Preparing developing countries for the future of work: understanding skills-ecosystem in a digital era

Background Paper

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Pathways for Prosperity Commission
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This paper is part of a series of background papers on technological change and inclusive development, bringing together evidence, ideas and research to feed into the commission's thinking. The views and positions expressed in this paper are those of the author and do not represent the commission.

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Executive Summary

The fast-expanding digital economy is increasing the demand for three categories of skills:

- job-neutral digital skills
- job-specific digital skills
- soft skills.

Job-neutral digital skills include basic to intermediate industry-neutral digital skills needed for functioning and operating in the digital economy. *Basic digital skills* are important for workers to function at a minimum level in a digital economy, such as using mobile phones and the internet. *Intermediate digital skills* refers to skills for engaging with internet and digital technologies in a more productive manner that can help workers to adapt to technology changes, such as: use of Microsoft® Office and PowerPoint; use of social media and electronic platforms for digital marketing; use of data analytics, and so on.

Job-specific digital skills refer to *advanced digital skills* such as computer programming, network management, coding, big data analytics, and cryptography. These skills are mainly acquired through advanced formal education, but can also be learnt through incubators, boot camps, and other activities. (ITU, 2018).

Digital skills, in combination with different types of *soft skills*, such as analytical and critical thinking and socio-emotional skills, can increase competitiveness of the workforce in the digital economy. For instance, tasks of digital advertising and marketing involve use of both basic to intermediate digital skills along with the soft skills of communication and collaboration. Even advanced digital technologies, such as 3D printing, involve the use of specialist digital skills of 3D modelling and cognitive soft skills of problem-solving and creative design.

This paper takes a National Innovation System (NIS) approach towards understanding digital and soft skills development in the digital era. Skills development in this framework is a dynamic and interactive process that requires:

a) **education and skills development policies** for increasing the supply of digital skills
b) **policies to create incentives for skills development** through establishing competitive domestic markets, research and development (R&D), and so on
c) **linkages between supply and demand of skills** through intermediaries such as industry associations and complementary policies on technology transfer.

On the skills-supply side, there are three channels through which developing countries can strengthen/attract digital and soft skills: formal education and technical and vocational education training (TVET); non-formal TVET; and employer-led training.

The respective target audience of these channels and associated challenges are summarised in Table A. For formal education and TVET, there is an urgent need to incorporate digital literacy and basic ICT skills at the primary and lower-secondary level of education. Beyond increasing secondary

TVET enrolment – which is below 6% in low- and lower-middle income countries – there is a need to reorient TVET at the upper-secondary and tertiary level to increase provision of intermediate to advanced digital skills and soft skills. This can be done by revising learning frameworks through mapping transformative competencies. For out-of-school youth, marginalised sections of the society and adult learners, access to digital and soft skills training can be expanded through non-formal TVET, but training capacity needs to be leveraged through better co-ordination across existing players, and linkages with national accreditation systems.

Beyond increasing access to TVET and changes in the curricula, effective and quality provision of digital and soft skills training may require continuous professional development for TVET trainers, availability of resources to meet the relatively high cost of teaching Science, Technology, Engineering and Mathematics (STEM), building ICT capacity in education and teacher training, investment in digital infrastructure, and linkages with a dynamic private sector to align training with industry needs. There is also a need to establish or improve standard-setting bodies. They should be able to grade digital and soft skills according to different types and levels, and define them in terms of outcomes achieved (by both formal and non-formal TVET). These bodies can also recognise prior learning in digital and soft skills and provide certification recognised by employers and higher education institutions.

Currently, less than 50% of firms surveyed across several developing countries are offering any sort of formal training to workers. Digital skills training is also likely to be concentrated in ICT companies. Employer-led training in digital and soft skills tends to be faster, flexible and more productive. However, it remains constrained by low incentives for employers due to low labour retention rates, lack of awareness among firms about the kinds of training available; uncertainty about returns to investment in training, and the risks of 'free-riding'.

In Asian and African economies, employer-led training exhibits structure, but tends to be without certification and often in the form of informal apprenticeships. Developing industry-specific levy models, sensitive to digital and soft skills, can incentivise employer-led training.

On the demand side, skills development can be facilitated through a competitive domestic market and complementary policies on innovation, international co-operation, trade facilitation, technology transfer and data, foreign direct investment (FDI), regulatory reform, and digital capacities. A third set of policies is needed to facilitate linkages between the demand and supply of technology, within and across national boundaries. Innovation intermediaries form key linking mechanisms for increasing viability of technology, market expansions and skills diffusion in the economy.

It is important to note that digitalisation can increase the viability and efficiency of skills development policy solutions. For example, policies that support the formation and expansion of digital information platforms between large firms and local suppliers might help reduce the information asymmetry in the market. It could also increase the demand for skilled labour among small and medium enterprises, and reduce information gaps regarding certifications of local suppliers by providing online data.

