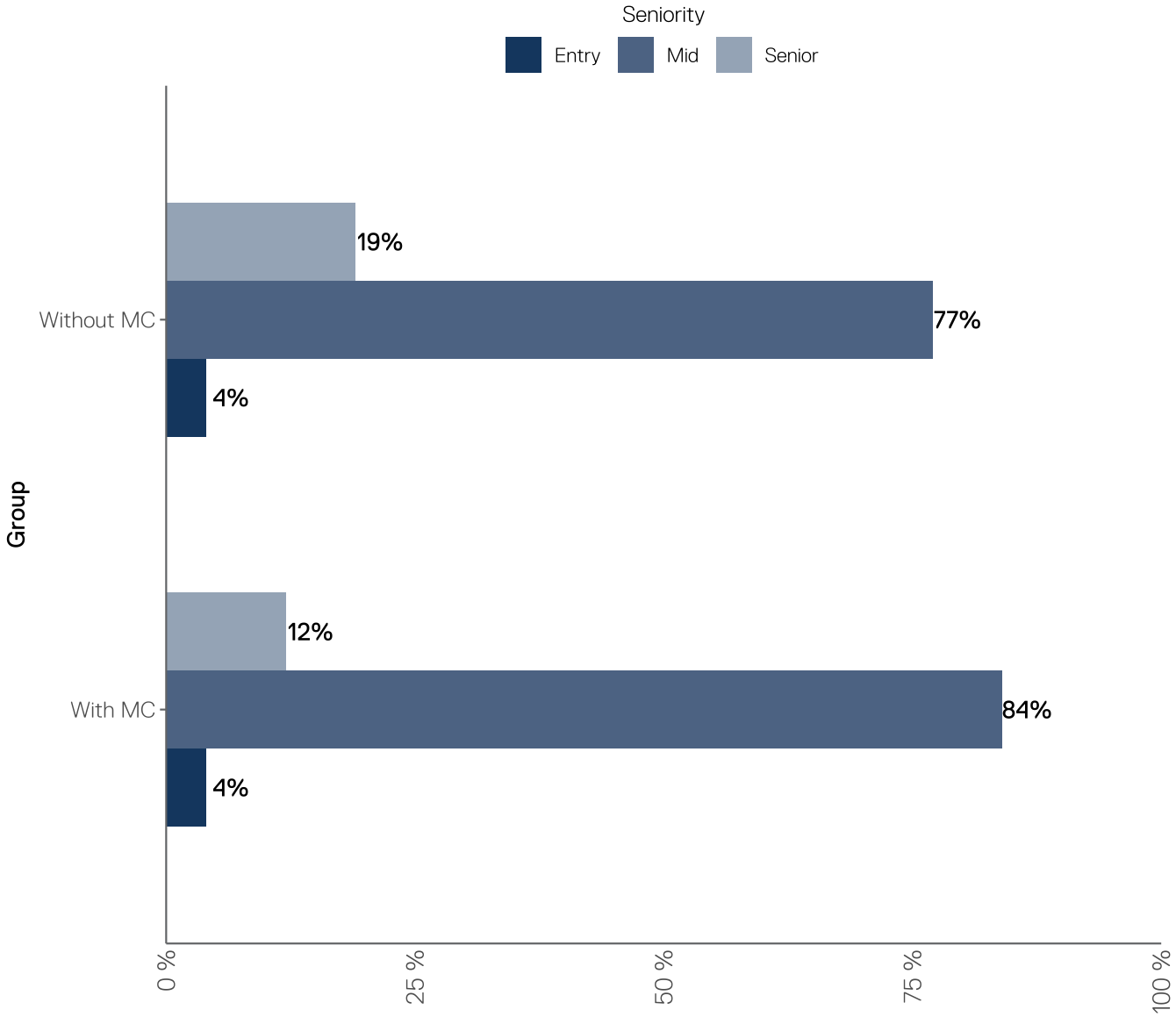
Data Scientists: Normalized Professionals
By Seniority




