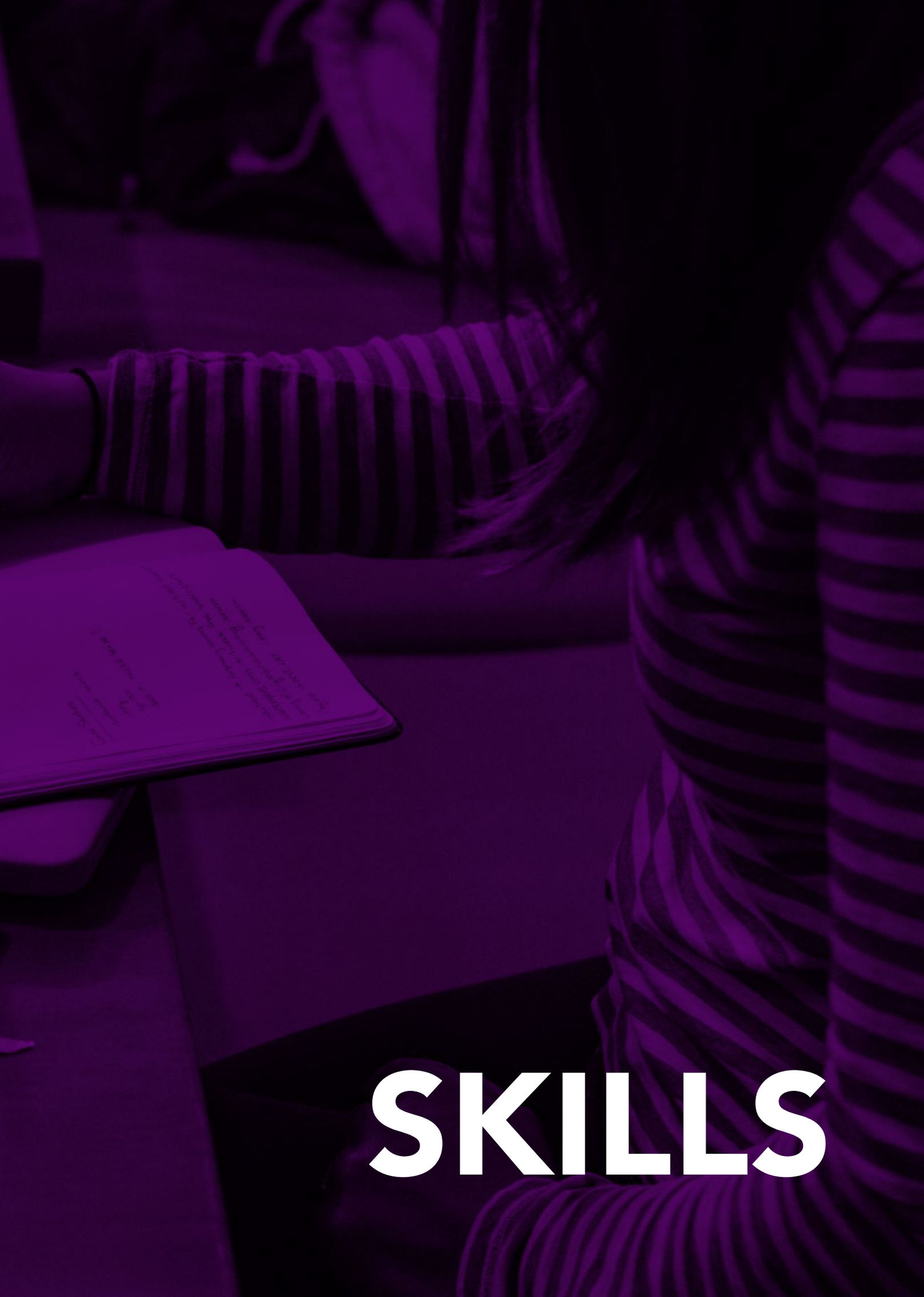

SKILLS

6

THE ROLE OF EDUCATIONAL INSTITUTIONS IN CLOSING STEM EDUCATION GAPS

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ABSTRACT

Several recent developments support the enrolment of women in STEM fields within educational institutions, including: educational institutions' adoption of policy frameworks advocating for increased STEM female participation; incentives for funding female STEM students; and criteria ensuring gender-sensitive institutional admissions. Curriculum design also has a role in increasing the representation of skilled females in STEM (Reyes, 2011), including viewing the humanities as representing critical skillsets relevant for STEM curriculum (Savaria & Monteiro, 2017). Such approaches also require complementary governance frameworks supporting female representation in STEM fields. Furthermore, organisations increasingly recognise the critical role of humanities in equipping the future STEM field workforce; the importance of human-centred skill sets has been recognised in the inclusion of arts skills into the STEM acronym, as STEAM. Today's workplace requirements include creative problem-solving skills as well as human-centred approaches to STEM challenges, prompting a discussion of the role of arts subjects within the field (Bequette & Bequette, 2013; Land, 2013). This chapter evaluates the role of higher learning institutions in improving female representation in STEM, by reviewing studies conducted globally in the period 2011–2017. It documents the lack of female representation in STEM fields and the role of new policy frameworks and practices in diversifying STEM student populations and workforces. The paper reviews lessons learnt from various countries' experiences and provide key recommendations for educational institutions to reduce the female student enrolment and human resources gap.

KEY FINDINGS

- The lack of female role models in STEM has been cited as a major factor in the low uptake of STEM programmes and courses by young girls in both elementary and higher educational institutions.
- The lack of a diverse academic and research STEM workforce in educational institutions, particularly in management roles, leads to perceptions of STEM as a male-dominated domain. Academic institutions thus find it difficult to attract and retain women both as students and as employees in STEM.
- Educational institutions have sought ways to improve the participation of women in STEM fields through student funding incentives, gender-sensitive institutional admission criteria, and gender-sensitive curriculum designs. These policies all have a role in increasing the representation of skilled women in STEM.

INTRODUCTION

The first industrial revolution introduced the use of mechanical power, complementing or replacing manual human labour to enable efficiency across industries; similarly, the second revolutionary industrial development, in the twentieth century, brought the use of electricity and wired communication. A third epoch of industrial change brought large-scale digitisation and advances in computing; in recent decades, further advances have produced a digital and cyber revolution that was designated as "the fourth Industrial Revolution" at the 2016 World Economic Forum (Schwab, 2016). This revolution will place major emphasis on skillsets in technology and engineering fields, including in areas such as robotics and artificial intelligence. Indeed, the fields of science, technology, engineering, and mathematics (STEM) prominently provide opportunities for young graduates to make significant contributions towards both economic growth and scientific research.

STEM skills are widely considered an essential skillset, particularly in the Global South, which suffers from a shortage of engineers, doctors, programmers, etc. However, many organisations have come to appreciate the importance of arts and human-centred skills in these fields. The acronym STEM has thus evolved further to include arts, to form the new name, STEAM.

Various studies have shown the importance of problem-solving inquiry skills such as novelty and ingenuity in addressing societal challenges, as well as compassion and related human-centred attributes; STEM academic programmes often neglect these key skills (Bequette & Bequette, 2013; Land, 2013; Saddiqui & Marcus, 2017). Addressing these human-centred skills can support the emphasis on equality of opportunity for female students. This chapter will examine these and other ways in which tertiary institutions play a role in improving female representation in STEM fields.

Institutions of higher learning have always played a vital role in encouraging the participation of women in the STEM fields, as key gateways to STEM employment. The higher education sector still struggles to achieve proportionate or even substantial representation of the female workforce. As a kind of snowball effect, with a disproportionately small number of women employed in STEM fields, their impact is limited as role models to women students. Similarly, higher education generally fails to challenge the dominant gender-stereotypical cultures and non-diverse workplace environments in STEM (Cheryan et al., 2016).

This chapter presents the following research question for evaluation: "What role can higher learning institutions play in improving the participation of females in STEM fields?"

THE ROLE OF INSTITUTIONS OF HIGHER LEARNING IN INCREASING STEM FEMALE PARTICIPATION

A range of factors contribute to strongly or disproportionately gendered STEM representation in higher learning institutions, including the following.

Standard STEM academic programmes. Traditional STEM offerings tend to focus narrowly on STEM majors and electives, with no attention to cultivating creativity and human-centred approaches in problem inquiry (Taylor & Taylor, 2017). While methods such as design thinking and co-design (Bequette & Bequette, 2012; Boy, 2013) are finding their way into some engineering and computing curriculums, STEM programmes' slowness in adapting means that fewer female students take STEM courses.

Cheryan, Ziegler and Montoya (2017) examined the relative prevalence of female students in the U.S. in biology, chemistry, and mathematics courses, in comparison to their numbers in engineering, computer science, and physical sciences courses. In addition to a dominating masculine culture, they point to a lack of practical opportunities for women in those fields, deterring women from enrolling as well as contributing to women leaving these programmes.

Pipeline factors. In countries where women's uptake of STEM academic programmes is especially low, the decline can be seen at the high-school level, when girls' interest in participating in mathematics and science subjects starts to decrease (Ellis et al., 2016; Shabangu, 2015; UNESCO, 2016a). Increased participation in higher learning institutions is unlikely, if learners have not acquired prerequisite skills at lower educational levels. The absence of primary female interaction in schools with the STEM subject field can also further affect the uptake of these programmes in higher learning institutions (Cheryan et al., 2016). While many higher learning institutions have created bridging opportunities to enable such learners to further their studies, continued focus is needed on basic education in mathematics and science. Additionally, in the OECD countries and the U.S., the cost of higher education puts it out of reach for many (Malsen, 2017).

Role models and stereotyping. In the UK, the Higher Education Statistics Agency (2016/2017) found that only 25% of professors are women, and only a fraction of them hold senior academic positions in STEM fields. Similar patterns hold in countries such as South Africa and the U.S., indicating a near-absence of women role models for students in STEM. More generally, gender stereotyping throughout society and the media has been identified as a contributing factor affecting the uptake of STEM studies in higher education (Wang and Degol, 2017).

Gendered content and programmes. School textbooks typically depict males dominating the science environment, while providing historical examples of men predominantly making significant contributions to the STEM field.

Lack of skilled teachers. To achieve SDG4, quality education, UNESCO has estimated the need for over 69 million teachers (UNESCO, 2016b). This need is particularly concentrated in mathematics and science-related subjects. Universities and vocational training institutions have a role to play in producing teachers with skills to meet the twenty-first century STEM demands, especially in countries where few women are engaged in STEM higher-learning institutions.

High gender equality and low uptake. Women may be underrepresented in STEM fields even in countries with high gender equality. Nordic countries that rank high in terms of gender equality were shown to have some of the lowest numbers of STEM female graduates in the world (Sossamon, 2018). Access to opportunities does not always mean guaranteed uptake of STEM subjects by young women. The lack of female representation in such resource-rich economies calls for further investigation into such factors as STEM role modelling, pipelining, and academic and workplace cultures in contributing to the lack of gender representation.

A UNESCO report on the levels of women's employment in STEM in Asia-Pacific countries found wide disparities: Japan at 15% and Korea at 18% of the STEM workforce, as compared to Kazakstan at 52% and Thailand at 53% (UNESCO, 2016a). Khazakstan and Thailand showed the highest participation of women in both higher learning institutions and the labour force. In the U.S., 14% of engineers are women, compared to 45% of mathematicians and 47% of employees in life sciences (UNESCO, 2016a). The fact that gender-sensitive policies do not always translate into increased participation of women in STEM fields can also be seen in the low participation levels in developed G20 countries compared to those in gender-conservative countries such as Algeria, Turkey, and the United Arab Emirates.
The role of higher learning institutions is fundamental to educating the labour force in STEM fields as well as producing researchers and entrepreneurs. Gender awareness needs to be incorporated as a critical factor in national science and technology programmes. In addition, efforts need to be focused at the local level to attain the SDGs (Miroux, 2011).

IMPACT OF STATE POLICY ON HIGHER EDUCATION

Policies affecting STEM in higher-learning institutions differ markedly from one country to another. In OECD countries, including Korea and Japan, STEM policies are aimed at broadly increasing the workforce to fill the demands of mature industries. In the BRIC nations (Brazil, Russia, India, and China), STEM policies are aimed at generally improving the education system, mindful of related socio-welfare issues, alongside the specific need to grow STEM industries. Countries which have prioritised the STEM sectors, as well as increased participation of women and youth in these fields, show significant progress as a result of targeted strategies of implementation and funding (Marginson et al., 2013).

Education and employment. Women represent 28% of personnel in science research and development globally (UNESCO, 2018). Tunisia has the highest representation of females in STEM research, at 55% of the workforce, followed by South Africa at 48%. South Africa increased from 43.7% in 2015 by prioritising women's empowerment across all relevant ministries; national STEM research centers — the South African National Research Foundation and the National Department of Science and Technology —prioritise women and girls for educational scholarships and employment opportunities. The African Union Agenda 2063 places focus on prioritising STEM education, with women as key STEM beneficiaries, both in education and business. Rwanda has also experienced a steady increase in women's participation in both primary and higher STEM education, owing to Rwanda Vision 2020, a governmental development programme that identifies women as the key beneficiaries of such funding increases.

Language inclusion. Several studies show that language can become a barrier in expanding STEM education and access to related opportunities. Inclusive language policies can therefore enhance STEM participation. Kenya supports the use of the mother tongue in primary education; China and Sweden have programmes designed for minority speakers; and Netherlands and Norway have programmes targeted to immigrant children.

Stoet and Geary (2018) used national data on secondary and tertiary education to evaluate the secondary school performance of females in STEM-related subject areas, and to evaluate gender representation among graduates and identify factors behind disparities between countries. They cited two key factors affecting female retention in STEM education: individual performance in the STEM subject areas, and the potential economic benefits associated with sought-after STEM skills. The study suggested that the greater the potential benefits, the more likely women would be to pursue STEM education, even in conservative countries. The study found notably high STEM graduate representation of women in Algeria, at 41%, in contrast to Finland and other countries highly ranked in the Global Gender Gap Index (Figure 6.1).

INCREASING FEMALE REPRESENTATION IN STEM EDUCATION

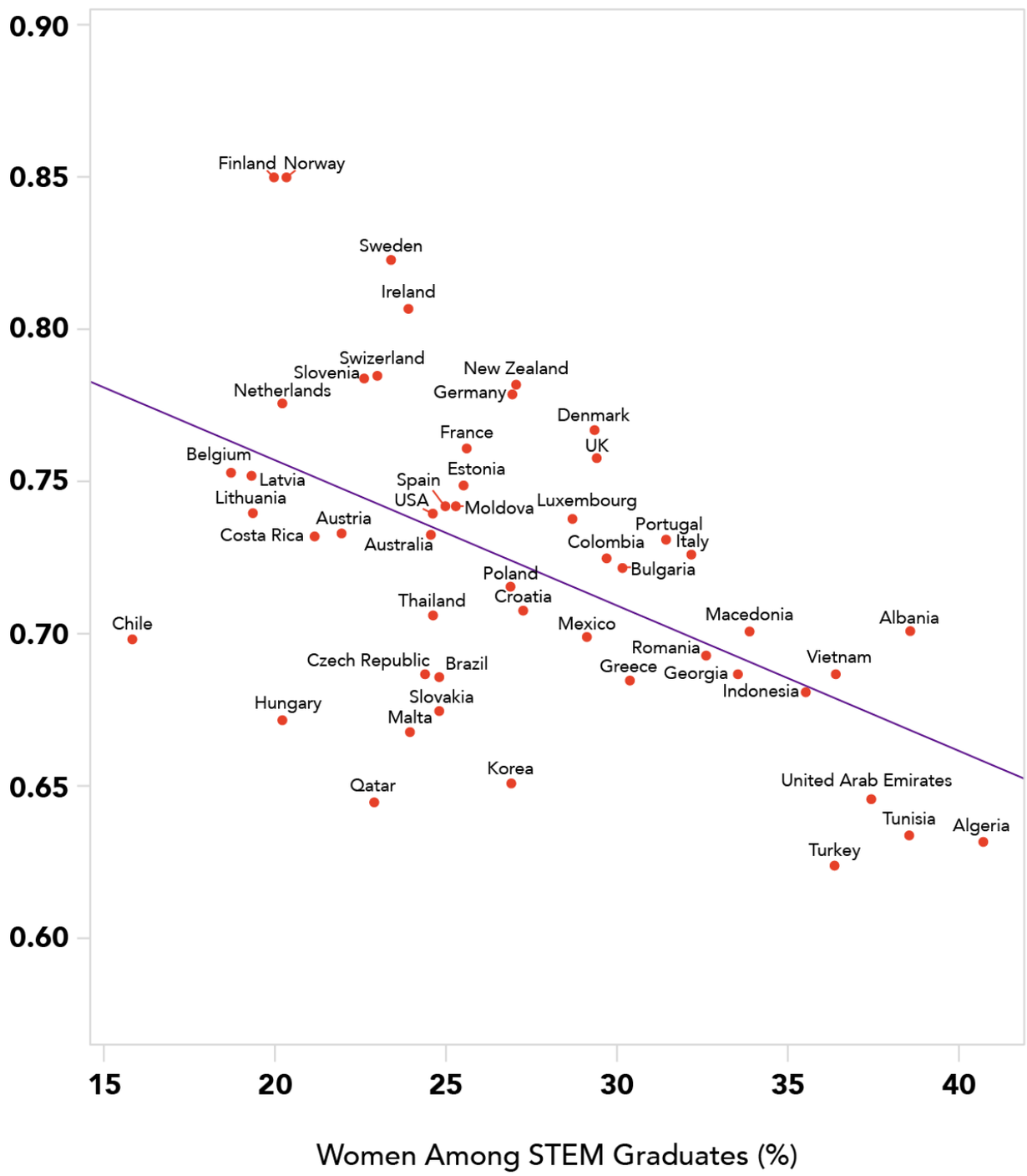
Higher learning institutions can encourage participation of women through various approaches, such as gender-sensitive funding and gender-focused academic programmes. National policies can motivate the schools to support girls to enter higher learning institutions. This section evaluates some of these efforts.