Table A: Summary Table

Delivery channel	Delivery type	Target audience	How?	Challenges	Illustrative examples
Schools and Universities: Formal education and TVET	Primary and lower-secondary education	Youth in schools and colleges	Embedding basic and intermediate digital skills, computational thinking and soft skills in the curriculum	Sustainable business models for scalability, upskilling of teachers, improving school ICT infrastructure, internet access, developing relevant and flexible curriculum, accreditation (ITU, 2018)	Australia: early learning initiatives in K12 focused on STEM (Timms et al, 2018)
	Upper-secondary, post-secondary and tertiary education	Youth in TVET	Increasing access to STEM-focused TVET with intermediate and advanced digital skills training, job-placement opportunities and apprenticeships with private sector	Standardising accreditation, incentivising private sector, lowering entry costs for students into these programmes, affordability of training, infrastructure, forward-facing curricula, skills-mismatch	India: polytechnical institutes in tertiary education (UNESCO, 2018).
Non-formal TVET	Training institutes, community technology centres, NGOs, public libraries, boot camps, hubs, etc.	Out-of-school youth, women, disadvantaged youth, job seekers	Basic-advanced digital skills training, soft skills training	ICT infrastructure, upskilling instructors, spreading awareness about these programmes, skills-mismatch, overlapping in trainings, lack of co-ordination across players	Bangladesh's Digital Skills for Entrepreneurs programme, has trained 3,000 women entrepreneurs on business skills, digital skills, and hardware repairs (ITU, 2018)
Employer-led training	Training in private institutes, on-the-job learning, or a mixture of both.	Skilling or re-skilling of workforce	Intermediate-advanced digital skills training, soft skills training in management etc.	Low incentives, lack of funding, quality of trainers, low labour retention, risk of free-riding.	Dual training programmes offered by many German companies which involves classroom learning at a vocational school and on-the-job training (UNESCO-UNEVOC WTD, 2012)

1. Introduction

Rapid deployment of digital technologies along the different stages of the value chain is changing the work and skills landscape. Routine tasks that can be more easily codified are at higher risk of being automated, while the share of non-routine tasks is likely to increase in the future. There are three categories of 'core' skills for non-routine tasks in the digital economy:

- job-specific digital skills such as coding and mobile app development
- job-neutral digital skills such as data analysis and digital marketing
- soft skills such as management, communication and critical thinking (Banga and te Velde, 2018a).

Developing economies are lagging in skill-readiness. These countries rank lower in routine cognitive, interpersonal and analytical skills, and skills shortages have increased over time in some African countries (ibid).

This paper draws on an NIS approach for developing a holistic understanding of skills development in a digital economy. In this framework, delivery of digital and soft skills occurs through three pathways:

- Embedding skills within education and formal TVET – education, training and skills development relating to a wide range of occupational fields, production, services and livelihoods
- Skills development for out-of-school youth and adult learners through non-formal TVET
- Employer-led training.

These modes of delivery address different skills development issues, including: preparing youth for the labour market; digitally skilling the workforce; re-skilling workers who have lost jobs as a result of automation; and upskilling workers so that they remain competitive in face of the fast-changing technology.

The framework also recognises the importance of the increasing demand of digital and soft skills through fostering competitive domestic markets and R&D culture. Linking the demand for skills with supply through institutional intermediaries, it acknowledges that access to foreign technology and markets can affect skills development in developing countries on both the supply and demand sides.

This paper discusses the changing landscape of skills in the digital economy. We map out the current ecosystem and a framework for skills development in the digital economy. We apply the framework to channels for supplying digital and soft skills in developing countries, examining country-specific examples to understand best practices and challenges. Finally, we discuss policy priorities for increasing the supply and demand of digital and soft skills and facilitating skills diffusion.

2. The changing landscape of skills in a digital economy[1]

Many developing countries are facing a critical challenge of unemployment, particularly for the youth population. For example, in Sub-Saharan Africa, around 18 million new and productive jobs need to be created each year through to 2035 to simply keep up with demographic challenges of youth influx into the labour market (IMF, 2015). Given this context, rising automation and digitalisation is contributing to fears about increasing unemployment and, in particular, that human labour will be substituted with machines and automation.

Several studies have discussed the digital economy's impact on employment.[2] They suggest that the impact of digitalisation on aggregate employment varies across countries and sectors, and depends on factors such as economic and technical feasibility, labour and capital market responses, and complementary policies and institutions. The use of digital technologies can lower the cost of production, increase productivity and lower barriers to entry into the export market, all of which can lead to an expansion of output and exports, and create new jobs linked to these exports. However, digitalisation is raising concerns of 'jobless growth', whereby productivity gains may not translate into large-scale employment gains (Rodrik, 2018). The cost of capital is rapidly declining in developed countries, increasing the threat of reshoring manufacturing and limiting opportunities for future offshoring of digitally-advanced production. This can have an adverse impact on jobs in developing economies.

The level of digitalisation lower in low-income countries compared to other parts of the world. Digitalisation's impact on manufacturing labour productivity is also lower. This hints at a two-pronged problem faced by less-developed countries in the digital economy (Banga and te Velde, 2018a).

A major factor contributing to the digital divide in both 'access' and 'use' of modern technologies in developing countries is the lack of skills, or shortage of 'relevant' skills in these economies.[3]

Consider the case of Kenya – the country's ICT survey suggests that, while 90% of Kenyan manufacturing firms have access to internet and computers, only 55% have a website, and only 27% are engaged in online selling. This is likely indicative of a digital skills gap in Kenyan manufacturing. The share of skilled labour in digitalised Kenyan firms – firms that have a website and are using the internet for e-commerce – is, on an average, 20 percentage points higher than non-digitalised Kenyan firms with no internet access (ibid).

[1] This section draws heavily on *Skill Needs for the Future*, an earlier paper by the authors.

[2] Some examples include: Brynjolfsson and McAfee, 2012; Bughin et al., 2017; Acemoglu and Restrepo, 2017; Banga and te Velde, 2018; and World Bank, 2019.