Source: LinkedIn Talent Insights Data, July 2023

## Figure 10

Software Professionals: Normalized Professionals
By Seniority

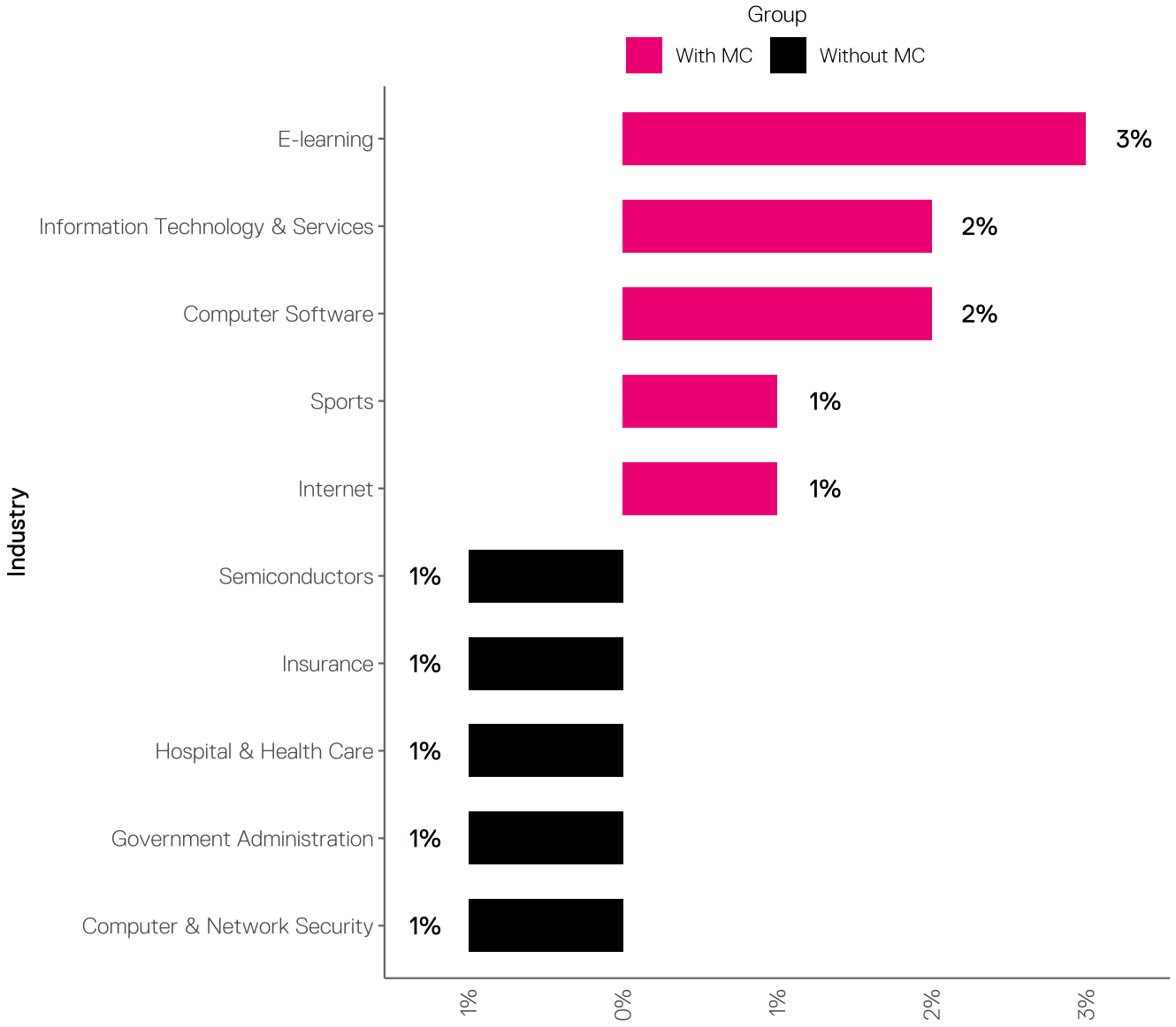



Source: LinkedIn Talent Insights Data, July 2023

Figures 11 and 12 compare data science and software professionals based on **industry of employment**. For both occupations, while magnitudes are small, microcredentials holders were more likely to report employment in the computer software industry. Additionally, we analyzed whether microcredential holders were more or less likely to be in Information and Communication Technology (ICT) industries and found no significant differences between those who held microcredentials compared to those who do not.

**Figure 11**

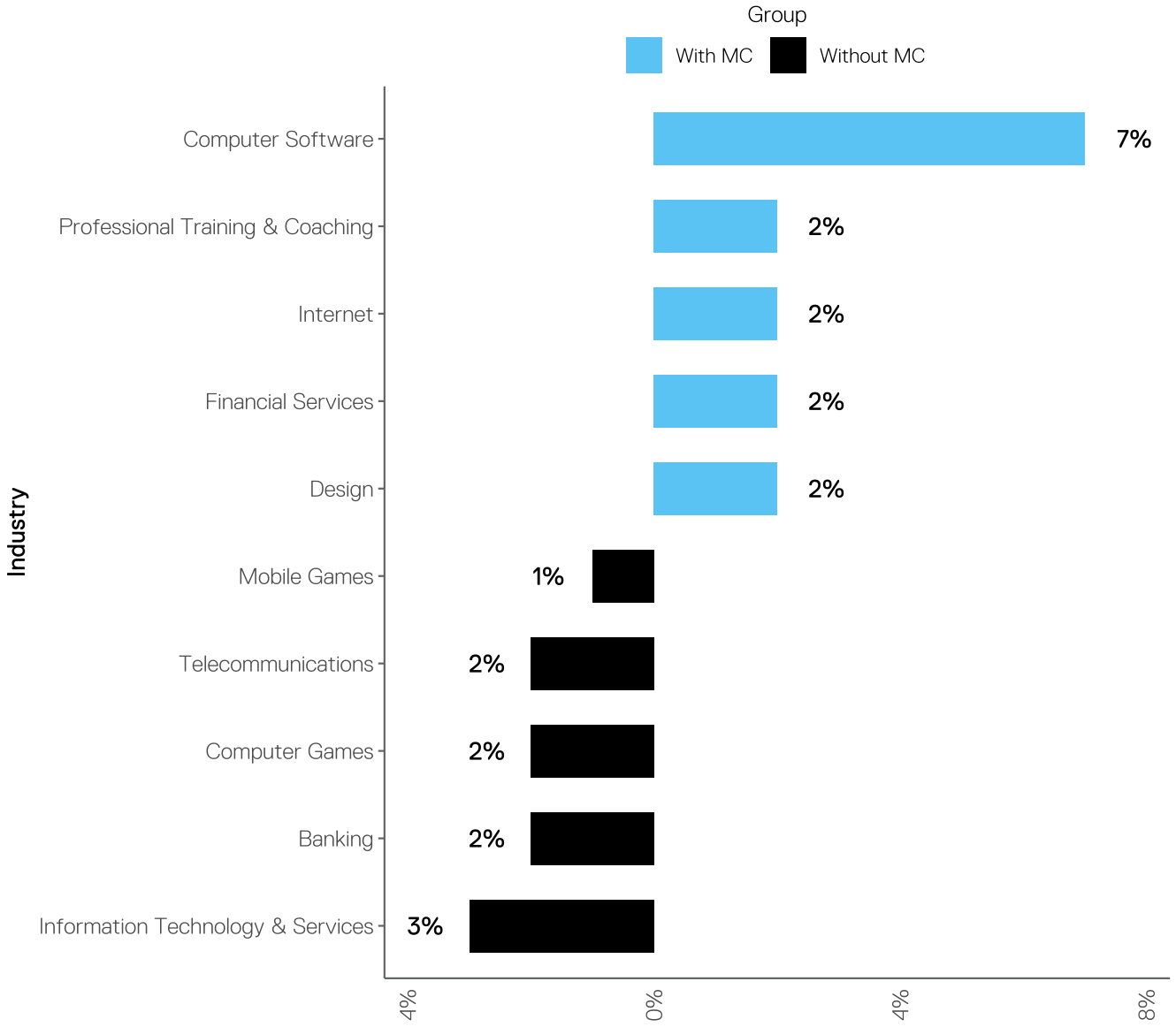
Data Scientists: Industries Differences Based on Microcredential Completion