Mentoring and teacher programmes. The 2009 "Educate to Innovate" policy in the U.S. led funding programmes to focus on increasing STEM participation and representation. For example, the commitment to increase public-private partnership to fund STEM programmes enabled higher learning institutions to train over 10,000 STEM teachers (Burke & McNeill, 2011). Another initiative was the Bringing Up Girls in Science programme, funded by the U.S. National Science Foundation — an after-school science curriculum for girls that also linked school learners with university female mentors. A follow-up study found that the participants subsequently had a greater understanding and exposure to STEM fields (Wood et al., 2011).

Programmes such as the MIT Women's Initiative (MIT, 2018) present examples of partnerships between schools and higher learning institutions aimed at improving STEM participation. The MIT initiative assists teachers to create content tailored towards attracting young girls to STEM and helping them understand concepts in mathematics and science. Participants conduct a series of intriguing experiments and hear from university students about their experiences, giving them a better understanding of the work required for STEM participation.

Internationally, such initiatives have grown significantly. Developers in Vogue (Ghana) teaches young girls software development skills and links them to related work opportunities. Girl Hype (South Africa) is an entrepreneurship and coding academy giving women digital work skills. Feminist Approaches to Technology (India) educates young girls in using technology to empower themselves, to explore, and to develop leadership skills. Levers in Heels (Africa) introduces girl students to women in academia and STEM professions, and showcases research about women in STEM. WomenEng, a women-in-

Figure 6.1
Percentage of females among STEM graduates, by country



Source: Stoet and Geary, 2018, pp. 587.
Note: Y axis = country's percentage on the Global Gender Gap Index (higher percentage is more equal); X axis = country's percentage of female graduates

engineering organisation, provides engineering education programmes in Malawi, Mexico, Brazil, South Africa, and Kenya. The programmes are geared towards providing fellowships for young women in the engineering field, giving them theoretical instruction, practical experiences, and mentoring to pursue an engineering career.

Creating a community of female academics. Universities in the U.S. have created initiatives, such as Empowering Women in Science (Cornell) and Engineering Women (University of Minnesota), that showcase professional women in STEM research and facilitate seminars on positions and compensation in STEM (Sportelli, 2016). Cornell now observes an equal uptake of engineering programmes by male and female students as a result of intensive outreach[63]. Such programmes provide a network, enabling women students to become aware of opportunities in STEM and fostering relationships between senior and junior females in STEM fields. This approach also promotes the retention of young women in STEM through mentoring opportunities.

In Kenya, the Women for Science Working Group developed out of The Network of African Science Academies; it aims to enable a network of women in STEM fields, cultivating collaboration and sharing experiences among women in related research and academic institutions, with the aim of influencing priority areas of research. The network's publications showcase the contribution of African women in STEM fields. A growing number of awards recognise the contribution of women in STEM fields. The United Nations "Equals in Tech" Awards includes a skills and research category to recognise women in the STEM field; the African Union Kwame Nkrumah Awards for Scientific Excellence includes a category recognising women in STEM fields.

Funding. There has been a global increase in academic funding earmarked for outstanding women in STEM, such as the Graca Machel scholarship for women from the South African Development Community (SADC) region, the Anita Borg Global Scholarship, and L'Oréal-UNESCO Fellowships for Women in Science. Such initiatives enable talented females to pursue studies in STEM fields in prestigious academic institutions while growing their research expertise.

A South African example combines government policy with government and private sector funding. Ranked eighteenth on the World Economic Forum Global Gender Index, South Africa adopted targeted policies to increase representation of women in the STEM fields. Through a public-private partnership between the South African National Research Foundation (NRF) and the First Rand Foundation of the private banking sector, funding is earmarked to enable over 40 women in South Africa's higher learning institutions to focus on their research and ultimately to increase the number of female professors, particularly in the STEM field.

63 *https://i100rocks.com/news/025520-cornell-engineering-women/*

CONCLUSIONS AND FURTHER WORK

Institutions of higher learning play a critical role, both in training women as STEM employees and entrepreneurs and in conducting research in STEM. The lack of female academics in STEM fields means that girl students have few role models. Teaching and learning resources are rarely gender-sensitive, and examples from text books lack diverse gender representation. Language barriers can also place barriers in the teaching and learning process when female students are not first-language speakers of the language of instruction.

Exposure to STEM fields at an early age is a critical factor in the uptake of STEM courses. Programmes that encourage suitable teaching and learning environments for women in STEM have encouraged increased female representation across the field. Institutional initiatives can be further strengthened by national and regional policies as well as funding support. Further studies in this area might provide longitudinal findings on the success of initiatives from primary level through tertiary education to women's employment in STEM fields. Contextual and localised Massive Open Online Courses (MOOCs) as well as open educational resources can also introduce girls to basic STEM skills (ideally through accessible open platforms), enabling young women in almost any context to access educational resources of high value.

REFERENCES

Bequette, J.W. & Bequette, M.B. (2012). A place for art and design education in the STEM conversation. Art Education, 65(2), pp.40-47.

Boy, G.A. (2013). From STEM to STEM: Toward a human-centred education, creativity and learning thinking. In: Proceedings of the 31st European Conference on Cognitive Ergonomics, p. 3. ACM.

Burke, L.M. & McNeill, J.B. (2011). Educate to innovate: How the Obama plan for STEM education falls short. Backgrounder, 2504, 1-8.

Cheryan, S., Ziegler, S.A., Montoya, A.K. & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? Psychological Bulletin, 143(1), 1.

Ellis, J., Fosdick, B.K. & Rasmussen, C. (2016). Women 1.5 times more likely to leave STEM pipeline after calculus compared to men: Lack of mathematical confidence a potential culprit. PloS One, 11(7), p.e0157447.

HESA. Higher Education Staff Statistics: UK (2016/17). Retrieved from: https://www.hesa.ac.uk/news/18-01-

2018/sfr248-higher-education-staff-statistics

Land, M.H. (2013). Full STEM ahead: The benefits of integrating the arts into STEM. Procedia Computer Science, 20, 547-552.

Malsen, G. (2017). Most university students in OECD now pay tuition fees. Retrieved from: www.universityworldnews.com/article.php?story=20170916062250661

Marginson, S., Tytler, R., Freeman, B. & Roberts, K. (2013). STEM: Country comparisons: International comparisons of science, technology, engineering and mathematics (STEM) education. Melbourne: Australian Council of Learned Academies.

Mejia, Z. (2018). More women entered STEM over the past 40 years than any other field, new data shows. CNBC. Retrieved from: https://www.cnbc.com/2018/03/07/more-women-entered-stem-over-the-past-40-years-than-any-other-field.html

MIT. MIT women's initiative: Inspiring ideas for girls. Retrieved from: web.mit.edu/wi/

Miroux, A. (2011). Mainstreaming a gender perspective in science, technology, and innovation policy. Interactive expert panel: Key policy initiatives and capacity building mainstreaming – Focus on science and technology. United Nations Commission on the Status of Women, 55th Session.

Reyes, M.E. (2011). Unique challenges for women of color in STEM transferring from community colleges to universities. Harvard Educational Review, 81(2), 241-263.

Saddiqui, S. & Marcus, M. (2017). STEM and project-based learning: Equipping young women with 21st century skills. World Academy of Science, Engineering and Technology, International Journal of Educational and Pedagogical Sciences, 4(12).

Savaria, M. & Monteiro, K. (2017). A critical discourse analysis of engineering course syllabi and recommendations for increasing engagement among women in STEM. Journal of STEM Education: Innovations and Research, 18(1).

Sassler, S., Michelmore, K. & Smith, K. (2017). A tale of two majors: Explaining the gender gap in STEM employment among computer science and engineering degree holders. Social Sciences, 6(3), 69.

Schwab, K. (2016). The Fourth Industrial Revolution: What it means, how to respond. Retrieved from: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Shabangu, M. (2015). The status of women in the South African economy. Retrieved from: https://www.gov.za/sites/www.gov.za/files/Status_of_women_in_SA_economy.pdf

Sossamon, J. (2018). In countries with higher gender equality, women are less likely to get STEM degrees. Retrieved from: https://www.weforum.org/agenda/2018/02/does-gender-equality-result-in-fewer-female-stem-grads/

Sportelli, N. (2016). The 13 most important STEM colleges for women. Forbes. Retrieved from: https://www.forbes.com/sites/nataliesportelli/2016/03/29/13-best-value-stem-colleges-for-women/#7de6d9ce7686.

Stoet, G. & Geary, D.C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. Psychological Science, 29(4), 581-593.

Taylor, E. & Taylor, P.C. (2017). Breaking down enlightenment silos: From STEM to STEAM education, and beyond. In: Bryan, L.A. & Tobin, K.G. (Eds.), Thirteen Questions: Reframing Education's Conversation: Science (455-472). New York: Peter Lang Publishing.

Wang, M.T. & Degol, J.L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. Educational Psychology Review, 29 (1), 119-140.

UNESCO. (2016a). Closing the gender gap in STEM. UNECSO Asia Pacific education thematic brief.
UNESCO. (2016b). The World Needs Almost 69 Million New Teachers to Reach the 2030 Education Goals. Retrieved from: http://uis.unesco.org/en/topic/teachers

7

THE GENDER WAGE GAP IN THE DIGITAL ERA: THE ROLE OF SKILLS

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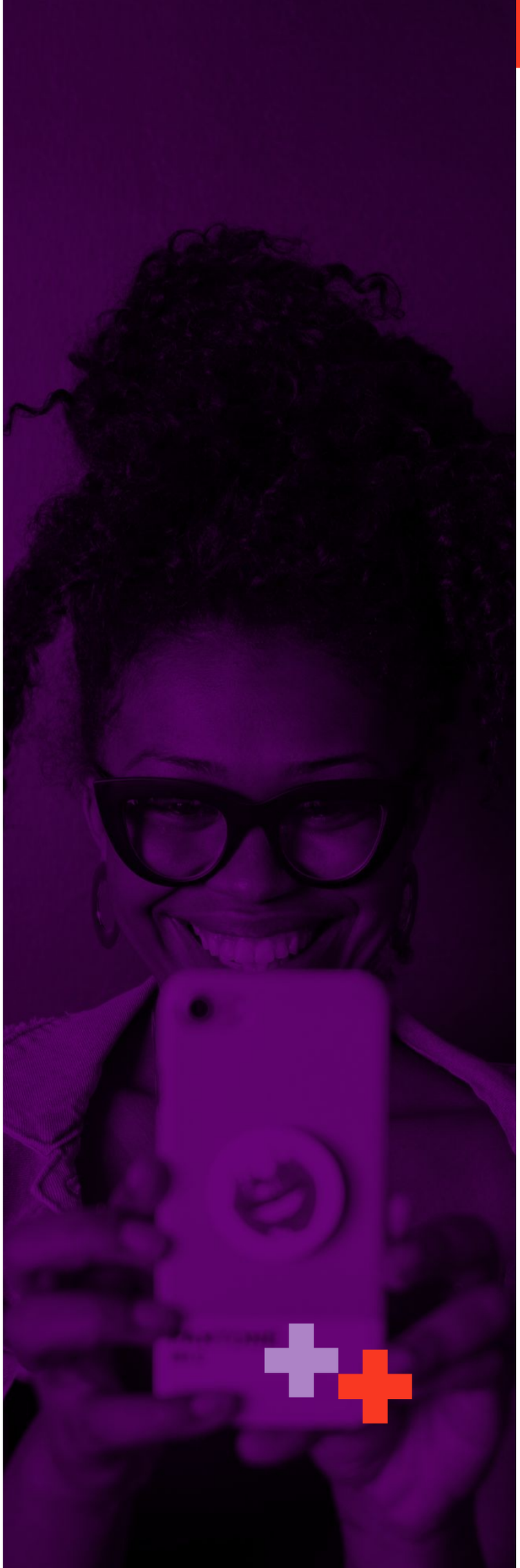


ABSTRACT

As the digital revolution contributes to changing the nature and content of jobs, the demand for skills also changes. This chapter addresses whether women are equipped with the skills needed to navigate the digital economy. It analyses data from 31 countries to compare the returns to skills for men and women in terms of wages, and how these returns vary between digital-intensive and other industries. If labour markets value different skills differently, with greater rewards to specific skills needed in the digital era, wage differences should highlight high-demand skills and show the degrees of wage variation in digital-intensive in comparison to other industries. Results show that the digital transformation may be contributing to widening the gender wage gap: digital-intensive sectors display greater gender wage disparities than less digital-intensive sectors, even after accounting for specific features of workers and places of employment.

KEY FINDINGS

- Variations in workers' skills, both cognitive and non-cognitive, explain only part of the gender wage gap, in 31 countries.
- Men on average are more likely than women to have the task-based skills that are most demanded in digital-intensive industries: managing and communication, self-organisation, and advanced numeracy skills.
- Men generally obtain higher returns than women for the same high-demand skills in digitally intensive sectors, but not in less digitally intensive industries.
- Women are more likely than men to have specific information and communication technology (ICT) task-based skills, and they are better rewarded for them, in both digital-intensive and less digital-intensive sectors.

A NARROWING GENDER WAGE GAP?

Significant progress has been made in recent years to reduce gender inequality along many dimensions. Young girls in OECD countries now out-perform boys at school and represent the majority of tertiary graduates (OECD, 2017a, 2017b). Gender gaps in employment also appear to have narrowed, although a 12-percentage point difference in labour market participation still exists, on average, across OECD countries. Importantly, gender inequality features among the top policy priorities of G20 and G7 countries; in 2014, G20 countries adopted as a key goal narrowing the gender gap in labour force participation by 25% by 2025[64].

Despite all this, there is still a long way to go to attain gender equality. In higher education, girls are not well represented in the scientific and technical disciplines, areas currently commanding high wages. In OECD countries, the gender wage gap still averages 14.3% across all sectors (OECD, 2017b). Women are scarce in senior management, public leadership, and entrepreneurship roles, accounting for only 4.8% of CEOs in 2016. It is likely that similar, if not greater, gender wage gaps exist in non-OECD countries.

The ongoing digital transformation is already affecting the life and work of women. On the one hand, the transformation can offer women new opportunities for economic empowerment, through new forms of work created by e-businesses, workspace platforms, and flexible working arrangements, for example. On the other hand, digital technologies may increase the gender divide, if women lack the needed skills or if flexible work arrangements mean low quality jobs.

This chapter points to specific policies which can ensure that women are equipped with the skills needed to thrive in the digital era. To what extent do skill differences between men and women contribute to the gender wage gap? What types of skills are in high demand in the digital era, and how do various industries reward them?[65] Econometric analysis allows us to explore the factors determining individual wages, in digital-intensive versus less digital-intensive sectors, with a focus on workers' skills. Data comes from the Programme for the International Assessment of Adult Skills (PIAAC) dataset, described below.

Skills are found to explain part — but not all — of the gender wage gap; differences emerge in the way digital-intensive and less digital-intensive sectors reward workers' skills. On average, men are more likely to have the skills most in demand in digital-intensive industries: managing and communication, self-organisation, and advanced numeracy skills, and are likely to obtain higher returns than women with the same skills in digitally-intensive sectors[66]. Women are more likely than men to have ICT task-based skills, and they are rewarded relatively more for them, in both digital-intensive and less digital-intensive sectors, than men with similar skills.

64 *http://www.g20.utoronto.ca/2014/2014-1116-communique.html*

65 *These skills need not perfectly coincide with "digital skills" as defined in different contexts (e.g., OECD, 2016; Carretero et al., 2017).*

66 *Self-organisation here relates to workers' ability to plan or decide the tasks to be carried out, the style and speed of work, and the possibility to plan working hours. Management and communication task-based skills relate to negotiating with people, planning the activities of others, and to instructing, advising, persuading or influencing others.*

Many factors, observable and unobservable, contribute to shape the gender wage gap, as reviewed in Blau and Kahn (2017). These can include: schooling, work experience, psycho-emotional characteristics, sector of employment, family responsibilities, and job characteristics, as well as cultural norms and discrimination. Gender may affect the specific tasks carried out on the job: women may be less able to commit to tasks requiring flexibility in working hours, or travelling on short notice (Goldin, 2014). This chapter finally takes note of how digital technologies are affecting some components of work.