[3] Skills have been defined as the "relevant knowledge and experience needed to perform a specific task or job and/or the product of education, training and experience which, together with relevant know-how, are the characteristics of technical knowledge" (UNESCO, 1984). In modern understanding, skills can be regarded as the ability to carry out a task, which can be altered through experience and interventions (Saraf, 2017).

If nothing is done to address the skills gap in developing countries, the digital divide is likely to exacerbate. For instance, if workers have insufficient skills to operate modern machines, these will remain underutilised. In turn, this will reduce incentives for firms to invest in digital technologies and modern machines, further lowering productivity of workers. In the current literature, this is called the 'low-skill low-tech trap'.

To prepare the labour force for productive employment and changes in the labour market, developing countries need to urgently adapt to the changing landscape of skills in the digital economy. Evidence from developed countries suggests that labour markets are 'hollowing out', which refers to increasing demand for high- and low-skilled workers at the expense of middle-skilled workers (Beaudry, et al. 2016).

These middle-skilled workers tend to perform routine tasks that can be more easily coded and automated, in contrast to high-skilled workers performing non-routine cognitive tasks (eg R&D and professional services) and low-skilled workers performing non-routine manual tasks (eg nursing and childcare). However, evidence from developing economies on labour market polarisation remains mixed: while some countries such as Malaysia, Mauritius, Uganda and India have witnessed a decreasing employment share of middle-skilled workers between 1995–2012, others such as Ethiopia, South Africa and Ghana document a decline in low-skilled employment (World Bank, 2016). In India, rapid digital progress in some sectors has been accompanied by proliferation of low-paid service jobs in activities that are, (at least for now), difficult to automate (Turner, 2018). The Kenyan manufacturing firm, Megh Cushion Industries, reports a decline in the share of middle-skilled workers, but has put in place strategies to retrain displaced workers for performing other tasks (Banga and te Velde, 2018b).

While some jobs related to routine tasks are likely to be automated in the digital economy, new jobs can be created through productivity effects, and in sectors related to these machines. These include manufacturing sectors such as computer and electronics and electrical machinery, which are responsible for supplying hardware for these technologies, as well as service sectors such as repair and maintenance and software, which are going to be in increasingly demand in the digital economy.

Banga and te Velde (2018) conduct a review on the changing employment structures in developing countries, and conclude that digitalisation is likely to increase the share of non-routine tasks in jobs, leading to three types of skills being demanded in the digital future.

2.1 Job-neutral skills

Job-neutral digital skills include basic to intermediate industry-neutral digital skills needed for operating in the digital economy. Basic digital skills are important for workers to function at a minimum level in a digital economy, such as using a computer and going online. Intermediate digital skills are those needed for engaging with the internet and digital technologies in a more productive manner. This includes computer technology (for instance, use of Microsoft® Office

and PowerPoint), digital design (User Interface design, Photoshop, etc.), digital marketing (use of social media and electronic platforms) and data analytics and storage, as well as secure use of the internet to carry out such tasks.

These skills prepare workers for a wide range of digital tasks and help them adapt as technology changes. For instance, data skills feature more prominently as the data revolution gains further momentum, generating demand for skills needed to produce, analyse, interpret, and visualise large amounts of data (ITU, 2018).

2.2 Job-specific digital skills

Job-specific digital skills are advanced digital skills of computer programming, network management, coding, big data analytics, cryptography, and so on. Such skills are mainly acquired through advanced formal education, but can also be learnt through incubators, boot camps, etc. (ITU, 2018).

2.3 Soft skills

Digital skills, in combination with different types of soft skills, such as analytical and critical thinking, communication and collaboration, and socio-emotional skills can increase competitiveness of the workforce in the digital economy. For instance, tasks of digital advertising and marketing involve use of both basic to intermediate digital skills along with the soft skills of communication and collaboration.

Tasks such as technology design, which require content and knowledge creation, involve use of both intermediate to specialist digital skills and soft skills of creative and innovative thinking. Even advanced digital technologies, such as 3D printing, involve the use of specialist digital skills of 3D modelling as well as cognitive soft skills of problem-solving, critical thinking and creative designing.

Digital technologies are changing the landscape of labour markets and the associated skills needs. There is an urgent need for targeted interventions to increase competitiveness in the digital economy for workers in developing countries, by focusing on building the workforces' digital and soft skills.

3. Understanding the ecosystem for skills development in a digital economy

Several studies have noted the importance of an NIS for technological and skills development, in both developed and developing countries. The existing literature suggests that firms in emerging markets normally follow a different technological trajectory to developed countries (Figueiredo, 2001). Technological knowledge in developing economies may be acquired by initially searching for, operating, and mastering technology developed by others, rather than developing technology locally. Technology trajectories also typically follow a sequence of initially developing operational or production capabilities, design, engineering and associated management capabilities, and eventually developing local R&D capabilities (Bell, 2007). NIS in developing countries should therefore serve as a purposeful strategic management for catching up, which has been a common focus of newly industrialised economies in the past (Gu, 1999).

Figure 1 takes the case of developing countries and maps out digital skills development, drawing on the NIS approach. In this framework, national skills development can occur through three channels:

- increasing the supply of new technology and skills
- increasing demand for new technology and skills
- linking the demand of skills with supply by facilitating co-ordinating mechanisms such as technology parks and hubs, industry associations and R&D consortia.

On the supply side, skills development can be facilitated through three channels:

- Formal education and TVET
- Non-formal TVET
- Employer led-training.