Source: LinkedIn Talent Insights Data, July 2023

## Figure 12

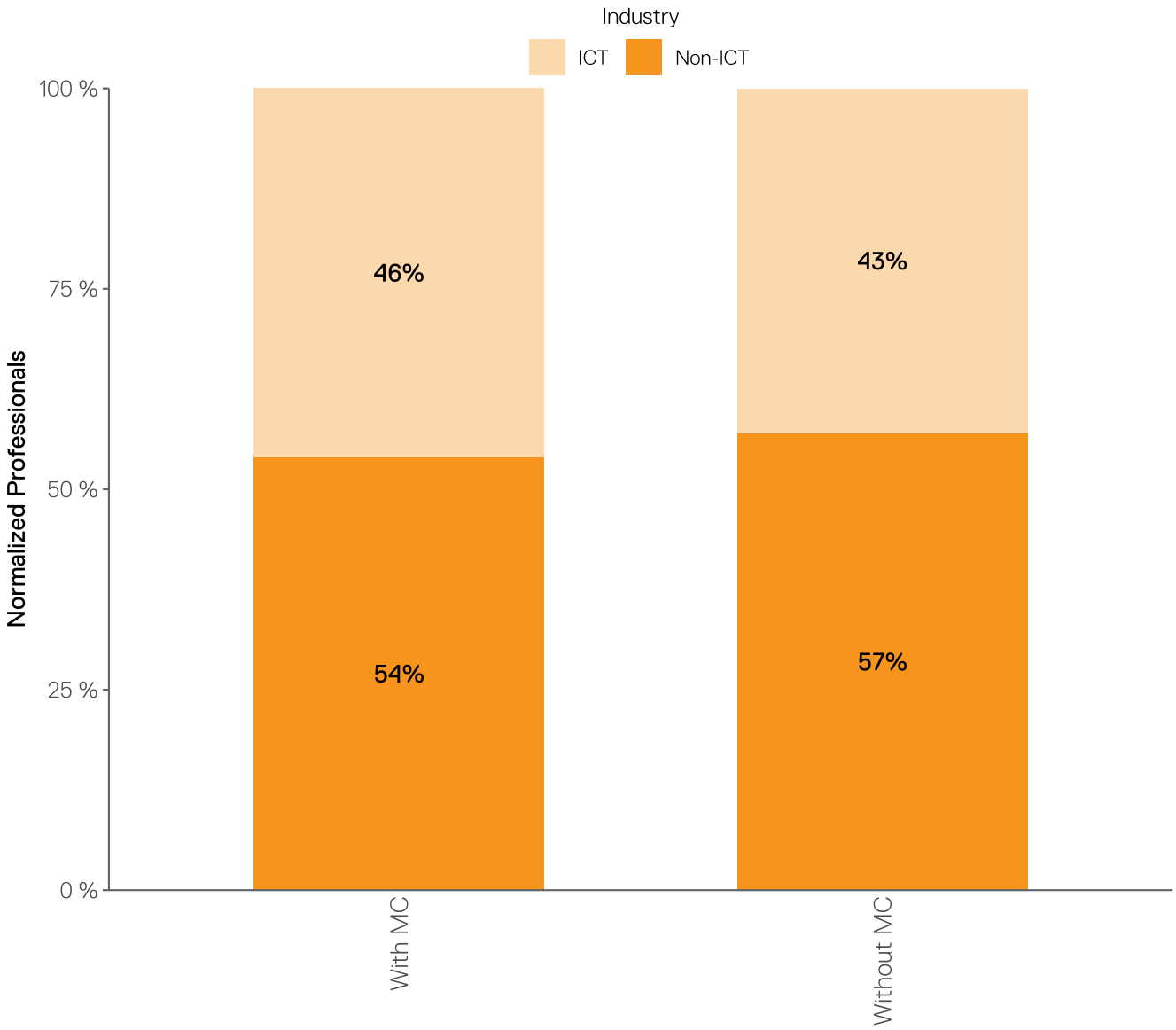
Software Professionals: Industry Differences Based on Microcredential Completion