THE GENDER WAGE GAP IN THE DIGITAL ERA: THE ROLE OF SKILLS

The last century saw narrowing differences between men and women in terms of labour force participation, paid hours of work, and hours devoted to household production, as well as in type of occupation, educational attainment, and choice of college majors (Goldin et al., 2006). Gender wage gaps also narrowed, to varying extent among different countries (OECD, 2017b). Examining the relationship between workers' wages and their competencies and skill use at work, we can assess the contribution of workers' skills to the gender wage gap. A novel OECD index shows the digital penetration of industries (Calvino, Criscuolo, Marcolin, & Squicciarini, 2018), allowing us to compare the wage gender gap and its determinants in digital-intensive as compared to less digital-intensive industries, while controlling for features such as workers' education and age and size of firm.

We rely on measures of the cognitive, non-cognitive, and social skills of workers for 31 countries, as extracted from the OECD Survey of Adult Skills (Programme for International Assessment of Adult Competencies, or PIAAC) (Grundke, Kalamova, Keslair, Jamet, & Squicciarini, 2017). PIAAC surveyed 154,293 individuals aged 16–65, between 2012 and 2015, in 31 countries (all but three OECD countries). In each country, the sample was chosen to be representative of the population (albeit with different sampling schemes). We combine the skills results with PIAAC-based information on labour market participation and the socio-economic background of workers[67]. The analysis assumes that work is composed of a set of tasks which workers are required to carry out on the job, and for which they are rewarded. This is in line with studies arguing that human capital needs are highly specific to the particular tasks carried out, and less determined by the occupation, industry, or firm (Gathman & Schoenberg, 2010; Gibbons & Waldman, 2004; Poletaev & Robinson, 2008)[68].

67 *OECD (2018c).*

68 *Several studies take a task perspective in assessing the returns to working in a given occupation, and how technological change affects them (e.g., Acemoglu & Autor, 2011; Acemoglu & Handel, 2013).*

Cognitive and socio-emotional skills are both considered in the analysis. Studies point to the role of social skills and personality traits in determining earnings (Heckman, Stixrud, & Urzua, 2006; Heckman & Kautz, 2012), and combinations of social and cognitive skills are seen to be especially rewarded (Deming & Kahn, 2017; Weinberger, 2014) — particularly in jobs that are more ICT-intensive (Deming, 2017).

AN EMPIRICAL ASSESSMENT OF THE RETURNS TO SKILLS IN DIGITAL-INTENSIVE AND LESS DIGITAL-INTENSIVE SECTORS

To understand how the digital transformation affects the demand for different types of skills — cognitive, non-cognitive, and social — we examine how workers' skills are rewarded and whether rewards vary according to the digital intensity of the sector. Valued skills in short supply should command higher returns. Higher returns in digital-intensive industries, accordingly, should point to the skills that are in relatively high demand in jobs that are more exposed to the digital transformation, and that may represent needed complements to the deployment of digital technologies at the workplace[69].

The analysis is carried out on data from the OECD Survey of Adult Skills (PIAAC), covering 31 countries. PIAAC provides a wealth of information about workers' skills, the tasks they perform on the job, and their workplace, making it possible to estimate the role of skills in determining wages with greater accuracy than in the past. Workers' cognitive skills (literacy, numeracy, and problem solving in technology-rich environments) are assessed through administered tests, limiting the risk of mismeasurement. By relying on the six task-based skill indicators identified in Grundke et al. (2017), it is possible to see how non-cognitive and social skills are rewarded in both digital and less digital-intensive industries.

Digital-intensive and less digital-intensive industries are identified on the basis of an OECD taxonomy (Calvino et al., 2018) that uses selected indicators to assess the degree of digital transformation of particular sectors. The authors have collected and cleaned data on several of these indicators of digital transformation, specifically targeting technological, market, and human capital components. The technological component is proxied by the sector's intensity in ICT investment, including purchases of intermediate ICT goods and services as well as robots. The human capital component is proxied by the share

69 *For a full description of the approach, see Grundke et al. (2018).*

of ICT specialists in the workforce. Digital marketing is proxied by the share of e-commerce. Sectors are ranked along each dimension, and the rankings are then aggregated to yield a single taxonomy of sectors by digital intensity[70]. (Sectors are defined according to the UN classification, published as the International Standard Industrial Classification (ISIC), Revision 4.)

We control for many characteristics relating to wage or skill levels (e.g. years of education, age, gender, as well as country, industry, and occupation. The analysis isolates variation of skills and wages within the same type of job and aims for an unbiased comparison between men's and women's earnings. Differences in the occupational composition of digital and less digital-intensive industries should not influence the findings on return to workers' skills in different industries.

Digital-intensive industries appear to pay better than less-digital intensive industries for workers with higher levels of managing and communication, self-organisation, and advanced numeracy skills[71]. These results may reflect characteristics of tasks in those industries: the need to operate in a more independent or decentralised fashion; to communicate across disciplinary boundaries and in diverse and decentralised teams; to perform more non-routine tasks; to be better matched with the tasks to be carried out; or to deal with continuously changing settings, for which self-organisation, management, and communication skills are important.
Do women possess the skills that are more in demand in the digital era? Do rewards for these skills differ between men and women? These questions are key to understanding whether the gender divide may widen with the ongoing digital transformation.

70 *The dichotomy between digital and less digital-intensive sectors is an artefact used for analytical purposes. In reality, there is a distribution of digital intensity levels, both between and within sectors; moreover, specific employers may be more (or less) digitally intensive than their sector.*

71 *See Grundke et al. (2018) and OECD (2018c).*

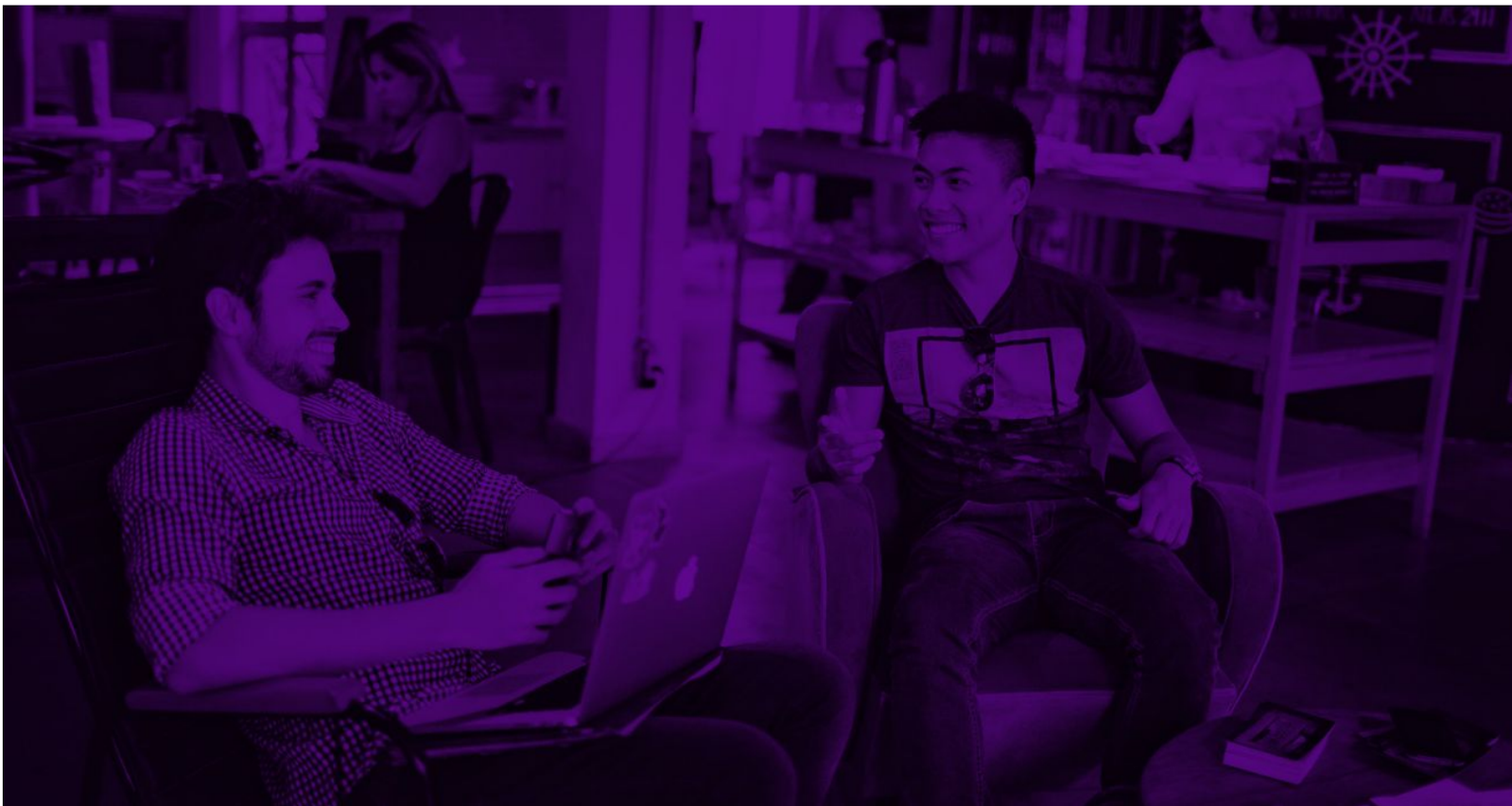
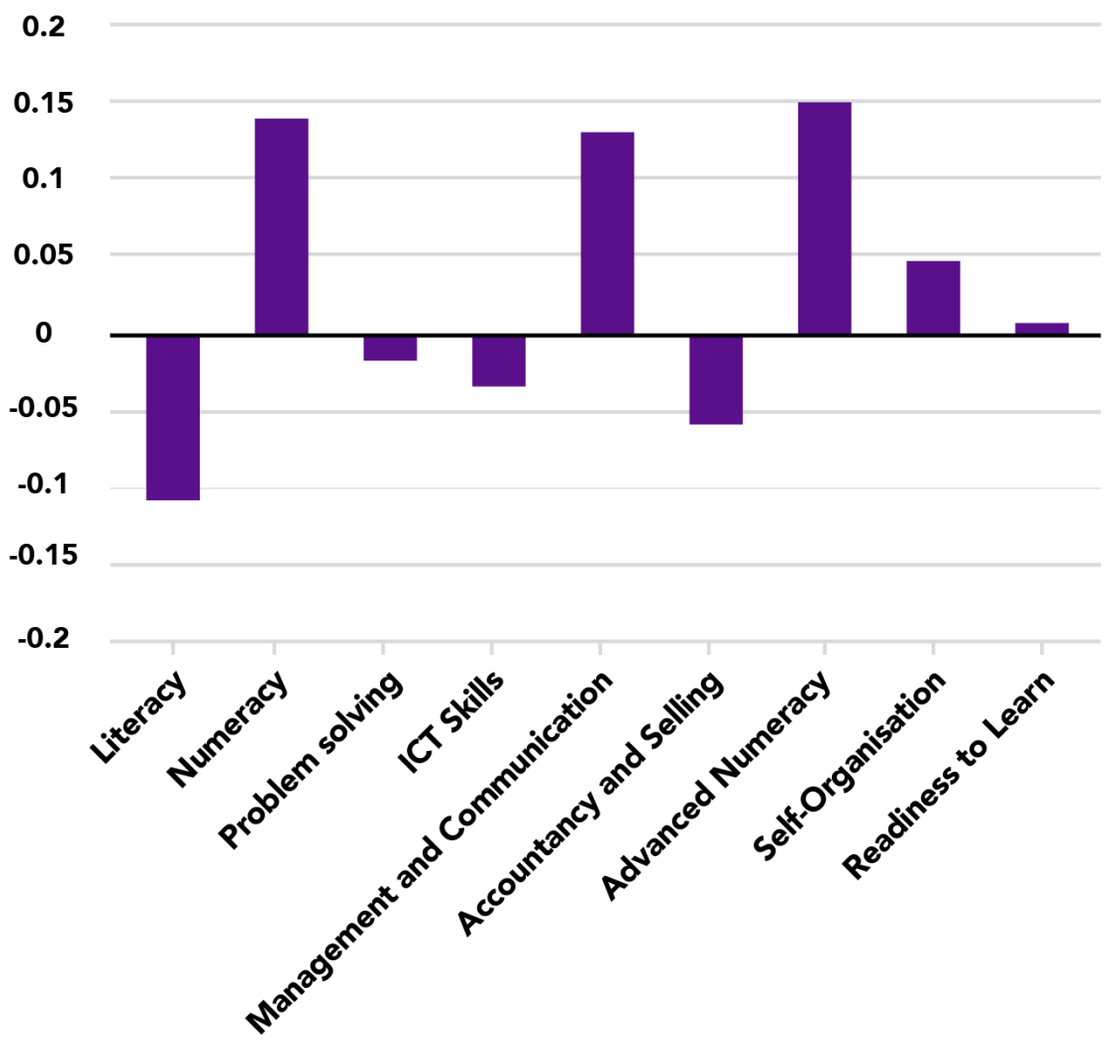


Figure 7.1
Difference in standardised skill scores between men and women
(conditional on covariates), 31 countries, 2012 or 2015



Source: OECD (2018c), based on PIAAC data.
Note: Differences in standardised skill scores between men and women are conditional on the covariates from the wage regressions. The skill measures are taken from Grundke et al. (2017). For each skill variable, OLS regressions of workers' skill endowment on the covariates from the wage regressions are estimated on the pooled set of 31 countries. For each of these regressions, the bars show the coefficients of the "male" variable, which takes value 1 if the individual is male and 0 if female. Striped bars signal that differences between men and women are not statistically significant at the 5% level. Bars above the x-axis represent the skills that men scored higher on; bars below the x-axis show skills that women scored higher on.

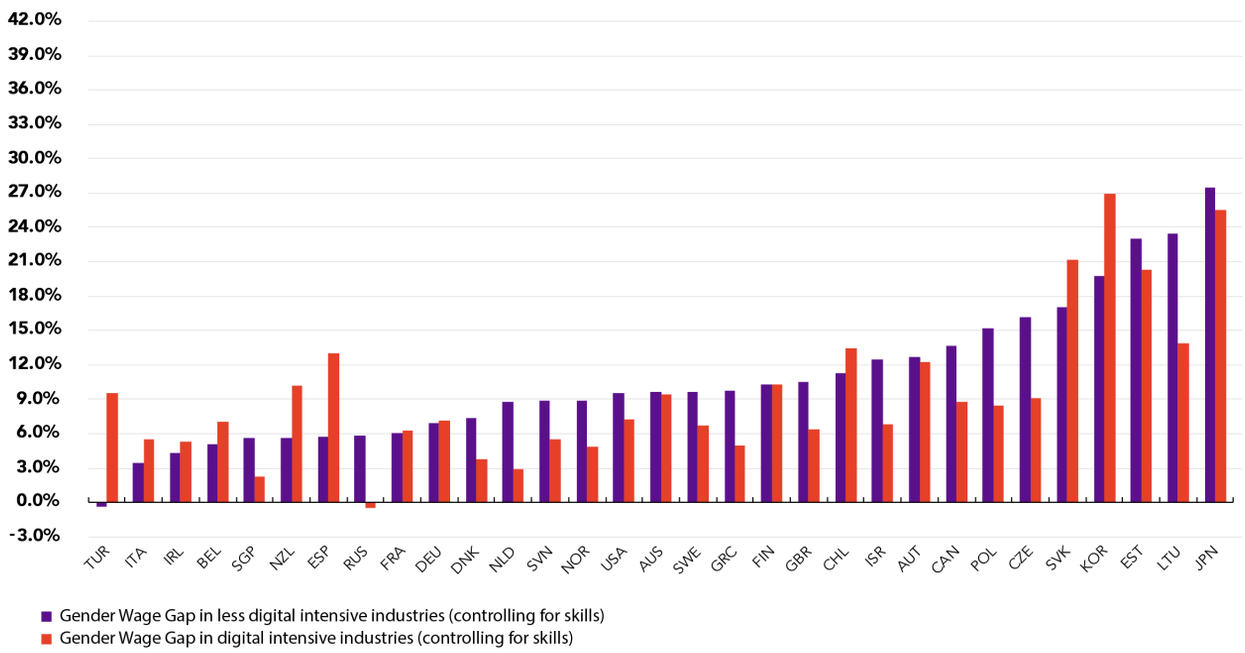
Figure 7.1 shows that men are generally more likely to possess the skills that command wage premiums in digital-intensive industries. Independent of age, education, occupation, country, industry, or size of firm, and whether full- or part-time, men overall have higher numeracy and advanced numeracy skills as well as higher task-based skills related to self-organisation, management, and communication[72].