Formal education and TVET

Formal channels of skills development include academic education in school and universities – which is usually divided into primary, secondary and tertiary levels, and technical and vocational education and training (or TVET).

TVET is part of lifelong learning, and usually takes place at the secondary, post-secondary and tertiary levels of education, including work-based learning and continuing training and professional development (UNESCO, 2015). This kind of formal TVET is provided by government-accredited education or training institutes, such as the Ministry of Education, and occurs through a structured format that leads to qualifications and certifications. For example, technical education in India is offered at the tertiary level through polytechnic and specialised educational institutions (UNESCO-UNEVOC WTD, 2018).

Non-formal TVET

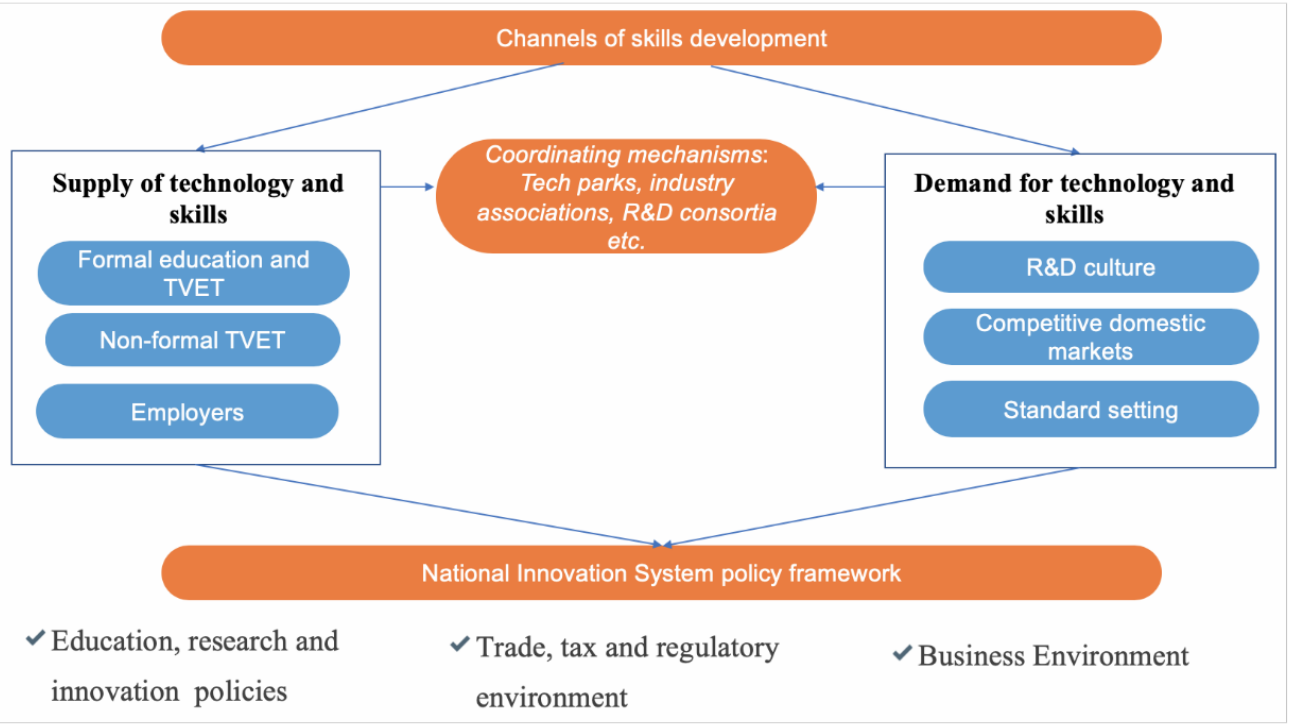
Given the broader scope of adult learning, particularly for digital and soft skills, schools and universities alone cannot help to equip adult learners with relevant skills. This has led to development of the **non-formal TVET channels**, provided through both national and private institutions. TVET training can be provided by government institutes outside the formal education system, non-governmental organisations (NGOs) and civil society, international organisations, and the private sector.

Such training also tends to be organised and systematic, targeting sub-groups of populations for which the formal channel may not be effective – for instance, adult workers, out-of-school youth, and disadvantaged groups, including rural youth and young girls who may not have the same access to skills training through formal education (Tight, 2002). Given the target audience, this type of training tends to be more flexible in terms of duration of training and curricula, and accommodates learning interests and the different capability levels of the participants.

Employer-led training

Employer-led training forms the third channel, which is oriented towards skills development for the existing workforce. This focuses on training and retraining workers in skills relevant to the employer. Training can occur through a mixture of classroom-based learning and use of an in-house or training institute that adheres to private standards established by the firm.

Figure 1: Ecosystem for skills development in the digital economy



Source: adapted from Kayal (2008)

On the demand side, digital and soft skills development can be facilitated through a competitive domestic market, R&D culture (eg through tax credits and subsidies) and exposure to international competition and foreign buyers. This can create incentives to innovate and upgrade through technological development, creating demand for skills-upgrading. Firms facing greater competition in their product markets are inclined to raise the minimum productivity threshold to operate profitably and reduce inefficiencies, which is partly done through investing in productivity-enhancing activities such as adoption of new technologies and skills development (Almeida and Aterido 2008).