Source: LinkedIn Talent Insights Data, July 2023

**Figure 13**

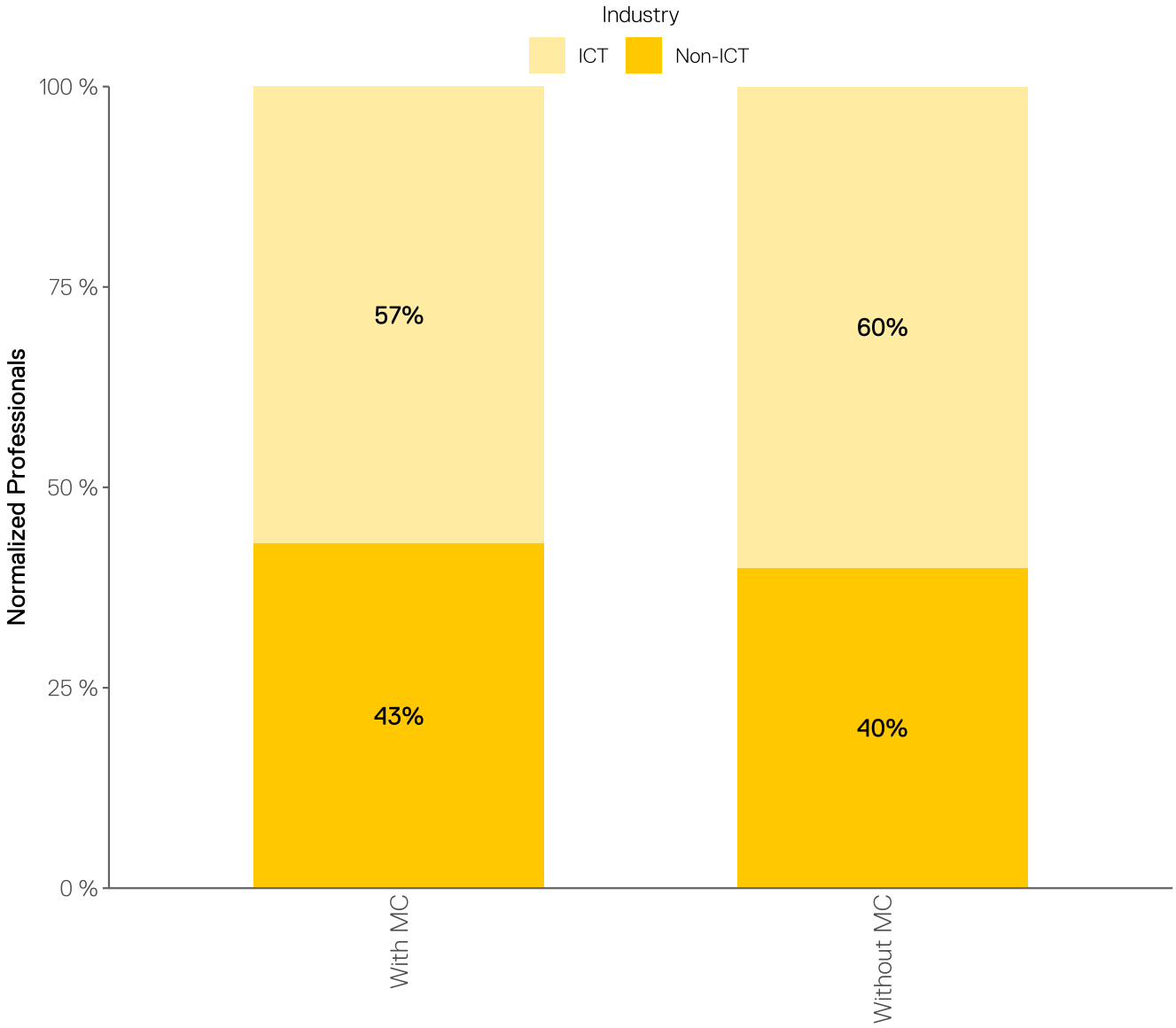
Data Scientists: Normalized Professionals In ICT