These results are worrisome, especially because the digital transformation will ultimately affect all industries, including those that are less digital-intensive. Women's lower scores in the skills needed in the digital age may thus lead to increasing wage inequality between men and women. Additional results show that the gender wage gap is indeed higher in digital-intensive than in less digital-intensive industries (Figure 7.2). This is partly due to the different skills possessed by men and women: the

72 *See also OECD (2018c).*

Figure 7.2

Gender wage gap by country and industry (conditional difference in hourly wages for men and women, in %), 31 countries, 2012 or 2015



Source: OECD (2018c), based on PIAAC data.
Note: The figure shows the differences in hourly wages for men and women (in percentages) for employees in more and less digital-intensive industries. The estimates are based on OLS wage regressions, using data from the OECD Survey of Adult Skills (PIAAC), and control for the same covariates as in Figure 7.1 as well as for skills.

same graph displays larger gaps when not controlling for skills (results omitted here). (For more discussion, see OECD (2018c).) To address this effect of the digital transformation on gender-based income inequalities, governments need to ensure that women have opportunities to gain advanced numeracy skills and to develop management, communication, and self-organisation skills.

Nevertheless, women do not lag behind men across the whole spectrum of skills needed in the digital era. Women generally score better in literacy skills as well as in ICT, accountancy, and selling skills[73]. While women have higher ICT skills than men (and they conduct more ICT-related tasks than men in the same occupation), this may not be reflected in higher earnings. This study does not find higher returns to ICT skills in digital as compared to less digital-intensive industries, even though ICT skills are obviously important in the digital era. However, when we control for cognitive and task-based skills as well as country, industry, and occupation, we see ICT skills commanding the highest wage returns[74]. Possibly women's advantage in ICT skills may help to reduce gender-based wage inequality over time. Policy makers may therefore want to focus efforts on increasing ICT skills to reduce the gender wage gap.

Skill sets explain only part of the gender gap. When we control for cognitive, non-cognitive, and social skills, the gender wage gap is greater than can be explained by the difference in workers' skills[75]. In addition, the gap is considerably larger in digital-intensive industries than in less digital-intensive ones. Contributing factors may include women's longer out-of-work spells (e.g., for child-bearing), household duties, and gender-based roles and division of labour (Blau & Kahn 2017; Goldin, 2014). In addition to possible measurement issues, other factors in the wage gap may include gender discrimination. If digital-intensive industries reward men more than women for certain skills, more than is the case in less digital-intensive industries, the gender wage gap will be higher in digital-intensive industries even for workers with similar skills.

73 *ICT skills relate to the use of programming languages, emails, word processing software, and spreadsheets, as well as processing transactions through the internet.*

74 *See Grundke et al. (2018) and OECD (2018c).*

75 *See OECD (2018c).*

Figure 7.3 shows the skill returns for men and women in digital vs. less digital-intensive industries. Men obtain significantly higher returns than women for advanced numeracy and management and communication skills in digitally intensive industries (Figure 7.3a). The differences are not statistically significant in less digital-intensive industries (Figure 7.3b). However, for one of the key skills in the digital era — ICT skills — women obtain higher returns than men, in both digital-intensive and less digital-intensive industries. The analysis controlled for observable characteristics of the individual (age, education, part-time status) and for country, industry, occupation, and size of firm.

Factors that may contribute to the gender difference in earnings include: network effects among male colleagues; better wage bargaining outcomes stemming from the greater self-confidence of men (found, for instance, by Niederle & Vesterlund 2007); and proportionally higher bonuses associated with advanced numeracy and management and communication skills. Also, broader productivity effects may be a factor, if companies that are more productive require (and better reward) the skill sets more associated with men. Finally, if digital-intensive industries are more dynamic, they may require more competitive behaviours and stronger negotiation skills than less digital-intensive industries; this may hurt women, as studies have shown that women are less oriented to negotiating and competing than men and are more risk averse. For reviews, see Bertrand (2011) and Croson and Gneezy (2009).

Figure 7.3
Labour market returns to skills by gender across 31 countries, 2012 or 2015

Figure 7.3a
Digital-intensive industries

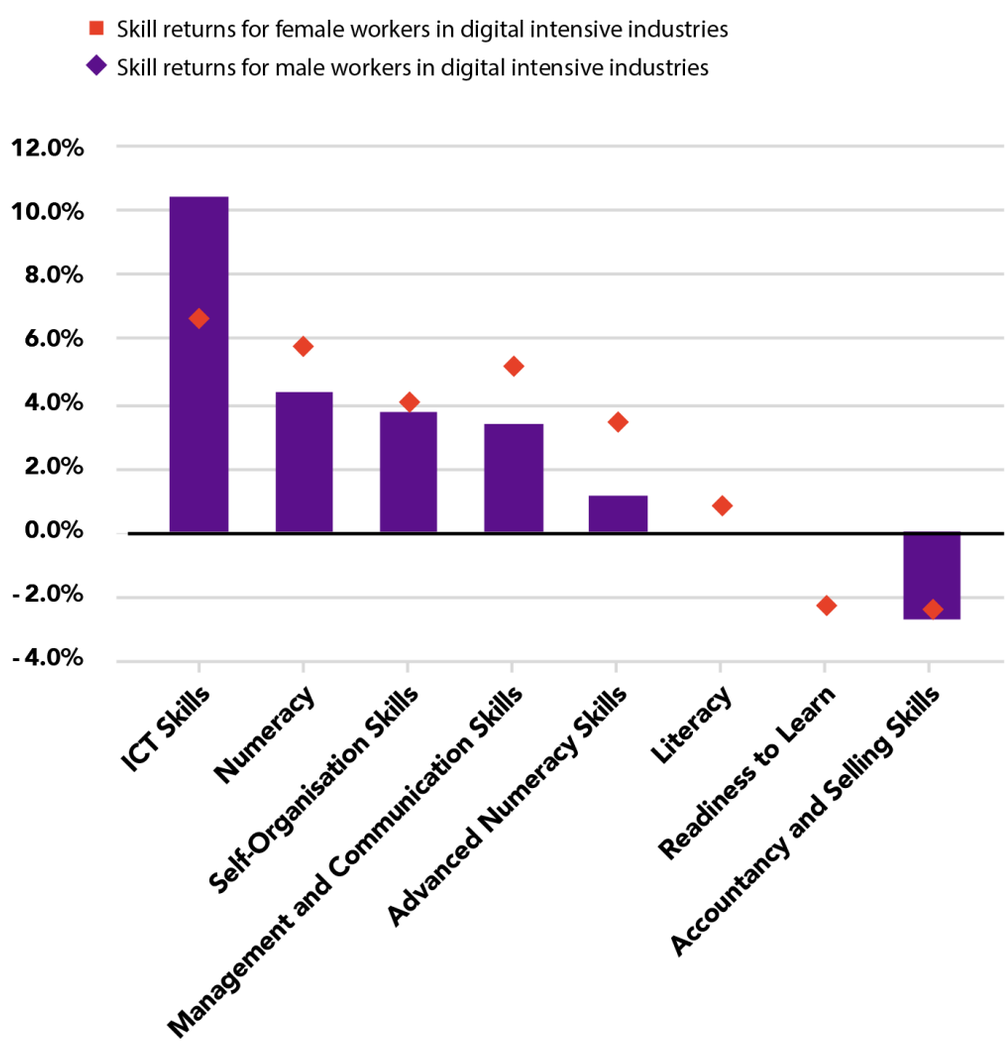
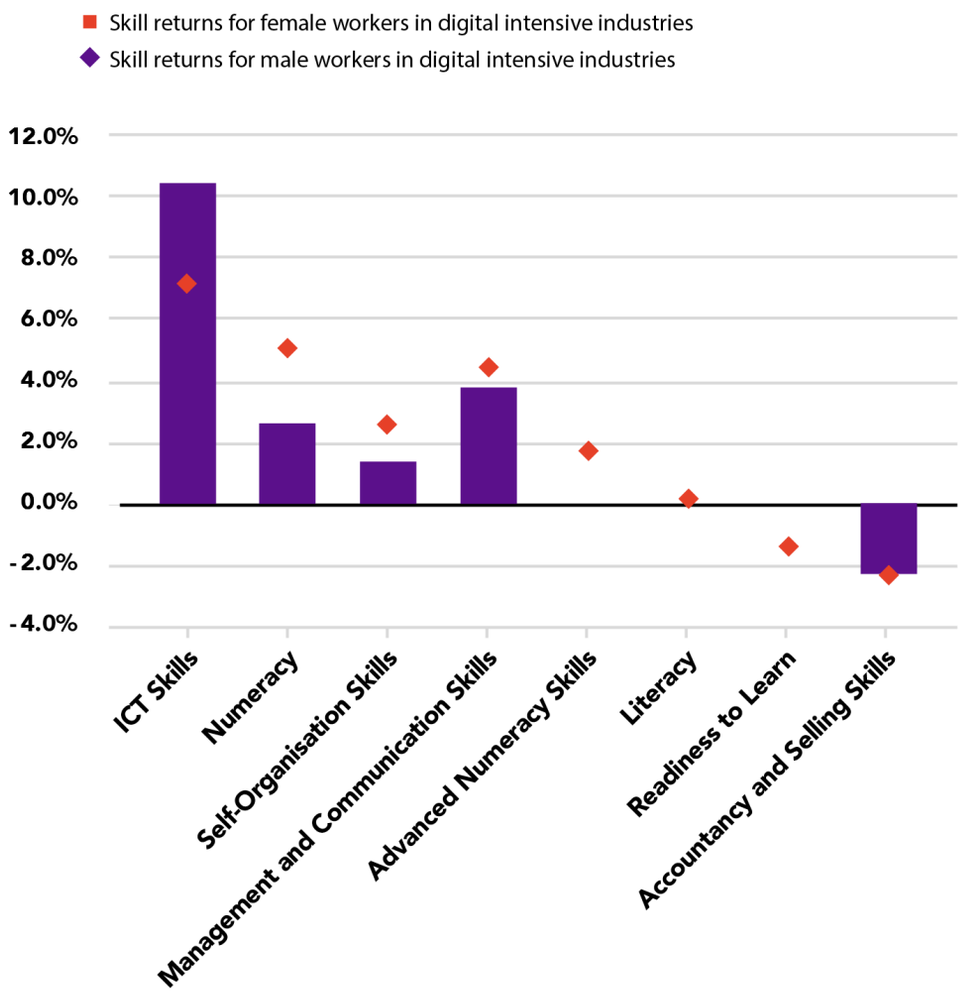


Figure 7.3b

Less digital-intensive industries



Source: OECD (2018c), based on PIAAC data.
Note: Results are based on OLS wage regressions pooling data for 31 countries. Digital-intensive industries are defined following Calvino et al. (2018). Skill measures are based on PIAAC and are taken from Grundke et al. (2017). The estimates by gender are obtained by including an interaction term of the skill variable and a variable taking value 1 if the individual is male and 0 if female. Wage regressions control for the same covariates as in the baseline analysis. The figure shows the percentage changes in wages determined by an increase in skills by one standard deviation. Striped diamonds and bars indicate results that are not statistically significant at the 5% level.

CONCLUSIONS AND POLICY IMPLICATIONS

The digital transformation is deeply transforming economies and societies, including disrupting labour markets: some occupations are disappearing and others are changing in nature, as is the demand profile for skills. The speed, scale, and scope of the ongoing transformation far outmatches the lengthy timeframe for building the human capital required, and the associated need to adapt education and training systems. Governments need to act promptly to ensure that workers, especially women, are not left behind due to lack of relevant skills.

The digital transformation is changing the demand for skills in both OECD and non-OECD countries. A wide range of skills appears to be required for firms and individuals to perform successfully in the digital era: foundational skills such as literacy and numeracy; and skills that are transferable across jobs, including technical and socio-emotional skills (including self-organisation, management, and communication). However, skill sets differ as between men and women, and different skills are rewarded in different ways for men and women, in digital and less digital-intensive industries.

LEARNING MATTERS: SHARING THE COST AND BENEFITS OF LIFE-LONG LEARNING

Making the digital transformation more gender-inclusive entails extending education and training to all, and especially to girls and women, both at a young age and later in life. Narrowing the gender wage gap further requires giving girls a solid educational foundation, especially in numeracy, to address early gender gaps. Education and training may need to become more flexible and adaptive: the digital transformation enhances opportunities to learn outside of working or school hours, and digital tools can help mitigate or overcome societal barriers and norms. As the digital transformation accentuates the need to continue learning throughout life, policy makers need to (re)design life-long learning systems: providing sound initial education, and fostering synergies among all stakeholders — individuals, governments, and the private sector — to further enhance human capital, especially of women[76]. The private sector of course benefits directly from a trained workforce and also provides training for workers.

TECHNOLOGY FOR LEARNING

Recent years have seen significant progress in women's education. In OECD countries, more women now achieve tertiary education than men (OECD, 2017a); across the 31 countries considered, the proportion of women engaging in on-the-job training is higher, on average, than that of men (OECD, 2018a). However, when workers' characteristics are taken into account (e.g., age, education, part-time contracts, industry, and occupation), men are found to receive 5% longer training than women. In many non-OECD countries, women's access to education still lags behind men's. Digital technologies can support more equitable access to education and training by lowering the direct cost of accessing educational material, or by allowing distance learning on a flexible schedule — important for women having to combine education and household duties. Governments should ensure that access to technologies such as mobile phones and broadband is universal and equitable. This may require investments in infrastructure deployment, especially in remote areas, or financial schemes to lower the costs of accessing such technologies, especially for low-income individuals.

FOCUS ON THE 'RIGHT' (SETS OF) SKILLS

The gender wage gap is related in part to the type of skills possessed by workers. Digital technologies display different degrees of complementarity and substitutability of skill sets. Interestingly, women perform ICT-related tasks slightly more frequently than men; moreover, they are rewarded significantly more for those tasks and skills. Policies to promote ICT skills for women can help to narrow the gender wage gap.

Advanced numeracy (STEM) skills are among the most demanded skills in digital-intensive sectors, and these skills are associated more with male than female workers, even within narrowly defined industries and occupations. Policies to enhance female workers' advanced numeracy skills will therefore be important to address the gender wage gap. As skill set differences are influenced by educational choices, and the decision to pursue fields such as ICT and STEM (OECD, 2017b), educational policies are important: encouraging girls' enrolment in STEM studies at young ages; creating single-sex classes where women feel freer of stereotypes (Booth, Cardona-Sosa, & Nolen, 2014; Dustmann, Ku, & Kwak, 2017); facilitating women's access to STEM-related apprenticeships; and addressing gender biases in education curricula, parental preferences, and social norms (OECD, 2018c)[77]. These policies are relevant to both OECD and non-OECD countries; of course, equal access to education is an essential first step. The private and non-governmental sectors can also be involved in this effort, influencing the public debate and leading by example.

PROMOTE WOMEN'S PARTICIPATION IN LABOUR MARKETS

The skills mix needed to succeed in digital-intensive sectors includes non-technical skills such as management, communication, and self-organisational skills. Women may be hindered from developing these skills by constrained access to the labour market. This problem can be addressed directly through training programmes, and indirectly by fostering women's labour market participation. Digital technologies can facilitate women participation in the labour market by offering new work opportunities (e.g., through e-commerce and digital platforms) and by making work more flexible[78]. Flexible working arrangements, powered by technology, can enable individuals living in remote areas and those with costly commutes to enter the labour market or extend their working

76 *Under the "SkillsFuture" programme in Singapore, employers provide input about the skills they believe will be required by workers in the near future (3–5 years). Students and workers are then given a government subsidy through their learning accounts; they receive a skill certification at the end of the training.*

77 *For example, U.S. schools participating to the Building, Recruiting and Inclusion for Diversity (BRAID) initiative commit to several actions, including increasing the number of female instructors, providing teachers with better computer science teaching skills, or promote female role-models in STEM.*

78 *Platforms are likely to affect participation of women to the labour market, by decreasing the entry cost and possibly limiting the role of cultural norms. So far, however, platform work has been difficult to measure. When possible (albeit with approximation), "gig" workers were found to display lower returns to skill than employees or other self-employed individuals, independently on gender (OECD, 2018c).*

hours. Flexible arrangements can also be valuable for individuals constrained by family duties — preponderantly women — and can thus enhance female participation in the labour market. This has the potential to help women build their confidence, experience, human capital, and networks, and thus to reduce the gender wage gap over time. However, flexible work arrangements may translate into low-quality jobs (OECD, 2017b); they may also entail longer working hours and little separation between work and personal life. Policies should ensure that "more flexible" also means "better". Ideally, women's increased labour market participation would need to be accompanied by greater gender equality in household and family-related duties.