An NIS approach towards skills development will require policymakers in developing countries to divert attention towards a number of areas, including: possible systemic failures; lack of interaction between the actors and institutions in the system; mismatches between basic research in the public sector and more applied research in industry; poor absorptive capacity of enterprises; and malfunctioning of technology transfer across institutions (OECD, 2017). This highlights the need for co-ordinating mechanisms to address systemic failures by targeting improvements in interaction and collaboration across educational and research institutes, training providers, enterprises, and fostering skills diffusion. Some examples of these intermediate institutions include industry associations, R&D consortia, and technology hubs or parks.

These intermediaries act as a bridge, linking knowledge directly or indirectly, co-ordinating interests among actors, and promoting the transformation of scientific and technological achievements (Siegel et al., 2003). In Africa, the success of iHub in Kenya and Kumasi Hive in Ghana are well documented as drivers of innovation and skills (Banga and te Velde, 2018a). In a digital economy, these intermediaries can also be online platforms – for instance, portals that link jobs with supply of skills.

Both national and international pathways affect skills development in the economy. National policies on science and technology, education, research and innovation (Kayal, 2008) can enable countries to strengthen digital skills and move from basic digital skills towards development of intermediate and advanced digital skills. Policies for improving the business environment on trade, tax and regulations can also foster greater demand for digital skills in the economy and facilitate skills diffusion through collaboration with intermediaries. In Taiwan, for example, the NIS supported the 'Reverse Value Chain' – that is, development of process capabilities, followed by product innovation and branding activities (Wong, 1999). This can occur through government policies based on supply and demand, by alleviation of taxation, loan subsidy, technological assistance, government procurement, and cultivation of manpower (Shyu and Chiu, 2002).

With global production becoming increasingly digital, policies on technology transfer with foreign multinational enterprises can act as a key stimulus for development of digital skills in host firms. For example, Singapore – one of the digital leaders in Asia – adopted a model of NIS that can be best characterised as one emphasising government facilitation of technological learning from multinational corporations (Kayal, 2008). The mode and ease of technology transfer will, however, crucially depend on the type of knowledge. When knowledge is more easily codified, technology transfer is more likely to take place through licensing agreements, or direct transfer from foreign firms to subsidiaries – for example, through blueprints.

However, as the tacit nature of knowledge increases, technology transfer will require learning through reverse engineering or movements of skilled migrants. South Korea's success in technology transfer, for instance, was largely attributed to its public R&D centres, which developed new technologies for the private sector through reverse engineering foreign technologies, especially when those foreign firms refused to license advanced technologies to Korea (Kim, 1991). Beyond foreign collaboration in education and research institutions, linking into global value chains increases exposure to foreign competition and investment, creating incentives for domestic employers to innovate and undertake skills training. Similarly, large private sector players such as Google and Amazon can increase access to skills training. For example, with the launch of its Digital Unlocked initiative in 2017, Google promised to provide training in areas such as digital marketing for India's 51 million small and medium-sized enterprises (SMEs) through a three-year programme of 5,000 workshops on 23 topics in 40 cities across the country (Pichai, 2017).

Overall, skills development is a dynamic and interactive process. National channels for skills development also impact on the capabilities of firms and countries to acquire and absorb foreign technology. For instance, te Velde and McGrath's (2005) review on education and globalisation processes finds that primary schooling is positively related to higher growth, productivity, and inward FDI, whereas tertiary education can determine export structures of a country, offshoring of R&D and innovation, and attracts FDI. Similarly, vocational education can lead to development of entrepreneurship, communication and leadership skills that can increase participation in global value chains and help developing country firms to upgrade into higher value-added exports. Technical and engineering skills can further attract FDI into manufacturing.

4. Channels for supplying digital and soft skills in developing countries

This section draws on the skills ecosystem in Figure 1 to understand the current challenges in building digital and soft skills in developing countries. It is key to note that the relationship between pathways for skills development in the digital economy and digitalisation is two-way. Policies on targeted skills development can help equip workers in developing economies with future-relevant skills to leverage digitalisation. Targeted skills can also increase the viability and efficiency of the policy solutions – for instance, through mass online educational and skills development courses, and online portals for matching skills to jobs, or students with relevant skills to digital jobs.

4.1 Skills development through formal education and TVET

Skills development through formal education is particularly important in the digital economy where 'learning to learn' is emerging as a key skill for workers to remain competitive. Developing countries need to continue to target increasing access to primary education, higher completion rates and increased quality of teaching at the primary level and lower-secondary level. The aim of the education type should be to equip students with knowledge across a range of subjects and foundational skills to engage with TVET. In most countries, this begins at the upper secondary levels (UNESCO-UNEVOC WTD, 2018). These foundational skills refer to the cognitive skills of reading and writing, as well as non-cognitive soft skills, such as communication, that help to increase students' employability, and which are developed through interactions with peers.

Having basic ICT skills is increasingly being recognised as a key foundational skill for functioning in a digital economy. In an effort to boost basic digital literacy and ICT skills,[4] a number of countries have started equipping schools with ICT infrastructure such as computers, internet and software to familiarise students with technologies at a young age. For example, Australia has made heavy investments in incorporating digital literacy in the K-12[5] school curriculum. The National STEM school education strategy 2016 – 2026 endorsed by Australian education ministers focused on 'a renewed national focus on STEM in school education' (Education Council, 2015). Following this, polices have promoted a number of STEM education initiatives, including revision of curricula to include 'Design and Technologies', and 'Digital Technologies at the Lower-secondary Level' (ibid).