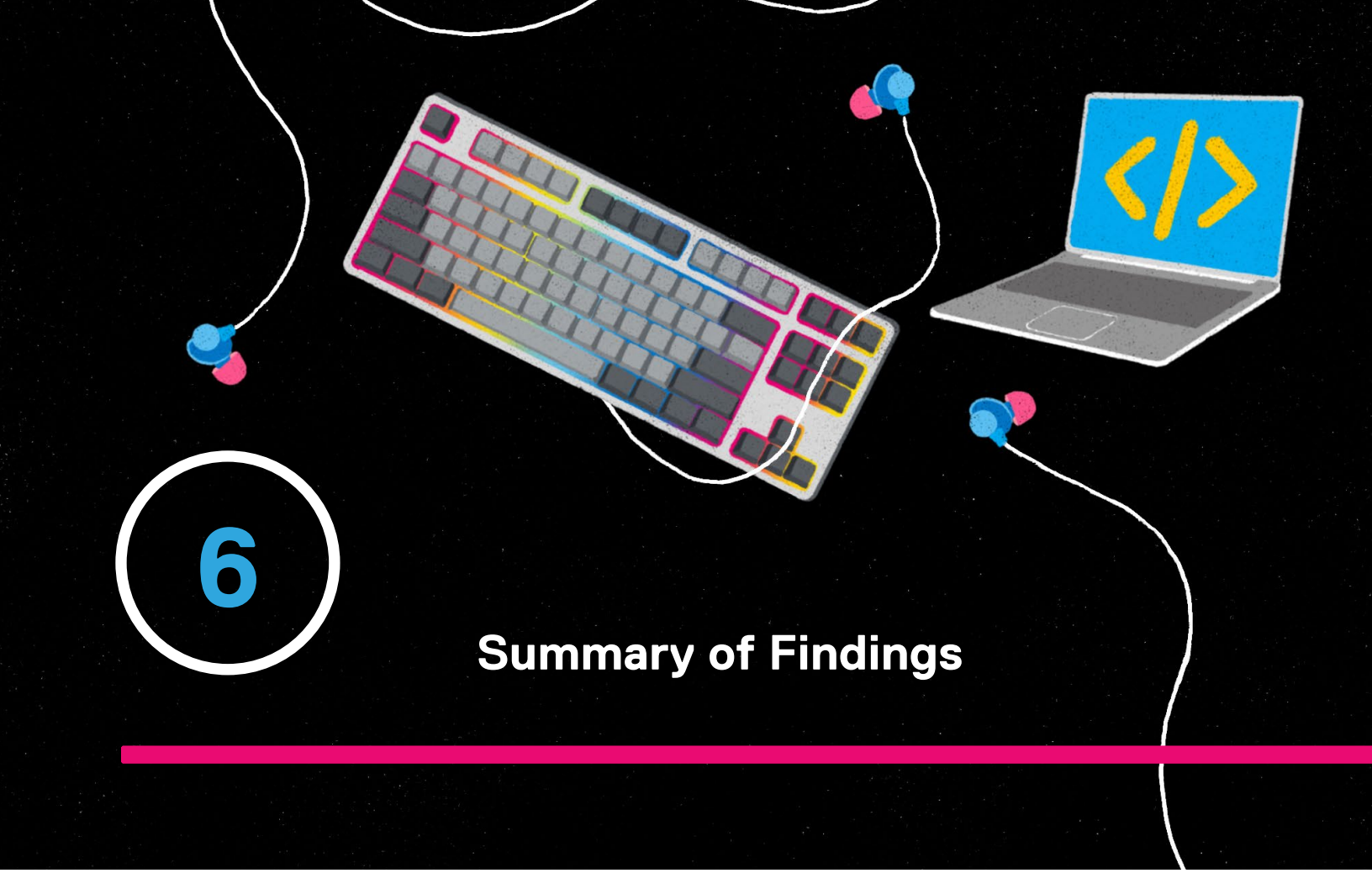

Source: LinkedIn Talent Insights Data, July 2023

## Figure 14

Software Professionals: Normalized Professionals
In ICT




Source: LinkedIn Talent Insights Data, July 2023



# 6 Summary of Findings

Microcredentials have received significant attention in recent years as a potential new model of education to rapidly equip students and workers with in-demand skills. Yet very little is understood about what type of learners are taking these programs, and these programs' impacts on the labour market in Canada. This study uses a rarely studied data set, profile data from LinkedIn Talent Insights, to assess the uptake and profile characteristics of professionals who report having completed microcredentials versus those who have not. In particular, we focus on two prominent digital occupations: data scientists, and software professionals (combining software developers and engineers NOCs).

We find that uptake of self-reported microcredentials completed by professionals in these occupations remains very low to date: just 3.4 percent of data scientists and 3.2 percent of software professionals. While the small sample of professionals reporting completion suggests some caution should be warranted in drawing firm conclusions regarding differences we find between them, the comprehensive coverage in LinkedIn Talent Insights for the two professions allow us to make inferences about potential labour market characteristics of those who report completing microcredentials.

**Despite the low uptake among the two digital occupations, this study reinforces that microcredentials are being used as an upskilling tool for professionals established in their careers, complementary to existing credentials they hold.**

**Microcredentials are being used as a complement to university degrees that can facilitate minor industry and occupational transitions. University degrees develop broadly applicable knowledge areas, while microcredentials allow a worker to gain competency in a specific skill, application or technology tool that leverage the knowledge gained through the university degree.**

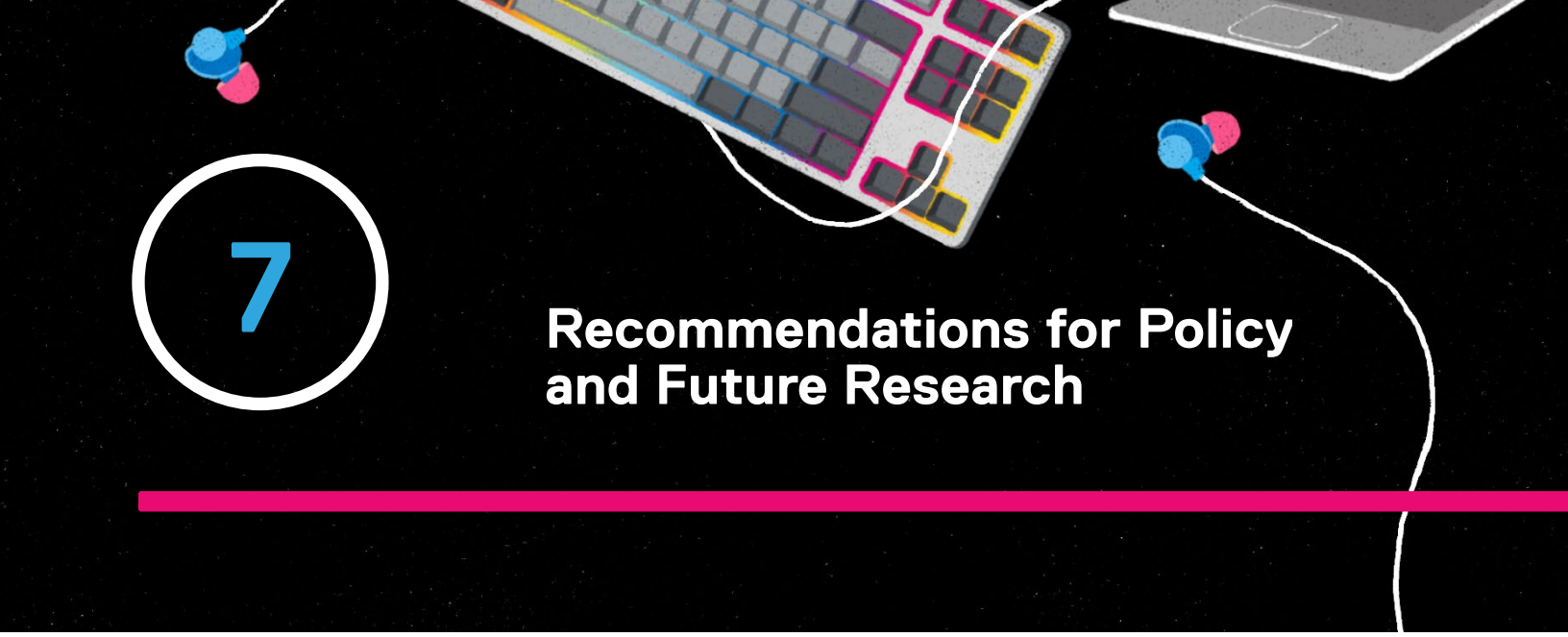
Microcredential holders are more likely to list skills, tools, and technologies that are more recent compared to those without (e.g., Machine Learning versus C++), and were less likely to list broad knowledge areas such as "software development" and "computer science." More professionals with microcredentials have educational backgrounds outside of STEM fields of study, from BHASE fields (Business, Humanities, Health, Arts, Social Sciences, and Education). When we looked at differences in the type of university degrees held by those with and without microcredentials, MBAs emerged as the degree with the largest variance. Those with an MBA were more than twice as likely to report having a microcredential in both professions. Microcredential holders also tended to have more professional experience in the two occupations (i.e., more than five years).