IMPROVE THE (GENDER) FAIRNESS OF THE SYSTEM

Women's lower labour market participation can reflect the uneven burden of family duties. Government policies can expand the public provision of child care services; they can also support a redistribution of family duties, for instance through paid paternal leave. Within the workplace, affirmative action and even quotas can be considered to address discrimination, especially in filling leadership positions. Improving the (gender) fairness of the economic system may at times require imposing a minimum number of women in governing boards, parliaments, or policy cabinets. However, softer approaches — such as voluntary target setting and disclosure of existing gender outcomes, often initiated within the private sector itself — may be effective while avoiding triggering confrontational attitudes (OECD, 2017a).

Policy measures have little hope of success where gender discrimination is ingrained in culture and society. Social norms influence women's participation in the labour market, as well as the way they may own and manage economic resources — including technology. While the role of such norms in shaping the gender gaps resists empirical analysis, they certainly contribute to the "residual" gender wage gap that remains when other determinants have been accounted for.

The socio-economic change fostered by the digital transformation can influence cultural norms, challenge traditional ideas on the role of women in society, and help women form new or different aspirations. These changes can be supported by information campaigns to raise awareness on gender discrimination, promote more gender-balanced narratives, and dispel stereotypes.

A HOLISTIC POLICY APPROACH TO THE GENDER GAP

Closing the gender gap in skills and wages requires cross-cutting approaches that involve most, if not all, aspects of public policy and that include specific gender-related objectives (OECD, 2018b). Digital strategies will be especially important in this regard, to shape the interplay between digital technologies and workers' jobs and skills.

REFERENCES

Acemoglu, D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In: D. Card & O. Ashenfelter (Eds.), Handbook of labour economics (1043-1171). San Diego and Amsterdam: Elsevier.

Autor, D. H., & Handel, M. J. (2013). Putting tasks to the test: Human capital, job tasks, and wages. Journal of Labor Economics, 31(S1), S59-S96. Retrieved from: https://doi.org/10.1086/669332

Blau, F. D., & Kahn, L. M. (2017). The gender wage gap: Extent, trends, and explanations. Journal of Economic Literature, 55(3), 789-865. Retrieved from: http://dx.doi.org/10.1257/jel.20160995

Booth, A., Cardona-Sosa, L., & Nolen, P. (2014). Gender differences in risk aversion: Do single-sex environments affect their development? Journal of economic behavior & organization, 99, 126-154. Retrieved from: https://doi.org/10.1016/j.jebo.2013.12.017

Calvino, F., Criscuolo, C., Marcolin, L., & Squicciarini, M. (2018). A taxonomy of digital sectors. Science, Technology and Industry Working Paper. Paris: OECD Publishing. Retrieved from: https://doi.org/10.1787/f404736a-en

Carretero, S., Vuorikari, R., & Punie, Y. (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. EUR 28558 EN. Retrieved from: http://doi.org/10.2760/38842

Croson, R. & U. Gneezy (2009). Gender Differences in Preferences. Journal of Economic Literature, 47(2), 448–74. Retrieved from: https://doi.org/10.1257/jel.47.2.448

David, H. (2015). Why are there still so many jobs? The history and future of workplace automation. Journal of Economic Perspectives, 29(3), 3-30. Retrieved from: http://dx.doi.org/10.1257/jep.29.3.3

Deming, D. J. (2017). The growing importance of social skills in the labor market. The Quarterly Journal of Economics, 132(4), 1593-1640. Retrieved from: https://doi.org/10.1093/qje/qjx022

Deming, D. J., & Kahn, L. B (2017). Firm Heterogeneity in Skill Demands. NBER Working Paper No. 23328. Washington, DC: National Bureau of Economic

Research, Inc.

Dustmann, C., Ku, H., & Kwak, D. W. (2018). Why are single-sex schools successful? Labour Economics, 54, 79-99.

Gathmann, C., & Schönberg, U. (2010). How general is human capital? A task-based approach. Journal of Labor Economics, 28(1), 1-49. Retrieved from: https://doi.org/10.1086/649786

Gibbons, R., & Waldman, M. (2004). Task-specific human capital. American Economic Review, 94(2), 203-207.

Goldin, C. (2014). A grand gender convergence: Its last chapter. American Economic Review, 104(4), 1091-1119. Retrieved from: http://dx.doi.org/10.1257/aer.104.4.1091

Grundke, R., Kalamova, M., Keslair, F., Jamet, S., & Squicciarini, M. (2017). Skills and Global Value Chains: A Characterisation. OECD Science, Technology and Industry Working Papers. Paris: OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/cdb5de9b-en

Grundke, R., Marcolin, L., & Squicciarini, M. (2018). Which skills for the digital era?: Returns to skills analysis. OECD Science, Technology and Industry Working Papers. Paris: OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/9a9479b5-en

Heckman, J. J., & Kautz, T. (2012). Hard evidence on soft skills. Labour economics, 19(4), 451-464. Retrieved from: https://doi.org/10.1016/j.labeco.2012.05.014

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. Journal of Labor economics, 24(3), 411-482. Retrieved from: http://dx.doi.org/10.1086/504455

Marianne, B. (2011). New perspectives on gender. In: O. Ashenfelter & D. Card (Eds.), Handbook of labor economics (1543–90). Amsterdam and Boston: Elsevier. Retrieved from: http://dx.doi.org/10.1016/S0169-7218(11)02415-4

Niederle, M., & Vesterlund, L. (2007). Do women shy away from competition? Do men compete too much? The quarterly journal of economics, 122(3), 1067-1101. Retrieved from: https://doi.org/10.1162/qjec.122.3.1067

OECD (2016). New Skills for the Digital Economy. OECD Digital Economy Paper No. 258. Paris: OECD Publishing. Retrieved from: https://doi.org/10.1787/5jlwnkm2fc9x-en

OECD (2017a). Education at a glance 2017: OECD indicators. Paris: OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/eag-2017-en

OECD (2017b). The pursuit of gender equality: An uphill battle. Paris: OECD Publishing. Retrieved from: http://dx.doi.org/10.1787/9789264281318-en

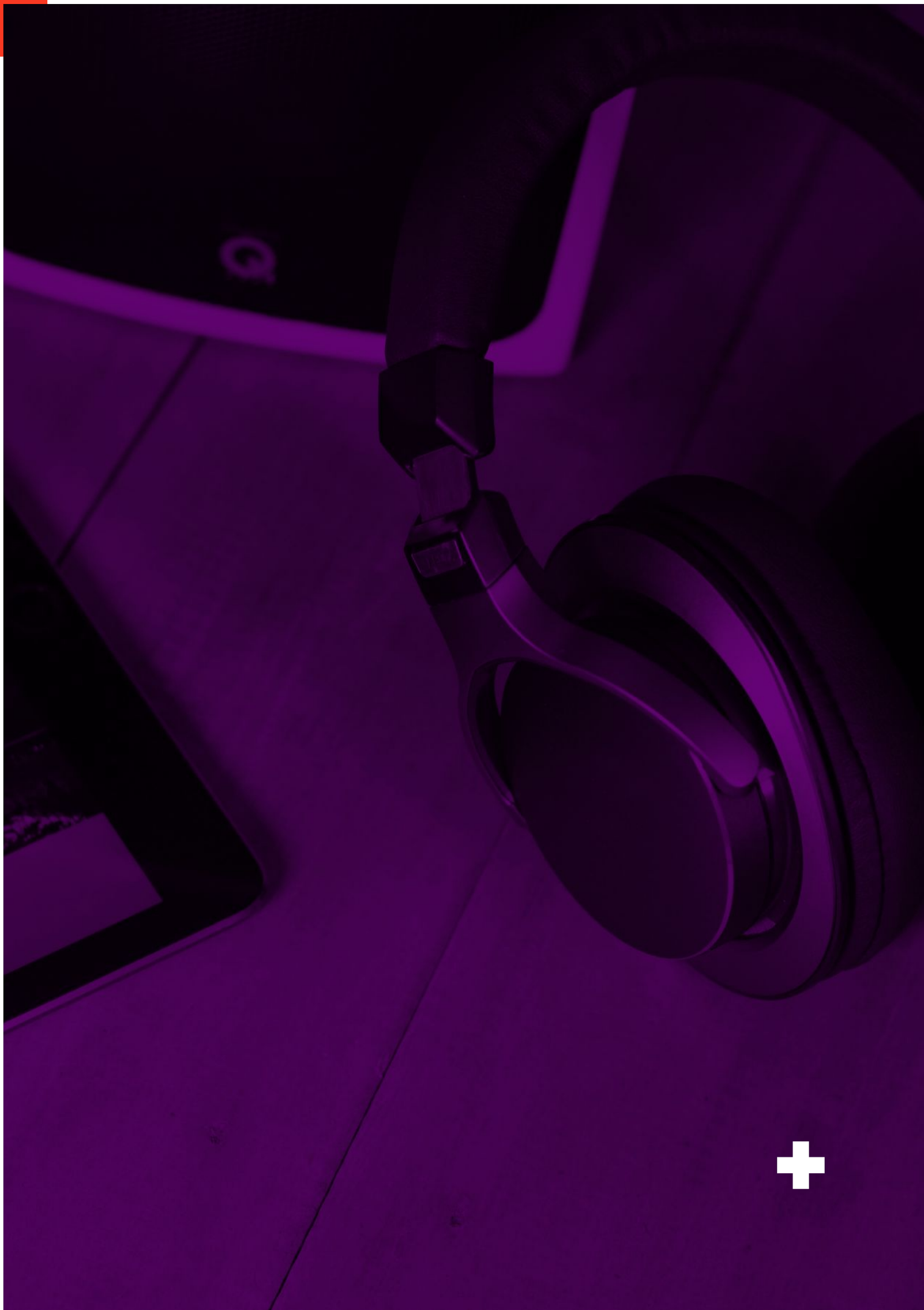
OECD (2018a). Towards the implementation of the G20 Roadmap for digitalisation: Skills, business dynamics and competition. Paris: OECD Publishing.

OECD (2018b). Toolkit for gender equality in governance: Implementing the 2015 OECD recommendation on gender equality in public life. Paris: OECD Publishing.

OECD (2018c). Bridging the digital gender divide: Include, upskill, innovate. Paris: OECD Publishing. Retrieved from: http://www.oecd.org/going-digital/bridging-the-digital-gender-divide.pdf

Poletaev, M., & Robinson, C. (2008). Human capital specificity: Evidence from the Dictionary of Occupational Titles and Displaced Worker Surveys, 1984–2000. Journal of Labor Economics, 26(3), 387-420. Retrieved from: http://dx.doi.org/10.1086/588180

Weinberger, C. J. (2014). The increasing complementarity between cognitive and social skills. Review of Economics and Statistics, 96(4), 849-861. Retrieved from: https://doi.org/10.1162/REST_a_00449



8

SKILLS DEVELOPMENT AND YOUNG WOMEN'S WORK IN THE CALL CENTRE INDUSTRY IN SOUTH AFRICA

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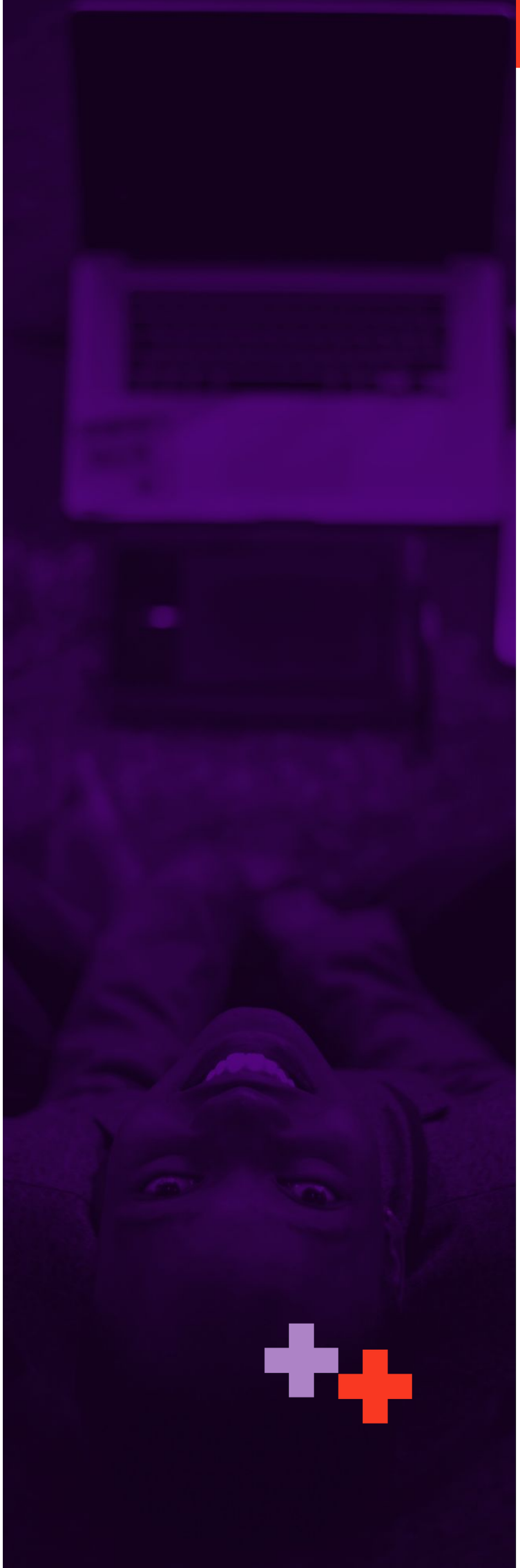


79 *The author acknowledges support from the National Research Foundation (Grant no. 99220) in South Africa.*

ABSTRACT

The call centre industry continues to grow as a major business outsourcing avenue. National and international organisations are increasingly using call centres for marketing as well as for outsourcing customer services, often based in developing countries. The South African government supports such business outsourcing through prioritising call centres for investments and as job creation for its young people. A quarterly labour force survey (QLFS), released by Statistics South Africa in the last quarter of 2017, shows a national unemployment rate of 26.7%, with a high youth unemployment rate of 29.7% among 15- to 24-year olds. Such high youth unemployment rates make call centres especially attractive in South Africa. Empirical findings from this sector show that 75% of the employees in South African call centres are young women who have just finished school and female college students. An exploration of skills development in the call centre industry is therefore also an exploration of skills development for young women, who are the majority of workers. This chapter presents findings from qualitative focus group discussions and individual interviews conducted with young women who work as agents in call centres in Cape Town and Johannesburg. We conducted four focus group discussions of six to eight participants and 20 semi-structured individual interviews, with women aged 19–34 years working as agents in various call centres. All interview participants were recruited through convenience and snowball sampling. Focus groups and interview data was analysed through a qualitative thematic analysis.

KEY FINDINGS

- Training for key competencies varied from organisation to organisation, from a few days to several weeks. Training took different forms: brief teaching sessions followed by tests; memorising scripts to answer possible questions; basic keyboard skills, including word processing and speed typing; communication skills of pronunciation, phone etiquette, and voice demeanour.
- Some participants indicated that training consisted of hands-on experience on the shop floor, with minimal prior training. This included informal side-by-side coaching, or "buddying up" to understudy their fellow workers.
- Agents might be put under pressure designed to test their level of resistance.
- Much emphasis was put on the development of "people skills"; respondents considered call centres highly focused on developing people skills, more than any technical or digital skills, no matter what technological systems were adopted in training. They questioned call centres' capability to promote technical skills development.
- Skills developed in call centres were specific to work in call centres rather than transferable to other work.
- Few leadership positions were available, and there was a lack of personal growth.

INTRODUCTION

Numerous business organisations have begun to use call-centres in developing countries, through both onshoring and outsourcing services, taking advantage of their cheap labour and favourable labour attrition rates. Call centres operate on information communication technology (ICT) platforms that enable easy global access. Key destinations for global outsourcing call centres are India, the Philippines, and, of late, South Africa and Kenya. The South African Government prioritises call centres for investments and job creation (Banks & Roodt, 2011). As such, the industry has grown tremendously over the years, becoming a key source of employment for young people. A quarterly labour force survey (QLFS), released by Statistics South Africa in the last quarter of 2017, shows a national unemployment rate of 26.7%, and 29.7% for youth aged 15–24. Given high youth unemployment levels, it is not surprising that the government supports call centres to address the issue.

This chapter draws on a project that explored young women's work in call centres in the cities of Cape Town and Johannesburg in South Africa. Focus groups and individual interviews were conducted with young women who work in call centres, to explore the dynamics of skills development in this largely digitalised industry. The chapter evaluates the skills development of the young women workers, considering the link between the training and skills acquired on the job and advancement prospects for workers, in view of evolving information and communication technological systems. It begins by looking at the nature of call centre work in South Africa, followed by an exploration of women's work in call centres. The chapter then presents the voices of young women, capturing the experience of skills development of these young workers.

LOCATING SOUTH AFRICAN CALL CENTRES IN THE GLOBAL ECONOMY

The call centre industry in South Africa has grown immensely since the '80s, becoming a thriving domestic industry and a key employer of young people who would otherwise be unemployed. Banks and Roodt (2011) describe the industry as growing largely through business-owned centres, which incorporate call centres as part of their own business processes. They emphasise that call centres have "moved from occupying a relatively small niche to being a significant part of the global economy" (Banks & Roodt, 2011, p. 3). South African call centres are an integral part of the global market system based on neoliberal capitalism.