[4] Possessing basic ICT skills is not the same as digital literacy, which refers to using digital technologies more effectively. For instance, performing a Google search is a basic ICT skill, but the ability to effectively use online search as a research tool includes choosing the right keywords, tracking information to credible sources, and conducting the search in a safe manner (for example, by recognising the use of cookies and bots, and the risk of computer viruses.

[5] K-12, a term used in education and educational technology in the United States, Canada, and possibly other countries, is a short form for the publicly supported school grades prior to college. These grades are kindergarten (K) and the 1st through to the 12th grade (1-12).

Analysing the level of provision for specific courses on basic computer skills (or computing) in developing countries, Table 1 reveals a varied picture. In some African countries, such as Uganda, and Zambia, a course in ICT is provided at all three levels; in others it is only provided at the lower and upper secondary education (eg Ethiopia); or only in the upper secondary education (eg Gambia, South Africa and Togo). Among Asian economies, China, Thailand and Malaysia provide basic computer skills at all levels, while this is true only at the upper secondary level in Cambodia, Nepal and Sri Lanka.

Table 1: Provision of a course on basic computer skills

	Primary education	Lower-secondary education	Upper-secondary education
Zambia	Yes	Yes	Yes
Uganda	Yes	Yes	Yes
Botswana	Yes	Yes	Yes
Bangladesh	Yes	Yes	Yes
Brazil	Yes	Yes	Yes
Thailand	Yes	Yes	Yes
Malaysia	Yes	Yes	Yes
Japan	Yes	Yes	Yes
Indonesia	Yes	Yes	Yes
China	Yes	Yes	Yes
Australia	Yes	Yes	Yes
Ethiopia	No	Yes	Yes
Togo	No	No	Yes
South Africa	No	No	Yes
Gambia	No	No	Yes
Sri Lanka	No	No	Yes
Nepal	No	No	Yes
Cambodia	No	No	Yes

Source: World Development Indicators (2015)

Some studies, such as Jakubowski et al. (2016) find that the approach of first providing general education and then TVET at a later stage is more effective in equipping students with learning skills. This trend has been observed in several OECD countries and Asian economies, where TVET starts at the upper-secondary level.[6]

TVET at the secondary level can be particularly useful for equipping students with job-neutral basic to intermediate digital skills such data analysis and digital marketing. This can be done by incorporating basic to intermediate ICT skills, coding and computational thinking as part of the

[6] A few developing economies, such as China and Kenya, recognise TVET even at the lower-secondary level, however, general secondary school enrolment remains a key challenge.

curriculum. For instance, in South African secondary schools, one curriculum stream in upper-secondary TVET is in Computer Applications Technology (CAT) (Draper, 2010), which trains students in basic ICT skills; Solution Development, Systems Technologies, Network Technologies, Information Management and Social Implications of ICT use.

Understanding what it means to be a good 'digital citizen' can also form an important course component at upper-secondary level. More advanced digital skills, such as computer programming, technology design and mobile app development can be embedded in the tertiary TVET curricula.

While reorienting TVET in tertiary education towards STEM is useful for delivery of job-specific procedural knowledge, along with advanced digital skills. Procedural knowledge also needs to be accompanied with practical-problem solving, since students will need to apply their knowledge in uncertain circumstances when they transition into the labour market. Students therefore require 'soft skills' that will increase their employability, including cognitive skills such as critical thinking, socio-emotional skills (eg empathy and understanding), and interpersonal skills (communication, presentation, collaboration and management). These can either be taught through regular classroom activities, which involve communicating, debating, and presenting in seminars, or through formal courses. In the Univerzita Karlova, Czech Republic, for example, there are formal courses on soft skills for Masters Students, which include problem-solving skills, communication and public speaking (Simeon-Fayomi et al. 2018). Significant efforts have also been made in Malaysia in boosting digital and soft skill straining through TVET, particularly at the tertiary level. In 2007, Malaysia's Ministry of Education instructed public universities to review their curricula to reflect soft skills in each course, with particular emphasis given to seven soft skills:

- communication skills
- critical thinking and problem-solving skills
- teamwork
- information management skills
- entrepreneurship skills
- ethics
- leadership skills.

Several studies have found a positive impact of this new policy, including on soft skills development in students (Wahab, 2014); and their employability, particularly in the services sector (Lim et al., 2016).

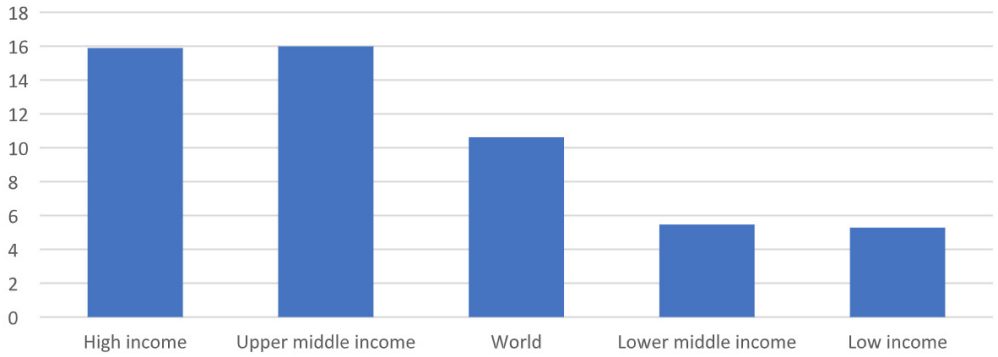
Incorporating soft skills in formal education can be particularly key for African countries where 'industries without smokestacks' (Newfarmer et al., 2019) such as tourism, transport and ICT-based services are fast-growing, and rank only second in terms of employment generation for the youth. However, the importance given to soft skills in African countries' curricula tends to be low. Assessing soft skill acquisition in Kenya through a survey of 200 TVET graduates, Murgor (2013) finds that some of the skills provided through training – such as interpersonal skills, personal qualities, ability to use numerical data, critical analysis, teamwork and experience – are below what is required in the job market. Similarly, Mohammed and Ismail (2018) confirm the lack of employability skills in the case of Nigerian TVET graduates. Conducting an analytical review of the

Electrical Technology Education programme curriculum, the authors find that the curriculum gave less attention to practice-based courses, compared to theory-based courses; there was no course component that focused on teaching the soft skills of problem-solving and decision-making.