Despite the low uptake among the two digital occupations, this study reinforces that microcredentials are being used as an upskilling tool for professionals established in their careers, complementary to existing credentials they hold. Though caution is warranted in extrapolating to other occupations and fields of study, the findings suggest that microcredentials are more often held by professionals with non-STEM educational credentials (such as MBAs), potentially as a way to develop complementary digital skills and/or to signal those skills to employers. At the same time, the analysis revealed no meaningful differences in the job titles, or job-title related seniority levels, of microcredential holders. While microcredential holders were slightly more prevalent in computer software fields, there was little difference by industry of employment, and no statistically significant difference in ICT industries specifically.

Combined with our understanding above regarding fields of study, this suggests that microcredentials are being used as a complement to university degrees that can facilitate minor industry and occupational transitions. University degrees develop broadly applicable knowledge areas, while microcredentials allow a worker to gain competency in a specific skill, application or technology tool that leverage the knowledge gained through the university degree.

Another clear implication, however, is that the absence of reliable data and the lack of standard definitions and frameworks for microcredentials presents a substantial barrier to robustly assessing their impact or value for learners, employers and policy in Canada. This novel labour market information source can provide significant value to labour market and education researchers and policymakers in many cases, but the self-reported LinkedIn profile data must be used with discretion when exploring occupations and skills that are less prevalent on online job platforms.

**The absence of reliable data and the lack of standard definitions and frameworks for microcredentials presents a substantial barrier to robustly assessing their impact or value for learners, employers and policy in Canada.**



# 7 Recommendations for Policy and Future Research

**Better data sources are required to assess the use and value of microcredentials.** This report assesses the uptake of microcredentials among highly technical digital sector professionals. LinkedIn profile data provides a granular, dynamic source of labour market information (LMI), unveiling skill and competencies reporting, job seniority, and educational granularity that is otherwise unavailable in government and administrative data sources. Existing data sources, such as Statistics Canada's Education and Labour Market Longitudinal Platform (ELMLP) can provide an alternative source of LMI for longitudinal microcredential research, albeit with less program granularity and timeliness as compared to LinkedIn profile data. Future approach could explore how private data sources like LinkedIn Talent Insights can be used in conjunction with public data sources collected by Statistics Canada in ways that preserve and protect privacy to improve labour market analysis.

**Standardizing microcredentials in Canada should be a priority for education leaders and policymakers.** While these new alternative credentials hold promise, the absence of common definitions and quality frameworks across Canada limit their growth potential for learners and employers—the ultimate arbiters of microcredentials' value. Standardization efforts, especially as they relate to quality and value, should align with institutional microcredential offerings in providing verification and assurance to employers and prospective students.

**Further research should extend this analysis to adjacent occupations and fields of study.** While this study focused on specific digitally-intensive roles (given that the data from online job platforms is ideal for digitally intensive careers), several adjacent roles can be examined. Given their similar incentives for accurate self-reporting of career information, adjacent professions such as security researchers or even relatively obscure professions, such as technology founders, offer an intriguing avenue for further research. On the other hand, examining less digitally intensive occupations might also be worthwhile, but technically more challenging. This larger scope could shed light on whether the utility of microcredentials is truly generalizable to a broader range of professions and help provide a more comprehensive understanding of labour market-related information. Specifically, an extension to this work can look at occupations in information and quantitative-intensive occupations, like business intelligence analysts, data analysts, and consultants.

**Further research should explore the benefits of microcredentials to different populations and learners.** Finally, a critical study would be to dive deeper into the general applicability of microcredentials and their impacts on specific demographic groups. This includes answering questions like: Who do microcredentials benefit most? Are different income earners, age groups, or genders affected differently by microcredentials?

# 8 Conclusion

This analysis explores a novel source of labour market information and exposes a relatively under-studied education pathway for a set of in-demand occupations. Unlike other private sources of labour market information, LinkedIn focuses on individual worker profiles, providing a new avenue for investigating labour market trends, particularly for skills, education, seniority, and other characteristics. While the data lacks comprehensive coverage for some occupations, and particularly for workers without a university degree, it has sufficient coverage of tech workers with a university degree, the population of interest.

The findings identify several skill and educational differences among microcredential holders relative to the rest of their profession. They suggest that microcredentials are an upskilling tool that are additive to postsecondary education for digital sector professionals. We therefore suggest a move away from narrowly thinking about microcredentials in terms of an ad-hoc addition for more traditional degree programs, but as a potential complement that may work alongside our existing educational infrastructure.

**The findings identify several skill and educational differences among microcredential holders relative to the rest of their profession. They suggest that microcredentials are an upskilling tool that are additive to postsecondary education for digital sector professionals.**

# Appendix

## Table A

| Microcredential definitions | Definition | Updated | Link |
|---|---|---|---|
| Colleges & Institutes Canada | Certification of assessed competencies that is additional, alternate, complementary to, or a component of a formal qualification. | 2021 | Link |
| eCampusOntario | Certification of assessed learning associated with a specific and relevant skill or competency. microcredentials enable rapid retraining and augment traditional education through pathways into regular postsecondary programming. | 2023 | Link |
| British Columbia Ministry of Advanced Education and Skills Training | Microcredentials recognize stand-alone, short duration learning experiences that are competency-based, align with industry, employer, community and/or Indigenous community needs and can be assessed and recognized for employment or learning purposes. | 2021 | Link |
| New Zealand | A microcredential certifies achievement of a coherent set of skills and knowledge; and is specified by a statement of purpose, learning outcomes, and strong evidence of need by industry, employers, and/or the community. They are smaller than a qualification and focus on skill development opportunities not currently catered for in the regulated tertiary education system | 2020 | Link |
| European Commission | A microcredential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. microcredentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards. | 2020 | Link |
| Future Skills Centre | Focused certification issued by a recognized institution conferring some measure of competence in a given area. | 2022 | Link |
| The United Nations Educational, Scientific and Cultural Organization | A microcredential is a record of focused learning achievement verifying what the learner knows, understands or can do, includes assessment based on clearly defined standards and is awarded by a trusted provider, has standalone value and may also contribute to or complement other microcredentials or macro-credentials, including through recognition of prior learning, and meets the standards required by relevant quality assurance. | 2022 | Link |
| Higher Education Quality Council of Ontario | A microcredential is a representation of learning, awarded for completion of a short program that is focused on a discrete set of competencies (i.e., skills, knowledge, attributes), and is sometimes related to other credentials. | 2021 | Link |
| National Education Association | A microcredential is a short, competency-based recognition that allows an educator to demonstrate mastery in a particular area. | 2020 | Link |