Neoliberalisation favors opening up international markets through easing trade and labour regulations. Firms can benefit from access to external labour and capital markets for outsourcing services, capitalising on cheap labour as well as on flexible ways to build capital. Raewyn Connell sees neoliberalism as "the agenda of economic and social transformation'' which dominates "global politics" and is systematically implemented in "institutions under neoliberal control" (Connell, 2014, pp. 5-6). The globalised economy entails outsourcing ancillary services, such as tele-marketing and service provision, to emerging markets (Panday & Rogerson, 2014). Of concern to feminist scholars is that these outsourced services mostly depend on women's cheap labour.

In South Africa, call centres emerged in the late '80s, growing rapidly in the '90s due to improved technology and lower communication costs (Benner, 2006; Holman; Batt & Holtgrewe, 2007; Panday & Rogerson, 2014). The industry has grown steadily since then and now serves both local and international markets. Research shows that more than two-thirds of call centre employees in South Africa are young people under age 35 (Cohen, 2013; Panday & Rogerson, 2014); approximately 75% of these young people are women (Benner, Lewis, & Omar, 2007). This employment pattern is also a common global trend (Belt, 2002; Bonds, 2006; Darsun & Bayram, 2014). Any investigation into call centre work is also an investigation into women's work, the concern of this chapter.

UNDERSTANDING THE CALL CENTRE INDUSTRY IN SOUTH AFRICA

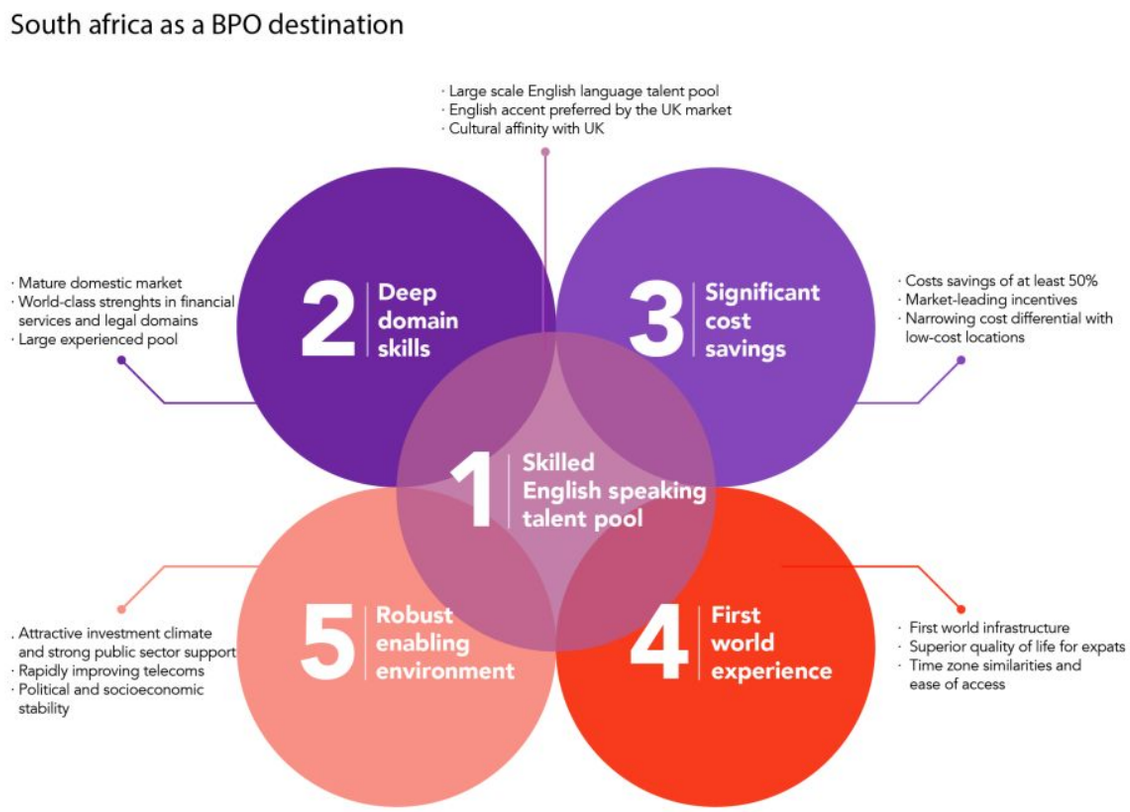
The South African government policy prioritising the call centre industry is focused on attracting international investors, a strategy that is emphasised in the recent Business Process Enabling South Africa (BPESA) Key Indicator Report (2016). The government Minister of Trade and Industry, Rob Davies, notes that South Africa was named the offshoring destination of the year at the Global Sourcing Association (GSA) awards in London in 2016, an award the country had also received in 2014 and 2012 (BPESA, 2016). Figure 8.1, from the BPESA report, illustrates some of South Africa's key strengths as a potential business outsourcing destination.

This strategic positioning of South Africa is widely documented (DTI, 2013; Hall, 2011). In line with neoliberal free market approaches, and to reduce unemployment, the South African Government is focused on strategies to develop a "sustainable skills" pool for its growing Business Processing Outsourcing (BPO) market (BPESA, 2016). Key strategies considered include the following (adapted from BPESA, 2016, p.9):

- extending BPO skills through development of industry-specific academies
- facilitating participation of government educational institutions in the BPO agenda
- addressing critical skills gaps
- building competence of team leaders and managers
- developing English and foreign language skills
- harnessing technology for skills development

It is still unclear how the South African government will translate this commitment into action, and what advantages and disadvantages it will entail for women working in this sector.

Figure 8.1
South Africa – strengths in business outsourcing



Source: BPESA, 2016, p. 6.

WOMEN'S WORK IN CALL CENTRES AND SOCIO-ECONOMIC TRENDS

South Africa serves as an ideal destination for BPO, particularly in the service sector. The growth of the service sector has seen a huge pool of women entering the global labour market (Gillard, Howcroft, Mitev, & Richardson, 2007; Eisenstein, 2009; Darsun & Bayram, 2014; Howcroft & Richardson, 2008), and the call centre industry is largely dependent on women's labour for both offshore and onshore services (Bonds, 2006). This global practice highlights the importance on women's labour as significant for global markets and international competition (Moghadom, 2000).

Scholars have viewed women's predominance in the call centre labour force in widely differing ways. On the positive side, some see the growth of the service sector resulting in substantial increases in the number of women in the labour force, especially in emerging markets. Labour force participation is seen as affording women economic independence, providing a basis for resisting patriarchy (Diane Wolf, cited in Eisenstein, 2009, p. 149); some endorse call centre jobs as decent work (Cohen, 2013). Other scholars argue that call centre work is service labour and thus likely to perpetuate the feminisation of labour (Standing, 1999; Howcroft & Robinson, 2008; Blin, 2010). Some scholars go further, accusing the governments of developing countries of being complicit in "offering up" their workforce as capable and affordable to a capitalist world largely driven by neoliberal market competition (Lacity & Wilcocks, 2013). Service provision jobs are criticised for centralising gendered notions of femininity, to justify women's participation in the labour force. These stereotypes are seen as contributing to the "devaluing" and "deskilling" of women's work, while promoting occupational segregation and polarisation (Bonds, 2006, p. 32). Such occupational segregation reinforces inequality in the labour force, since women in the call centres occupy the lower end of the employment spectrum.

The fact that women are the majority of workers in call centres also has clear economic implications: profit margins remain protected, or even increase, due to the devaluation of women's labour, which is always coupled with a reduction in labour costs (Gillard, et al. 2007). Furthermore, evidence shows that digital environments, such as that of the call centre industry, have the potential to "erode labour protection standards" (Gillwald, Mothobi & Schoentgen, 2017,

p. 2), especially because high levels of unionisation would deter investment. Eased labour protection standards can render women workers vulnerable to exploitation.

SKILLS DEVELOPMENT IN THE CALL CENTRE INDUSTRY

Scholarship on skills development in call centres is very limited. Evidence from sites that advertise call centre work shows that the industry does not routinely seek applicants with prior call centre skills, but rather offer their own training (see www.jobin.co.za). Recruitment efforts target marginalised, less-skilled young people, particularly women, who are either school leavers or college students (Benner, Lewis, & Omar, 2007). Call centres are highly routinised; the work requires little skills variety (Coetzee & Harry, 2015), and worker development is precluded by the flat organisational structure (Choi, S., Cheong & Feinberg, 2012). This research explores the implications of skills development for young women workers in South Africa, building on the body of scholarship on women's work in call centres in the Global South, particularly in the African context.

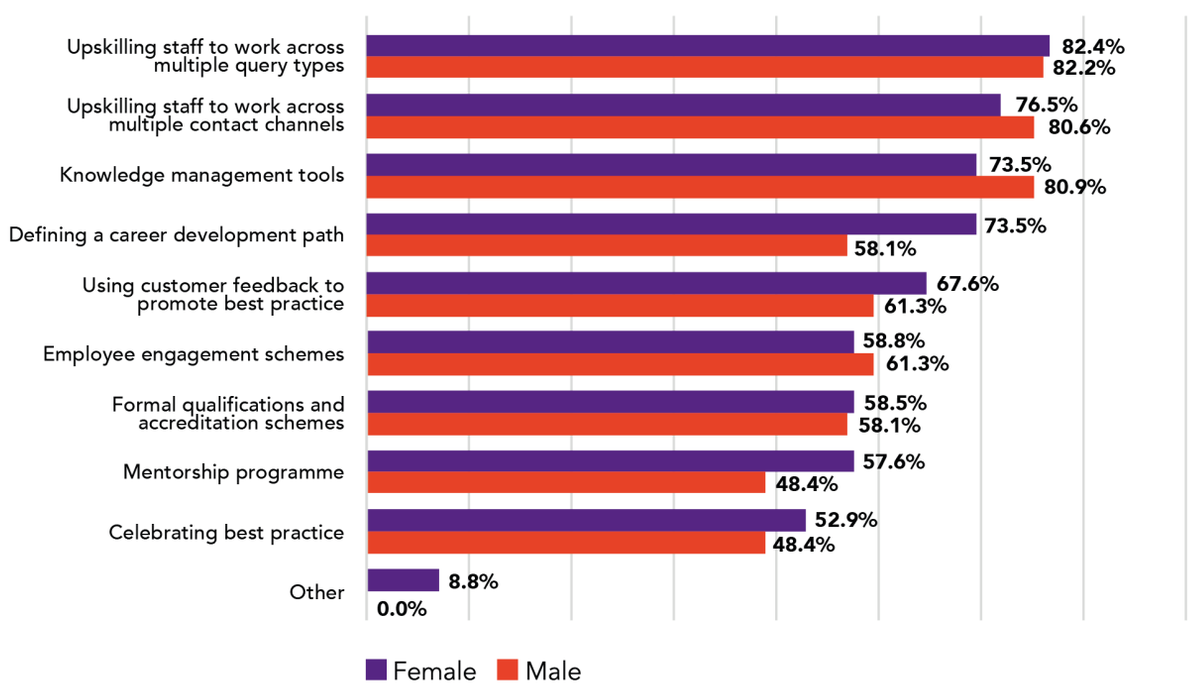
Figure 8.2 presents key skills-development approaches for managers in call centres in South Africa, as shown in the 2016 BPESA report. It shows that South African call centres pay significant attention to skills development, taking particular interest in upskilling staff.

METHODOLOGY

This chapter is based on a research project that investigated the participation of young women in the call centre industry in the cities of Cape Town and Johannesburg in South Africa, using surveys, focus group discussions, and individual interviews. Surveys noted demographic information on the participants as well as socio-economic and work-related factors. This paper draws particularly on the focus group discussions and individual interviews, to explore the impact of the call centre industry on skills development among these young women. Four focus group discussions of six to eight participants, as well as 20 semi-structured individual interviews, were conducted with young women aged 19–34 who currently worked as agents in different call centres. Participants included college students, school leavers, and other women. All interview participants were sampled through convenience and snowball sampling, and interview sessions took place in various settings where the participants would feel comfortable: at

Figure 8.2

Skills development in call centres in South Africa



Source: BPESA, 2016, p. 28.

their work place during breaks; at their homes or colleagues' homes; and at their colleges. Participation was voluntary, and all participants were informed that they could leave the study at any time without penalty. Focus group and interview data was analysed through a qualitative thematic analysis.

FINDINGS

The young women interviewed in this study included both part-time and full-time workers at call centres, which served British, American, and South African companies focusing on finance, telecoms, retail, data collection, and gaming. The interview questions concentrated on their experiences as workers, with particular reference to skills development. This section presents participants' perspectives and insights on skills acquisition for both job competency and career development.

SKILLS TRAINING FOR JOB COMPETENCY

Participants indicated that training took different forms that varied by organisation, with the initial training ranging from a few weeks to several months.

You get theory for like maybe 2 weeks, and then you are on the floor for another week.

The training was 3 months, and… you would need communication, interpersonal skills, be computer literate, patience, and I mean a lot of it, and then good listening skills.

You just get basic training on how to do the job: how to answer the phone, how to understand accents, how to operate their system and all that stuff. Their training is actually self-training, so you read stuff off the pc, then when you are done with that, they test you based on that and if you fail, they terminate your contract based on that.
There is a script that they give you that you memorise.

The training included teaching sessions followed by tests, that determined either progression to the floor or termination of contract. Agents also memorised scripts to master the questions they would have to answer on the shop floor. They were trained in basic keyboard skills, which included word processing and speed typing. They received training in communication skills: how to pronounce certain words, phone etiquette, and voice demeanour. Most of these skills have been labelled "effeminate" (Bonds, 2006) — and, scholars note, they are critical to these and similar industries that capitalise on women's biological and social characteristics to drive profits.

One participant touched on the issue of gendered recruitment when she emphasised how prospective employers considered it necessary to listen to her voice as part of training:

. . . so that my potential employers could hear the sound of my voice, whether my speech is slurred or… This is because call centres often want a voice that is pleasing and softer in terms of sound. Men are often linked to having voices that are rough and edgy, so maybe most men who apply do not get the job because of the sound of their voice, but I cannot be sure.

A number of participants felt that initial training sessions did not assist much in equipping them for their work, and that the most useful training occurred when they got to the shop floor.

INFORMAL TRAINING: 'WE LEARN ON THE FLOOR'

Some participants indicated that key readiness for tasks was developed only through hands-on experience on the shop floor. They spoke about side-by-side coaching, which they termed "buddying up", where they were assigned to understudy fellow workers or to be assisted by more experienced colleagues.

The first three days, you buddy up with someone else, you listen to their calls, you are with them as they take calls, you get to listen to the type of queries the clients raise, and you note how they are able to answer and then after that you go on your own.

You also have someone else buddying up with you. . . . It's the older people that come and listen in so if you're struggling and you need to ask something you can quickly ask to put the client on mute and in the meantime, you quickly find out the information that you require and then give it to the client. Then after that buddying up you're on your own.

They found this mode of training interesting and quite effective. Shop floor skills development was informal, however, and such informal processes do not secure skills recognition for career development, since they are not documented.

Training also involved putting agents under pressure to test their level of resistance, as one agent explained:

They suss up who can deal with high pressure situations and who can't — a lot of trainees leave at this point and do not return.

High pressure training was also linked to training towards achieving set targets that measure the worker's competency for the job.

The women workers admitted that all these forms of training and exposure provided them with some new skills. This chapter examines the nature of the skills acquired on the job and their value for career development.

THERE IS COMPANY GROWTH AND NO PERSONAL GROWTH: SKILLS TRAINING AND CAREER DEVELOPMENT

While some participants felt that the initial training improved their skills in some ways, others dismissed it as routine training that did not add to their skills. Respondents put emphasis on acquiring what are often called "people skills" (White & Roos, 2005), and agents believed they "picked up" these skills on the job.

I wouldn't say training empowered me with any skills but the work environment did. Having to deal with people, having to solve peoples' problems and having to think on your feet. It is the experience and not necessarily the training that matters. Training is just theory, information on the product the company offers and that is all. In most cases you forget those things, it's doing the work and you being active that gives you the training and experience that you take with you out of the call centre business, to other companies or to other aspects of your life where you will implement them.

I learnt to listen more attentively and work within very demanding circumstances. This job has also taught me to be very patient with the customers and use the different communication skills to connect with the customers.

So, what I am saying is that it's is not all bad, there is positivity in it. It will give you the opportunity and equip you for the future job that you want to do, it will give you soft skills, leadership skills, how to approach other situations as well.

Agents felt that call centre jobs developed soft skills and people skills more than technical or digital skills. While they appreciated developing people skills for personal growth, some questioned the importance of these skills for career growth.

Call centres are great, you meet people, acquire people skills, improve your communication skills, you improve yourself, you get promoted if you are lucky, to do the same thing anywhere —but the sad thing is that there is nowhere else you can fit with those skills. You have to work call centres or look for a job as a receptionist somewhere else! You can't take those skills anywhere.