Despite several initiatives by governments, low TVET enrolment in secondary education remains a persistent challenge in many developing countries; TVET enrolment in secondary education is below 6% in low- and lower-middle income countries (see Figure 2). Beyond increasing access to TVET and changes in the curricula, effective and quality provision of digital and soft skills training may require TVET trainers to undergo continuous professional development (Grijpstra, 2015), availability of resources to meet the relatively high cost of teaching STEM (Tikly et al 2018), building ICT capacity in education and teacher training, investment into digital infrastructure (including electricity, computers, hardware maintenance, internet access, software programs, etc.) and linkages with the private sector to align skills taught with industry needs.

Box 1 discusses how the multinational Siemens is solving some of these challenges and supporting digital skills development in developing countries.

Figure 2: TVET enrolment in secondary education (% of total secondary enrolment), 2017



Source: World Development Indicators

Box 1: Siemens and national skills development

Siemens is playing an import role in supporting digital skills development in developing countries by extending support to both formal education institutions and non-formal TVET. To ensure that engineering graduates who enter the workforce are trained on the most advanced technology available, Siemens is providing industrial automation equipment to engineering faculties at colleges and universities in South Africa, Nigeria, Ghana, Tanzania and Kenya. Similarly, in Myanmar, Siemens is helping the education sector prepare for the digital transformation by offering software grants to Myanmar's Department of Technical and Vocational Education and Training.

These grants will reach 35 universities and 29 technical and vocational training schools and cover 1,000 licences, and 580 software packages. For example, the software TIA Portal (Total Integrated Automation Portal) which was granted to the academic institutes is a practical tool to minimise engineering time by 30–50%, which results in lower costs, reduced time to market and increased flexibility.

Recognising that mining, an important sector in South Africa, is lagging in terms of modernisation and skills development, Siemens has launched an initiative called the Digital Mining Incubator (DMI) in co-operation with Wits University in South Africa. Located in a co-creation space, the DMI uses data, machine learning, artificial intelligence and more to develop 'smart' mines for the future and provide students with skills to transform the South African mining sector.

Source: Carlisle (2019); Makgamathe (2019)

4.2 Skills development through non-formal TVET

A number of non-formal channels also exist for providing skills training, including through TVET training led by NGOs, trade unions, private organisations, public/private sector led coding bootcamps and hubs, and so on. A number of foreign multinational enterprises are also contributing to skills training in developing countries through non-formal TVET. For example, Microsoft South Africa is working with the City of Johannesburg to teach one million residents the basics of digital literacy through the city's public libraries, in an attempt to upskill disadvantaged youth (ITU, 2018). A key advantage of such training programmes is that, as well as expanding skills training and development to adult learners, they also reach marginalised sections of the society such as out-of-school youth, women, disadvantaged youth, and job seekers through community technology centres, public libraries, 'makerspaces' and hubs.

In some countries, non-formal TVET is also provided through industry-specific training programmes. The textile sector, for example, is of key importance to the Indian economy – it is a high employability sector, requiring a diversity of skills sets in a wide range of segments. To harness the employment potential of this sector, the Ministry of Textiles in India launched the Integrated Skill Development Scheme (ISDS) in 2017 (Government of India, 2017). Courses offered under this scheme include training in:

- garments manufacturing technology, related to both hardware and software, such as mechatronics, robotics, computer-aided design and manufacturing (CAD/CAM)
- consumer-related soft skills and business skills, such as apparel merchandising, fashion marketing and retailing and visual merchandising
- digital imaging, designing and embroidery.

An e-certificate is offered to trainees who complete their training and pass the assessment examination. Successful implementation of this scheme involves leveraging the existing institutional strength and training experience through three components: institutions under the Ministry of Textiles; private industry partners in public–private partnership mode; and state government agencies. A variety of shareholders such as textile research associations, private training partners, industry associations, and state government institutions are working in co-operation. However, the involvement of a large number of actors, often overlapping in training and lacking in co-ordination, can also serve as an obstacle for non-formal TVET in many countries.

For example, in Kenya, a number of ministries offer non-formal TVET, such as the Ministry of Labour, Social Security and Services, Ministry of Industry, Trade and Cooperatives, and the Ministry of Public Service, Youth and Gender Affairs (UNESCO-UNEVOC WTD, 2018, Kenya). However, trainees do not receive a certificate, constraining their employability in the labour market (ibid). Other challenges for non-formal TVET include lack of linkages with a nationally accredited qualification system, lack of provisions for recognising prior learning, poor monitoring when linkages do exist, and poor co-ordination across key players in general. There is also a lack of awareness among youth; 70% of Indian youth, for instance, are not aware of the government-run initiatives (Choudhary, 2018).