## Table B: List of Microcredential Education Providers

| Microcredentials |
| --- |
| BrainStation |
| CodeCore College |
| CodingDojo |
| Coursera |
| DataCamp |
| Dataquest.io |
| edX |
| freeCodeCamp |
| General Assembly |
| Juno College of Technology |
| Le Wagon |
| Lighthouse Labs |
| McMaster University Continuing Education |
| Rogers Cybersecure Catalyst, Toronto Metropolitan University |
| Springboard |
| The G. Raymond Chang School of Continuing Education at Toronto Metropolitan University |
| Udacity |
| University of Toronto School of Continuing Studies |
| University of Toronto School of Continuing Studies Boot Camps |
| WeCloudData |
| York University School of Continuing Studies |
| 365 Data Science |

## Table C: LinkedIn Skill Disclosure and ONET Job Posting Skill Reporting For Data Scientist (Software Professional)

| Data Scientist Skills | % of professionals reporting | LinkedIn profile reporting rank | % Reported in job posting | O*NET rank |
|---|---|---|---|---|
| Python (programming language) | 80.7% | 1 | 78 | 1 |
| SQL | 64.4% | 2 | 52 | 2 |
| R (programming language) | 32.6% | 9 | 49 | 3 |
| Apache Spark | 18.5% | 28 | 25 | 4 |
| Amazon Web Services (AWS) | 21.4% | 21 | 22 | 5 |
| Tableau | 24.4% | 13 | 18 | 6 |
| TensorFlow | 17.5% | 33 | 17 | 7 |
| Apache Hadoop | 16.3% | 36 | 16 | 8 |
| Oracle Database | 8.2% | 70 | 15 | 9 |
| SAS (software) | 7.5% | 75 | 14 | 10 |
| Scala | 7.2% | 76 | 14 | 10 |
| Microsoft Azure | 14.9% | 41 | 13 | 12 |
| scikit-learn | 12% | 48 | 13 | 12 |
| PyTorch | 11.5% | 49 | 12 | 14 |
| C++ | 30.5% | 10 | 9 | 15 |
| Hive | 8.2% | 69 | 9 | 15 |
| pandas (software) | 13.3% | 43 | 8 | 17 |
| Keras | 9.4% | 58 | 6 | 18 |
| GitHub | 9.2% | 59 | 6 | 18 |
| MATLAB | 26.3% | 11 | 6 | 18 |
| NumPy | 9.9% | 57 | 6 | 18 |
| NoSQL | NA | NA | 5 | 22 |
| Docker products | 10.8% | 53 | 5 | 22 |
| PySpark | 8.6% | 65 | 5 | 22 |
| Microsoft Excel | NA | NA | 5 | 22 |

## Table D: LinkedIn Skill Disclosure and ONET Job Posting Skill Reporting For Data Scientist (Software Professional)

| Software Skills | % of professionals reporting | LinkedIn profile reporting rank | % Reported in job posting | O*NET rank |
|---|---|---|---|---|
| Oracle Java | 7.0% | 66 | 32 | 1 |
| SQL | 44.3% | 5 | 26 | 2 |
| JavaScript | 56.3% | 2 | 24 | 3 |
| Python (programming language) | 45.9% | 4 | 23 | 4 |
| Amazon Web Services (AWS) | 18.7% | 22 | 22 | 5 |
| C# | 29.2% | 10 | 15 | 6 |
| GitHub | 13.4% | 32 | 14 | 7 |
| Microsoft Azure | 8.4% | 55 | 14 | 7 |
| Angular | 7.8% | 61 | 14 | 7 |
| REST APIs | 8.9% | 52 | 13 | 10 |
| Cascading Style Sheets (CSS) | 37.8% | 6 | 12 | 11 |
| React | 26.3% | 13 | 12 | 11 |
| Docker products | 14.8% | 27 | 12 | 11 |
| Microservices | 6.1% | 77 | 12 | 11 |
| HTML | 37.4% | 7 | 11 | 15 |
| C++ | 34.6% | 8 | 11 | 15 |
| Linux | 26.1% | 15 | 11 | 15 |
| Kubernetes | 7.7% | 62 | 11 | 15 |
| Jenkins | 10.6% | 41 | 10 | 19 |
| Node.js | 23.3% | 16 | 9 | 20 |
| NoSQL | NA | NA | 7 | 21 |
| Jira | 14.0% | 30 | 7 | 21 |
| .NET Framework | 11.9% | 36 | 7 | 21 |
| C (Programming Language) | 26.5% | 12 | 6 | 24 |
| Web applications | 17.5% | 23 | 6 | 24 |
| XML | 11.5% | 37 | 6 | 24 |
| JSON | 8.5% | 54 | 6 | 24 |
| Spring Framework | 8.2% | 57 | 6 | 24 |
| Operating Systems | 4.6% | 94 | 6 | 24 |
| Apache Kafka | NA | NA | 5 | 30 |
| Microsoft SQL Server | 14.8% | 28 | 5 | 30 |
| TypeScript | 12.5% | 35 | 5 | 30 |
| PostgreSQL | 11.2% | 38 | 5 | 30 |
| Spring Boot | 6.5% | 70 | 5 | 30 |
| Unix | 5.4% | 81 | 5 | 30 |

# References


[1] "Micro-Credentials for Lifelong Learning and Employability: Uses and Possibilities," *OECD Education Policy Perspectives*, (Paris: OECD Publishing, 2023), https://www.oecd.org/publications/micro-credentials-for-lifelong-learning-and-employability-9c4b7b68-en.htm.