The only skill you take across is moving to another call centre to do the same thing, agent or team leader.

I have only learnt to withstand pressure and to be confident and nothing else.

Agents also described the challenges of getting promoted, due to the limited availability of leadership positions as well as the intense competition for the limited positions of growth.

You find people "playing game of thrones" [back stabbing each other] to climb ladders that do not exist — there is company growth and no personal growth there.

I have been working here for four years now, and there are very limited positions to grow within the workplace. For years I have been doing the same thing on a daily basis, but there have been no promotions.

The ceiling is low, you rise and get stuck there, who wants to be a 50-year-old answering phones? Call centres kill your mind.

I see this job as limiting, people working in call centres always work at call centres, and they tend to not change jobs. One of my colleagues has been working with this company for six years, doing the same stuff every day and is still in the same position.

Call centres do not promote growth or any type of growth in terms of career prospects. The job is repetitive because every day I do the same thing and this can be quite frustrating if you want to express your talents and creativity.

Participants repeatedly discussed the lack of career growth, with some characterising the nature of call centre work as exploitative. In this view, they saw some centres capitalising on workers' vulnerability, arising from a lack of alternative employment.

I would say that call centres are exploitative. They use the basic work loss that we have here in South Africa. . . . It's cheaper over here to employ people than it is overseas . . . and someone did mention that you are easily replaceable in a call centre.

You are told straight out if you are not happy, it's fine, leave, there is someone that wants that job that you don't want. You are easily replaceable, you are not important. You are just a number in a lot of numbers they can easily get rid of.

Although not a common observation, one participant also raised what she saw as the gendered nature of promotion in her organisation.

I have learned a lot of skills such as communication skills, persuasiveness, conflict management, computer skills, and skills on sales. . . . But the thing is, even though I have learned all these skills at this job, I am still in the same position I started off with. I have never been promoted. They mostly promote guys. When we ask why it's only guys that get promoted, they say

it's because they perform and that's why they earn it. Surely there must be at least one girl who performs in this job.

DISCUSSION

Call centres largely provide service through use of digital technologies. Firms engaged in outsourcing have absorbed large numbers of young people, especially women, into various occupations (Belt, 2002; Taylor & Bain, 2005; Singh & Pandey, 2005). Call centres are not gender-neutral, as the industry is significantly driven by women's labour (Russell, 2008). The feedback of workers in the surveys and interviews cited above indicates that call centres do not focus on developing skills that lead to career development. The skills acquired by working in the industry do not add significant value to women's advancement in the labour market, keeping them on the lower rungs of the employment ladder (Ngabaza, 2017; Webster, 2004). Similarly, this study shows that the minimal skills developed in call centres are not intended to empower the women employees but rather to maintain profit margins. The absence of unions represents a business policy, as high levels of unionisation might drive away possible investors (Benner et al., 2007) — further compromising labour protection standards (Gillard, et al., 2007; Gillwald, et al., 2017).

Examining the intersection of skills development with the gendered dynamics of employment can provide a more complete understanding of the implications of skills development for women call centre workers. Research shows that ICT-driven work can reach marginalised and vulnerable communities (World Bank, 2016); indeed, call centres in South Africa mainly employ young women from such communities. Since ICTs are not gender-neutral but are "embedded in a range of social economic and political contexts" (Bonds, 2006, p. 31), it is important to interrogate the gender dynamics to understand what the skills development process implies for workers.

The recruitment process focuses on "feminine" skills: basic keyboard skills, phone etiquette, word processing, and voice demeanour. Workplace skills development focuses on effective service provision, not career growth. Workers develop their skills informally, coached by colleagues or memorising scripts. Scholars note, in similar contexts, that such informally obtained skills are not recognised as skills or considered in promotion prospects (Webster, 2004). While some participants valued the interpersonal skills they had acquired, they felt that these were of limited value to their career progression, and that they had not gained technical skills that could lead to further employment in the information sector.

The key competencies developed in the "skilling" of call centre agents have been linked to essentialist feminine skills. Young women in call centres remain the core drivers of this digital industry, in a global context that promotes economic growth without career development. Some study participants indicated that the focus of call centres was on organisational and economic growth, at the expense of skills development that might enhance their personal and career growth; some said they were reduced to a "lot of numbers" and were easily replaceable. Such contexts perpetuate gender inequality (Scholarios & Taylor, 2010).

While call centres have been instrumental in job creation in South Africa, where unemployment is a major issue, gender inequalities cannot be overlooked in assessing projects promoting economic growth and job creation opportunities. Moghadam (2000) has shown how global neoliberal trade regimes and competition have capitalised on women's labour. More than a decade later, the same process is replicated in call centres, which embody the "feminisation of production in the new information economy" (Bonds, 2006, p. 32). Young women are marginalised for corporate profits in this digitally-anchored industry; their labour is a source of global economic growth, as companies compete for the best outsourcing destinations in new emerging markets. Many of the young women participants were aware of this exploitation, emphasising that call centre work was "part-time work" while focusing on building other skills for their careers. However, they were also aware of the strain of juggling call centre work and other areas of personal development, especially for those who were still studying. In spite of being based in information technologies, call centres remain limited in equipping their workers — especially the young women who represent the majority — with valuable skills for career growth.

REFERENCES

Belt, V. (2002). A Female Ghetto? Women's Careers in Telephone Call Centres. HRM Journal, 12(4), 56-66.

Banks, D., & Roodt, G. (2011). The efficiency and quality dilemma: What drives South African call centre management performance indicators? SA Journal of Human Resource Management, 9(1), 1-17.

Benner, C. (2006). "South Africa on call": Information technology and labour market restructuring in South African call centres. Regional Studies, 40: 1025-1040.

Benner, C., Lewis, C.& Omar, R. (2007). The South African call centre industry: A study of strategy, human resource practices, and performance. The Global Centre Industry Project.

Blin, M. (2010). Globalization, women and the labour market in Southern Africa. In M. Ruiters (Ed.). Gender instruments in Africa (114-129). South Africa: IGD.

Bonds, A. (2006). Calling on femininity? Gender, call centres, and restructuring in the rural American West. ACME: An International Journal for Critical Geographies, 5(1), 28-49.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3 (2), 77-101.

BPESA (2016). South Africa Business Process Services Key Indicator Report. Retrieved from: http://www.bpesa.org.za/wp-content/uploads/2017/06/Key-Indicator-Report-2016-low-res-1.pdf

Choi, S., Cheong, K. J. & Feinberg, R. A. (2012). Moderating effects of supervisor support, monetary rewards, and career paths on the relationship between job burnout and turnover intentions in the context of call centers. Managing Service Quality, 22(5), 492-516.

Cohen, M. (2013). South Africa ideal for call centres, accent "sounds British". Mail & Guardian, December 2. Retrieved from: http://mg.co.za/print/2013-12-02-south-africa-ripe-for-callcenter-expansion

Coetzee, M. & Harry, N. (2015). Gender and hardiness as predictors of career adaptability: An exploratory study among Black call centre agents. South African Journal of Psychology, 45(1), 81-92.

Connell, R. (2014). Global tides: Market and gender dynamics on a world scale. Social Currents, 1(1), 5-12.

Darsun, G. & Bayram, H.B. (2014). Women labour in call centres: Understanding characteristics of work. Journal of Global Analysis, 4(1), 35-51.

Gillard, H., Howcroft, D., Mitev, N., Richardson,H. & Ferneley, E. (2007). Shaping the global economy: Gender, ICTs and development research. In: Proceedings of the 9th International Conference on Social Implications of Computers in Developing Countries (28-30).

Gillwald, A., Mothobi, O., & Schoentgen, A. (2017). What is the state of microwork in Africa? A view from seven countries. #afteraccess Policy Paper Series, No. 2. Retrieved from: www.researchICTafrica.net

Eisenstein, H. (2009). Feminism seduced: How global elites use women's labour and ideas to exploit the world. Boulder, CO: Paradigm Publishers.

Holman, D., Batt, R., & Holtgrewe, U. (2007). The global call center report: International perspectives on management and employment. Ithaca, NY: Authors.

Howcroft, D. & Richardson, H. (2008). Gender matters in the global outsourcing of work. New Technology, Work and Employment, 23, 44-60.

Lacity, M. & Willcocks, L.P. (2013). Outsourcing business processes for innovation. MIT Sloan Management Review, 54 (3), 63-69.

Moghadam, V.M. (2000). Gender and the global economy. In: M. M. Ferree, J. Lorber & B. Hess (Eds.). Revisioning gender (129-152). Altamira press.

Ngabaza, S. (2017). Young women in South African call centres: A case of women's empowerment or a repackaging of the conventional global factory? In: International Conference on Social Implications of Computers in Developing Countries (135-143). Springer, Cham.

Pandy, W.R. & Rogerson, C. M. (2014). South Africa's call centre industry: The emerging challenges of a growing destination in the global South. Mediterranean Journal of Social Sciences, 5(8), 208-217.

Russell, B. (2008). Call centres: A decade of research. International Journal of Management Reviews, 10(11), 1468-2370.

Scholarios, D., & Taylor, P. (2010). Gender, choice and constraint in call centre employment. New Technology, Work and Employment, 25(2), 101-116.

Singh, P., & Pandey, A. (2005). Women in call centres. Economic and Political Weekly, 684-688.

Standing, G. (1999). Global feminization through flexible labour: A theme revisited. World Development, 27(3), 583-602.

Stats SA. (2018). Quarterly Labour Force Survey (QLFS), Fourth Quarter of 2017. Retrieved from: http://www.statssa.gov.za/?p=10884

Taylor, P. & Bain, P. (2005). "India calling to the far away towns": The call centre labour process and globalization. Work Employment & Society, 19(2), 261–282.

Thompson, G. (2013). Call centre special: Africa fights for its share of a global market. Retrieved from: http://www.balancingact-africa.com/news/en/issue-no- 169/topstory/call-centre-special/en

Webster, J. (2004). Digitising inequality: The cul-de-sac of women's work in European services. New Technology, Work and Employment, 19(3), 160-176.

White, C. & Roos, V. (2005). Core competencies of a call centre agent. SA Journal of Human Resource Management, 3(2), 41-47.

World Bank. (2016). World Development Report 2016: Digital Dividends. Washington, DC: World Bank.

9

A GENDER PERSPECTIVE ON SECURITY AND PRIVACY IN THE DIGITAL AGE

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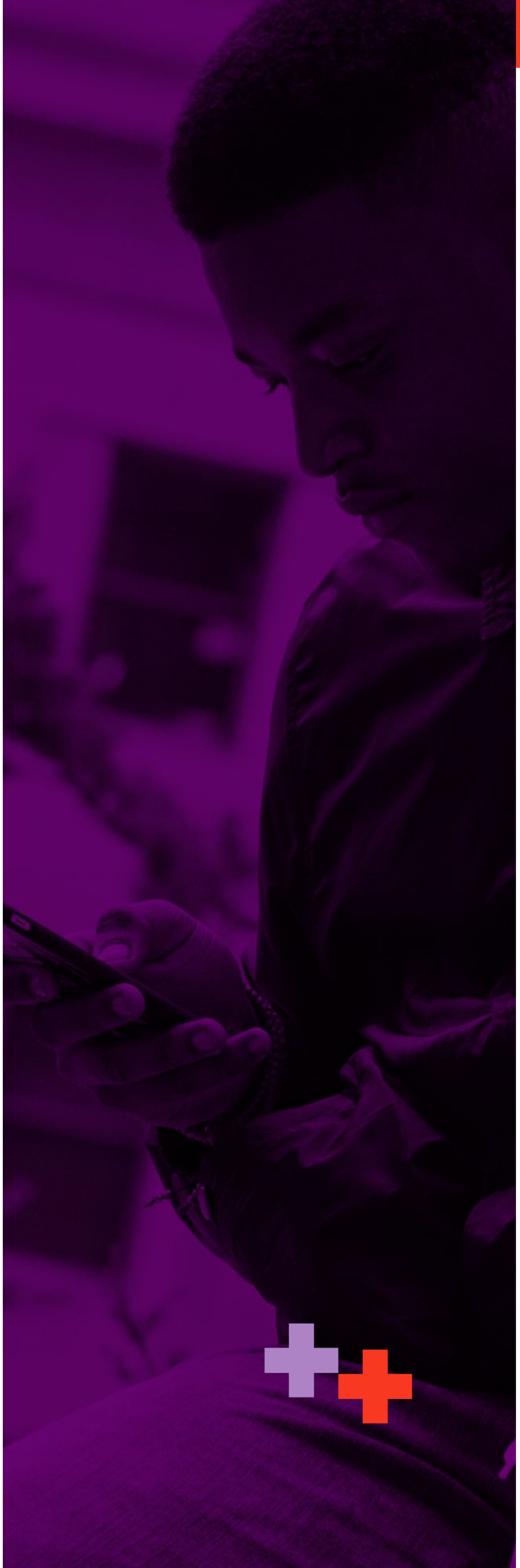

ABSTRACT

This chapter explores the fundamental notions of digital security and privacy from a gender perspective. In a world that is increasingly relying on digital technologies, learning how to be safe when online is of paramount importance. Studies show that, as much as digital technologies represent an undeniable opportunity for growth and change, they also offer a larger platform for abuse. The Association for Progressive Communication has pointed out that cyberstalking, online harassment, image manipulation, and privacy violations have compromised women and girls' safety both online and off-line, in many countries (APC, 2015). This disturbing behaviour extends to geo-tracking and surveillance, in some extreme cases. Equipping women with adequate digital knowledge and skills to ensure a more secure and private online experience can help to limit this kind of abuse. Going further, however, we advocate women's involvement in fundamentally rethinking security research and design in terms of gender. Security technology (including cryptography) is not gender-neutral; to date, it has been proposed and designed by a specific, non-diverse community, which has shaped its development. Specific trust assumptions, security models, and the technical language of security — using such terms as attacks and adversaries — that underpin contemporary security research appear to be male-driven and male-oriented. However, there is growing awareness that security solutions need to be designed in, and for, a specific context, and that they need to take incorporate diverse, context-sensitive design principles. This goal requires reducing the gender gap in digital literacy, ensuring that women have the necessary skills to experience technology in a private and secure way (for instance, with better understanding of password use, encryption functionality, and data integrity). Women's greater involvement in the design of security and cryptographic solutions is key to safer integration of digital technologies in our lives.

KEY FINDINGS

- Technology unfortunately provides a wider platform for abuse towards women. The solution requires both individual digital skills to enhance personal security and privacy, and women's participation in design and development of security and privacy technologies.
- In the field of Information Security, women are largely underrepresented: globally, women account for just 11% of the cyber security workforce, mainly in non-managerial positions.
- Security technology is gendered; cryptography incorporates gendered assumptions relating to sources of threat, potential "trusted" allies, and resource availability. More diverse design principles need to be developed.

INTRODUCTION

This chapter details how the lack of knowledge of online security and privacy can have a deeply negative effect on technology users, especially women. A straightforward solution to this problem is to equip women with the necessary skills, so the chapter then examines women's involvement in the area of information security. Finally, we note that this imbalance in skills has led to a lack of diversity in the design and development of security solutions, and in particular of even basic cryptographic concepts. In view of the fundamental role of digital security in the adoption of technology in our lives, reducing the gender gap in this field is of paramount importance.

SECURITY AND PRIVACY CONCERNS FOR WOMEN IN THE DIGITAL AGE

Technology is generally considered a fundamental driver of development and social change, not only in economic aspects but also for human development, abilities, and freedom (Deneulin & Shahani, 2009). Digital technology, in particular, has great potential to promote the advancement of women's economic opportunities as well as the equality of women and men. However, digital technology cannot be considered a mechanism in itself for promoting development and equality, but rather a contribution to that process, by highlighting, extending, and magnifying communicative and sharing capabilities (Sey, 2011).

Indeed, the digital age has proven, in some respects, to be liberating for women; access to technologies and the internet can be very empowering. Judy Wajcman, in TechnoFeminism (Wajcman, 2004), surveys feminist theories regarding the interplay between gender and technology. In the utopian views of cyberfeminists, technology will allow us to break free from the gender-based roles and restrictions that define us in the real world, because, in the digital world, women can be whoever they want. (Wajcman, 2004, pp. 56-77).

Society is immersing itself in the digital world. At the end of 2015, it was estimated that there were 3.2 billion people online (Internet Society, 2016); similarly, in 2016, it was estimated that 47% of the world's population is online (World Wide Web Foundation, 2016). To varying extent, women are accessing the internet, ranging from 76.3% in Europe, to 18.6% in Africa (Statista, 2017a); (ITU, 2017). (For some countries, these statistics are unavailable.) In social media access, 52% of Facebook users in the U.S. are female, as are 44% of Facebook users worldwide (Statista, 2018a).