[2] Alissa Bigelow et al., *ECampusOntario's Micro-Credential Toolkit* (Ontario Online Learning Consortium eCampusOntario, 2022), https://ecampusontario.pressbooks.pub/microcredentialtoolkit/.

[3] Ministry of Advanced Education and Skills Training, "Micro-Credential Framework for B.C.'s Public Post-Secondary Education System," (Government of British Columbia, September 2021), https://www2.gov.bc.ca/assets/gov/education/post-secondary-education/micro-credentials/mc_framework.pdf.

[4] Jacob Mincer, "Education, Experience, and the Distribution of Earnings and Employment: An Overview," in *Education, Income, and Human Behavior* (NBER, 1975), 71–94, https://www.nber.org/books-and-chapters/education-income-and-human-behavior/education-experience-and-distribution-earnings-and-employment-overview.

[5] Dale W. Jorgenson and Barbara M. Fraumeni, "Education and Productivity Growth in a Market Economy," *Atlantic Economic Journal* 21, no. 2 (June 1, 1993): 1–25, https://doi.org/10.1007/BF02302312.

[6] A foundational 1973 paper by Arrow provides a theoretical discussion on different forms of signalling in economic theory, including acquiring educational credentials. Kenneth J. Arrow, "Information and Economic Behavior" (Fort Belvoir, VA: Defense Technical Information Center, September 1, 1973), https://doi.org/10.21236/AD0768446.

[7] Nguyen Thi Ngoc Ha, Michael Spittle, Anthony Watt, and Nina Van Dyke, "A Systematic Literature Review of Micro-Credentials in Higher Education: A Non-Zero-Sum Game." Higher Education Research & Development 42 (6): 1527–48. https://doi.org/10.1080/07294360.2022.2146061.

[8] "Micro-credential Approval, Accreditation and Listing," New Zealand Qualifying Authority, https://www2.nzqa.govt.nz/tertiary/approval-accreditation-and-registration/micro-credentials/.

[9] "Focus on Microcredentials," *Future Skills Centre* (blog), https://fsc-ccf.ca/engage/focus-on-microcredentials.

[10] Emma Gooch et al., "The Future Is Micro: Digital Learning and Micro-Credentials for Education, Retraining and Lifelong Learning," (Toronto: Future Skills Centre, March 10, 2022), https://fsc-ccf.ca/wp-content/uploads/2022/03/TheFutureisMicro-Report-ENG.pdf.

[11] "CICan Launches New Report and Environmental Scan on Microcredentials," Colleges and Institutes Canada, April 12, 2021, https://www.collegesinstitutes.ca/news-release/cican-launches-new-report-and-environmental-scan-on-microcredentials/.

[12] Alex Usher et al., "Approaches to Stackability of Micro-Credentials: Options for Ontario," Higher Education Strategy Associates, prepared for Ontario Council on Articulation and Transfer, (Toronto: ONCAT, HESA, March 20, 2023), https://www.oncat.ca/sites/default/files/media-files/r2246_micro-credentials_final_report_21-3-23.pdf.

[13] Jackie Pichette, S. Brumwell, J. Rizk, S. Han, "Making Sense of Microcredentials" (Toronto: Higher Education Quality Council of Ontario, May 5, 2021), https://heqco.ca/wp-content/uploads/2021/05/Formatted_Microcredentials_FINAL1.pdf.

[14] David Harvey, Russ Wilde, and Partha Roy, "Employer and Employee Perceptions of Micro-Credentials" (Toronto: Future Skills Centre, April 2023), https://fsc-ccf.ca/wp-content/uploads/2023/06/NAIT_FSC_Report_April2023-1.pdf.

[15] Marc Frenette and Tomasz Handler, "Does Taking Short Postsecondary Programs or Independent Credits Benefit Recently Displaced Workers?" (Statistics Canada Economic and Social Reports, November 23, 2022), https://www150.statcan.gc.ca/n1/pub/36-28-0001/2022011/article/00003-eng.htm.

[16] Di Xu Ben Castleman, Kelli Bird, Sabrina Solanki, and Michael Cooper, "Noncredit Workforce Training Programs Are Very Popular. We Know next to Nothing about Them," *Brookings* (blog), May 23, 2023, https://www.brookings.edu/blog/brown-center-chalkboard/2023/05/23/noncredit-workforce-training-programs-are-very-popular-we-know-next-to-nothing-about-them/.

[17] Thomas Bailey and Clive Belfield, "Stackable Credentials: Do They Have Labor Market Value?" (Teachers College Columbia University, November 20, 2017), https://ccrc.tc.columbia.edu/publications/stackable-credentials-do-they-have-labor-market-value.html.

[18] Jessa Lewis Valentine and Janelle Clay, "Non-Degree Credentials Provide Value for Adults in the Labor Market," (Lumina Foundation, June 18, 2019), https://www.luminafoundation.org/resource/non-degree-credentials-provide-value-for-adults-in-the-labor-market/.

[19] Otto Kässi and Vili Lehdonvirta, "Do Microcredentials Help New Workers Enter the Market? Evidence from an Online Labor Platform," *Journal of Human Resources*, March 9, 2022 (date published online before print), https://doi.org/10.3368/jhr.0519-10226R3.

[20] We define competencies in accordance with ESDC's Skills and Competencies Taxonomy, specifically "The combined utilization of personal attributes, abilities, skills, and knowledge to effectively perform a job, role, function, task, or duty."

[21] Mike Brown, "Do People Tell the Truth on LinkedIn?" *LendEDU* (blog), June 5, 2017, https://lendedu.com/blog/drawbacks-deceptions-linkedin/.

[22] Andrew Fennell, "Study: Fake Job References and Resume Lies," *StandOut CV* (blog), November 23, 2022, https://standout-cv.com/usa/study-fake-job-references-resume-lies.

[23] Matthew Baird et al., "LinkedIn STEM Classification Methodology," (LinkedIn, February 2023), https://economicgraph.linkedin.com/content/dam/me/economicgraph/en-us/PDF/linkedin-stem-classification-methodology-egtn01.pdf.