Mobile phone usage is also growing. In the U.S., 94% of women own a mobile phone and 75% own a smartphone (Pew Research Center, 2018). These numbers are significantly lower in the Global South: in low- and middle-income countries (LMICs), the percentage of women owning a mobile phone was 41% in 2015 (GSMA, 2015). Pay-as-you-go mobile phones have been important in enabling women in LMICs to get connected (Wajcman, 2004, p. 120). In 2017, 36% of women were using, or had previously used, online dating sites or apps (Statista, 2017b).

What security and privacy concerns does such connectivity entail? The advent of mobile technology has enabled significant economic and social changes, especially in LMICs. Innovations include branchless and mobile banking, farming apps, and health-related applications (including home-based care, medical advice, counseling for HIV/AIDS patients, and anti-counterfeit checking of pharmaceuticals).

However, mobile technology can reveal tensions and complex relations between technological mobility and social—especially gender-based—restrictions. The generalisation that technology increases economic and social advances is too simplistic. An ethnographic study in India, conducted by Jo Tacchi, shows that in some households men control technology (phones in particular), believing that technology has a corrupting influence on women. However, when the power structure changes in a household (due to a death, for example), the constraints and restrictions on technology also shift (Tacchi, 2014). The use of mobile technology to control or track a daughter's movements, described in the same study, can be seen as either oppressive or protective, depending on the participant.

Social control can be exerted through simple calls and text messages, or it can be amplified through apps such as Phone Tracker and Find My Friends, which allow a user to follow a spouse or partner, for example. This can allow abusive partners to exert more control — particularly troubling when we consider that 35% of women worldwide have experienced physical or sexual violence (World Health Organisation, 2017).

Security and privacy may be even more at risk in the online world. American women are more likely than men to seek healthcare advice online (eMarketer, 2013). Women in the UK are reportedly seeking illegal abortions online, even though abortion in the UK is legal and publicly funded (New Scientist, 2017). Whether or not this indicates a problem in accessing abortion services, there is certainly some danger in seeking out medical help online. Illegal healthcare creates a security issue, placing women in danger, particularly with regard to reproductive health and abortion services; they may receive incorrect medical information or be given medications that, at best, do not work or, at worst, are dangerous.

The problems and dangers that may be encountered by women seeking health and human services on the internet include: difficulties in ascertaining the credentials and identity of service providers; accessing inaccurate information; reliance on untested methods; difficulties in online assessment; exposure to disinhibited communication; development of inappropriate online relationships; and lack of standards or regulation regarding online human service practice. In addition there is the possibility of victimisation through loss of privacy, cyberstalking, and identity theft (Finn & Banach, 2000).

Overall, use of these new technologies may expose users to an unprecedented level of threats, such as control, abuse, and theft of sensitive data, reflecting the lack of certain security properties (Quaglia & Heath, 2017). One solution is to equip women with digital knowledge and skills to ensure a more secure and private online experience, as well as greater agency in navigating information security.

This highlights the need for progress in increasing both the digital skillset required for personal security and privacy (for which training and schools are being developed), as well as women's participation in the design and development of security and privacy technologies. (We note that there is also the dual need to restrict and punish the abusers and perpetrators of online crime). This often comes in the form of calls for better and more balanced laws to prevent cyber-crime, online harassment, however this will not be the focus of our study). We focus on the need to increase women's participation in InfoSec, since this has received less attention in the literature so far.

WOMEN IN INFORMATION SECURITY

Globally, women only account for 11% of the cyber security workforce, and they are likely to hold non-managerial and entry-level positions. Men are much more likely than women to hold a C-level or executive management position. The prevalence of women in information security professions varies by region, ranging from 5% of the workforce in the Middle East to 14% in the U.S., but women are underrepresented globally (Executive Women's Forum, 2017).

Accordingly, decision making in information security is disproportionately carried out by men.

One reason for this gender gap is that women are less likely to interact with STEM subjects (i.e., science, technology, engineering, and mathematics). STEM background appears critical: 61% of women entering the information security workforce have a degree in a STEM subject, as do 74% of men (Executive Women's Forum, 2017). However, girls' uptake of STEM subjects in schools is low. For 16-year-olds in the UK, only 35% of girls choose to study a STEM subject, compared to 94% of boys (Wise, 2017). Jane Frankland points out that large numbers of women were engaged in STEM subjects throughout WWII, followed by a sudden drop-off. One factor, Frankland argues, may be media portrayal of STEM subjects as masculine areas of study; she cites examples of movies and popular media showing males interested in information security (Frankland, 2017, pp. 143-4). Another factor is misconceptions about gender, and gender bias. Gender bias can appear in many forms, from unequal pay to more subtle issues, such as asking women to perform different duties than men, influenced by gender norms (TechRepublic, 2015). Biases against women in the workplace include assumptions such as that a woman will leave to have children, or that she will not want to travel (Frankland, 2017).

Globally, 39% of women in information security do not come from a STEM background (Executive Women's Forum, 2017), compared to 30% of information security professionals overall (Alta Associates, 2017). Since women are more likely to enter the information security profession from a non-technical background, Frankland points to the importance of non-traditional (i.e., non-STEM) routes into cybersecurity; she prefers to refer to STEAM (science, technology, engineering, arts, and mathematics) (Frankland, 2017, pp. 87-88). Women are more likely to have interdisciplinary skills, and employers should consider the benefits this can bring to a workforce (Executive Women's Forum, 2017).

Programs that target information security initiatives at girls can help to raise awareness as well as increase digital skills. Girls Who Code operates across the U.S. and the UK (Girls who code, n.d.). IBM run the Women in Security Excelling Initiative (WISE), launching a 2016 programme called Cyber Day 4 Girls to teach girls in the U.S. and Canada cyber security awareness (IBM, 2016). Google launched a website in 2014, "Made with Code", that includes coding projects aimed at girls (Time, 2014). Government initiatives also exist, such as CyberFirst (CyberFirst, n.d.), run by the National Cyber Security Centre in the UK, that provides courses and competitions that aim to nurture talent. In the U.S., GenCyber is a free summer camp for students and teachers (GenCyber, n.d.). Many initiatives around the world relate to STEM participation more broadly (Mashable, 2016), as demonstrated in the EQUALS mapping initiative (https://www.equals.org/actionmap).

In order to address gender bias, employers must first be aware of possible bias and take positive action to prevent women being discriminated against. For example, since women are often disadvantaged for having children (Frankland, 2017, pp. 4-8), Google increased maternity leave for new mothers. By reducing the number of new mothers leaving the company, this step was also cost-efficient, saving costs of recruitment and training (Quartz, 2016).

While women's input to technological progress has been overlooked in the past (Wajcman, 2004, p. 13), their role in the history of technology is now being presented in popular media. Notably, the 2016 movie Hidden Figures documented the little-known role of African American female mathematicians in the U.S. space programme in the 1960s. Women's issues are widely covered, and campaigns against stereotypes of women in industry are reported in the media (BBC News, 2015). Women in different industries fight against gender inequality, using social media to highlight issues; the MeToo (Wikipedia, n.d.) and TimesUp (Wikipedia, n.d.) campaigns showed the power of online action.

GENDERED SECURITY

Radical feminists see all technology as intrinsically patriarchal, that is, as part of a system controlled by men to further male goals. These arguments are explored in (Wajcman, 2004, pp. 10-31). This argument can also apply to digital security and privacy: as part of the technology, security and privacy can also be considered to be gendered.

Cryptography focuses on enabling secure communication over an insecure channel, such as the internet. This is typically done by means of cryptographic primitives — basic algoriths, such as encryption and digital signature schemes — designed and tested by cryptographers.

In order to test that a system is secure, researchers adopt rigorous and precise definitions of security, modelling properties such as confidentiality, integrity, and anonymity. Each definition is carefully designed to capture a particular security property, under detailed assumptions about resources, required trust, network availability, and even the notion of identity.

As noted in Quaglia and Heath (2017), the assumptions regarding available resources (e.g., technology used and network access), as well as notions of identity and trust, can strongly influence the cryptographic solution design. In our experience, most assumptions are developed and tested exclusively in the (male) global north. Cryptography is not a neutral terrain. Even its language can embody masculine themes, as in expressions such as penetration testing (in the secure testing domain), and man-in-the-middle attack

(a classic attack against cryptographic protocols). More significantly, perhaps, cryptographic models make assumptions that may not be relevant to gender-specific threats.

The model of cryptographic threat incorporates the notion of attacker/adversary, which is often assumed to refer to a distant and unseen third party with malicious intentions. As discussed in Part 1, the malicious intentions towards women's security and privacy often originate from the domestic environment, and the assumption of a distant adversary appears irrelevant. Similarly, the trust assumptions made in these models often assume the existence of a trusted institution, such as a bank, a company, or the government, which can be fully relied on and considered benign. In countries where important institutions are male-dominated or male-oriented, such assumptions of trust could be detrimental to the security of women. Finally, even assumptions regarding resources can be considered biased: if a cryptographic solution is proved to be secure under specific resource requirements (e.g., power and network availability, computing capacity), when such requirements are not met security cannot be guaranteed. Given that women around the world tend to have limited access to resources, this basic assumption cannot be considered gender-neutral. These and related considerations need further research, to serve women's unique and urgent security and privacy concerns.

CONCLUDING REMARKS

This issue has not been raised before in the context of cryptography, as the analysis of security in general has been heavily influenced by gender. Feminist security studies have proposed a more people-centered notion of security, in which people contribute to and become part of the definition of security. Quaglia and Heath (2017) describe a growing awareness that technology needs to be designed for a cultural and societal context. Seminal work by Hall, Heath, and Coles-Kemp (2015) describes how visualising security with the use of LEGO bricks enables participants to question traditional notions of security (such as the one user/one password paradigm).

Rethinking security through a gender lens is a necessary step to ensure women's greater involvement in the design of security and, in particular, cryptographic solutions, enabling a successful integration of digital technologies in our everyday lives. There are some limitations to our considerations so far: for instance, we have not extensively covered issues of security and privacy globally, and we have not addressed intersectionality. This paper should represent a starting point for further detailed studies and research.

REFERENCES

Association for Progressive Communications (APC). (2015). Cases on women's experiences of technology-related VAW and their access justice. Retrieved from: https://www.apc.org/en/pubs/cases-women%E2%80%99s-experiences-technology-related-vaw-a

Alta Associates. (2017). 2017 Global Information Security Workforce Study. Frost & Sullivan. Retrieved from: https://iamcybersafe.org/wp-content/uploads/2017/06/europe-gisws-report.pdf

ARS Technica. (2017). Google fires engineer who "crossed the line" with diversity memo. Retrieved from: https://arstechnica.com/tech-policy/2017/08/google-fires-engineer-who-crossed-the-line-with-diversity-memo/

BBC News. (2015). "Too hot to be an engineer": Women mark Ada Lovelace Day. Retrieved from: http://www.bbc.co.uk/news/technology-34359936

CyberFirst. (n.d.). Retrieved from: https://www.cyberfirst.ncsc.gov.uk/

Deneulin, S., with Shahani, L. (2009). An introduction to the human development and capability approach: Freedom and agency. London: Earthscan.

eMarketer. (2013). Women more likely to seek healthcare advice online. Retrieved from: https://www.emarketer.com/Article/Women-More-Likely-Seek-Healthcare-Advice-Online/1009683

Frost, A., & Sullivan, W. (2017). The 2017 Global Information Security Workforce Study: Women in Cybersecurity. Retrieved from: https://iamcybersafe.org/wp-content/uploads/2017/03/WomensReport.pdf

Finn, J., & Banach, M. (2000). Victimization online: The downside of seeking human services for women on the Internet. CyberPsychology & Behavior, 3(5), 785-796. Retrieved from: http://dx.doi.org/10.1089/10949310050191764

Frankland, J. (2017). In security: Why a failure to attract and retain women in cybersecurity is making us all less safe. Rethink Press.

GenCyber. (n.d.). Retrieved from: https://www.gen-cyber.com/

Girls who code. (n.d.). Retrieved from: https://girlswhocode.com/

GSMA. (2015). Connected Women 2015: Bridging the gender gap: Mobile access and usage in low and middle-income countries.

Hall, P., Heath, C., & Coles-Kemp, L. (2015). Critical visualization: A case for rethinking how we visualize

risk and security. Journal of cybersecurity, 1(1), 93-108. Retrieved from: http://dx.doi.org/10.1093/cybsec/tyv004

IBM. (2016). Retrieved from: https://www.ibm.com/blogs/citizen-ibm/2016/10/ricciuto_girls_cyber_security/

Intel. (2012). Women and the Web. Intel Corporation.

Internet Society. (2016). Internet Society Global Internet Report 2016. Internet Society. Retrieved from: https://www.internetsociety.org/globalinternetreport/2016/?gclid=CjwKCAiAz-7UBRBAEiwAVrz-9RJtClvBj3WNdmj1ZJK7fB_fflqgVKCK3uwG0XmALw9IoIHGTx5QdRoCS7kQAvD_BwE

ITU (2017). Retrieved from: https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf

Jordan-Young, R. (2010). Brainstorm: The flaws in the science of sex-differences. Harvard University Press.

Mashable. (2016). These STEM initiatives are inspiring women and girls around the globe. Retrieved from: https://mashable.com/2016/01/22/women-in-stem-global/#dXPQa6LTUuqK

New Scientist. (2017). Hundreds of UK women are seeking illegal abortions online. Retrieved from: https://www.newscientist.com/article/2148066-hundreds-of-uk-women-are-seeking-illegal-abortions-online/

Pew Research Center. (2018). Mobile Fact Sheet. Retrieved from: http://www.pewinternet.org/fact-sheet/mobile/

Quaglia, E., & Heath, C. (In press). New directions in secure branchless banking.

Quartz. (2016). When Google increased paid maternity leave, the rate at which new mothers quit dropped 50%. Retrieved from: https://qz.com/604723/when-google-increased-paid-maternity-leave-the-rate-at-which-new-mothers-quit-dropped-50/

Research @ MSU. (2016). Prostitution has gone online – and pimps are thriving. Retrieved from: http://research.msu.edu/prostitution-has-gone-online-and-pimps-are-thriving/

Sey, A. (2011). We use it different, different: Making sense of trends in mobile phones use in Ghana. New Media & Society, 13(3), 375-390. Retrieved from: http://dx.doi.org/10.1177/1461444810393907

Statista. (2017a). Internet usage rate worldwide in 2017, by gender and region. Retrieved from: https://www.statista.com/statistics/491387/gender-distribution-of-internet-users-region/

Statista. (2017b). Share of internet users in the United States who have used online dating sites or apps as of April 2017, by gender. Retrieved from: https://www.statista.com/statistics/706497/us-adults-online-dating-site-app-gender/

Statista. (2018a). Distribution of Facebook users in the United States as of January 2018, by gender. Retrieved from: https://www.statista.com/statistics/266879/facebook-users-in-the-us-by-gender/

Statista. (2018b). Distribution of global Facebook users as of January 2018, by gender. Retrieved from: https://www.statista.com/statistics/699241/distribution-of-users-on-facebook-worldwide-gender/

Statista. (n.d.). Distribution of computer and video gamers in the United States from 2006 to 2017, by gender. Retrieved from: https://www.statista.com/statistics/232383/gender-split-of-us-computer-and-video-gamers/

Tacchi, J. (2014). Being meaningfully mobile: Mobile phones and development. In: Servaes, J. (ed.). Technological determinism and social change (105-124). Lanham, MD: Lexington Books.

TechRepublic. (2015). 10 examples of gender bias you may encounter in the workplace. Retrieved from: https://www.techrepublic.com/blog/10-things/10-examples-of-gender-bias-you-may-encounter-in-the-workplace/

The Guardian. (2014). 52% of gamers are women – but the industry doesn't know it. Retrieved from: https://www.theguardian.com/commentisfree/2014/sep/18/52-percent-people-playing-games-women-industry-doesnt-know

Time. (2014). Google invests $50 million to close the tech gender gap. Retrieved from: http://time.com/2901899/google-made-with-code-girls-in-tech/

Wajcman, J. (2004). TechnoFeminism. Cambridge: Polity Press.

Wikipedia. (n.d.). Me Too movement. Retrieved from: https://en.wikipedia.org/wiki/Me_Too_movement

Wikipedia. (n.d.). Time's Up (movement). Retrieved from: https://en.wikipedia.org/wiki/Time%27s_Up_(movement)

Wired. (2017). The Actual Science of James Damore's Google Memo. Retrieved from: https://www.wired.com/story/the-pernicious-science-of-james-damores-google-memo/

Wise. (2017). The STEM Education Pipeline 2017. Retrieved from: https://www.wisecampaign.org.uk/resources/2017/11/from-classroom-to-boardroom-the-stem-pipeline-2017

World Health Organisation. (2017). Violence Against Women. Retrieved from: http://www.who.int/mediacentre/factsheets/fs239/en/

World Wide Web Foundation. (2016). Digging into data on the gender digital divide. Retrieved from: https://webfoundation.org/2016/10/digging-into-data-on-the-gender-digital-divide/