The Australian case is often seen as 'best practice' for TVET; it is one of the most comprehensive yet flexible non-formal TVET systems, with multiple pathways to the Australian Qualifications Framework (AQF). Non-formal TVET in Australia is offered by multiple types of providers, with modes including full-time, part-time, online or distance learning, and can be extended through apprenticeships and Recognition of Prior Learning (RPL). Specifically, individuals can make applications to registered training organisations to get the skills, knowledge and experiences they have previously developed through informal and non-formal learning formally assessed and recognised for nationally accredited qualifications (UNESCO, 2018).

In Africa, Nigeria has developed a National Skills Qualifications Framework (NSQF) that recognises all prior learning (non-formal and informal), with the awarding bodies also having the mandate to determine the percentage to be allocated to the recognition of prior learning (NBTE, 2019). This framework promotes lifelong learning and provides quality assurance and recognition by encouraging relevant stakeholders (such as industry organisations and employers) to participate in skills development. The framework also aims to help public and private players improve co-ordination and monitoring of skills development activities. Engagement with the private sector is seen as crucial to equip workers with skills being demanded by industry (Oketch and Lolwana, 2017).

4.3 Skills development through employer-led training

Despite continued efforts and investments by developing country governments to boost TVET through formal and non-formal routes, many firms report a shortage of relevant skills in the workforce. In the period 2006–2013, the percentage of firms identifying inadequately skilled workforce as a major constraint to firm operations increasing in many African economies; roughly by 26 percentage points (pp) in Kenya, 2 pp in Tanzania, 16 pp in Rwanda, 11 pp in Ghana and 3.6 pp Uganda (Banga and te Velde, 2018). Firms that are digitalising manufacturing in Kenya also report a significant skills gap between what they require and what TVET graduates have to offer (Banga and Velde, 2018b).

TVET has often been found to have only relatively small impacts on young people's transitions into the labour market, whether the indicators measured are income, hours in employment or job satisfaction (see for instance, Tripney and Hombrados, 2013). TVET graduates aren't usually 'work ready'. This is due to a number of factors, including:

- inability of the TVET curricula to catch up with fast pace of change of technology and changing demand for skills (Wolter and Ryan, 2011)
- TVET trainees being trained on older machinery due to lack of modern machines in schools and TVET institutes
- training centres don't provide problem-solving and communication skills (ACET-MCF, 2019)
- mismatch between employers' expectations and students' skills (Hailu, 2012)
- different perceptions of TVET trainers and employers (Yamada et al., 2018)
- lack of effective trainers in TVET (ACET-MCF, 2019).

With fast-changing digital technologies, companies are also providing training and development opportunities for workers through a mixture of learning-by-doing and formal on-the-job training through, for example, classroom-based learning. "Employer-provided training is by far the most important source of further education and training after an individual enters the labour market" (Hannson 2008, p.5). Such training strategies are also expected to be faster, and enhance productivity, leading to higher wages and promotions (Wholey, 1990).

Findings from Banga and te Velde (2018b) suggest that the larger manufacturing firms in Kenya, which are using digital technologies, deal with the digital skills gap by providing in-house training on digital machinery. The authors shed light on the case of Megh Cushion Industries, an automotive Kenyan firm that was quick to adapt to the changing skills needs of digital technologies. When digital machinery was first imported, the firm hired engineers from abroad for installation and to train the workforce to repair and maintain the machinery. This was done by entering into import and annual maintenance contracts that involved after-sales support from English-speaking engineers who could offer training in the use of the machinery, and provide feedback in the case of breakdown.

Another example is Panesar Interiors, a furniture manufacturing firm in Kenya that identifies skills shortages in creativity, fine arts, architecture and dimensional drawing skills as key challenges to its operation. To address this challenge, on-the-job training is provided by the firm's own Panesar Training Institute, which follows a curriculum focusing on training workers in industrial skills such as woodwork, joinery and carpentry, but also in digital skills such as dual programming for Computer Numeric Control (CNC) and CAD/CAM systems (ibid).

In the services sector too, employer-led training is offered at different stages for employees' skills development. The IT giant IBM, for example, provides a training programme particularly for software developers, programmers and executive leadership for training on software such Oracle and SAP, leadership and soft skills development. Popular job training methods include on- and off-the-job training, job instruction training, project assignment, understudy method (eg internships), and apprenticeship training (IBM, 2019).

Box 2 highlights the case of skills training by Adidas Group, targeting executive managers in factories in Vietnam.

Box 2: Foreign multinational enterprises and soft skills development

For soft skills development, the Human Resources Management Systems Training (HRMS) is a collaborative approach initiated by Adidas, Reebok, Nike and Puma, launched in Vietnam in 2008. The core missions of the HRMS is to address recruitment policies, compensation systems, target setting, performance evaluations and more. HRMS tools include one-year practical training sessions, milestone-setting and feedback session.

In Vietnam in 2008, one-day workshops were set up for executive managers at factories to improve executive management commitment. Between 2008 and 2010, 15 suppliers completed the training programmes, with the Vietnam Chamber of Commerce and Industry (VCCI) contributing financial support to translate the training materials into a number of languages. The HRMS training has encouraged the development of HR manager networks which share good practice and collaborate on continuous improvement. Many participating suppliers saw increased operational efficiencies once the HRMS was implemented, with key performance indicators also reflecting significant improvements where suppliers implemented HRMS.

Source: Adidas Group, (2010)

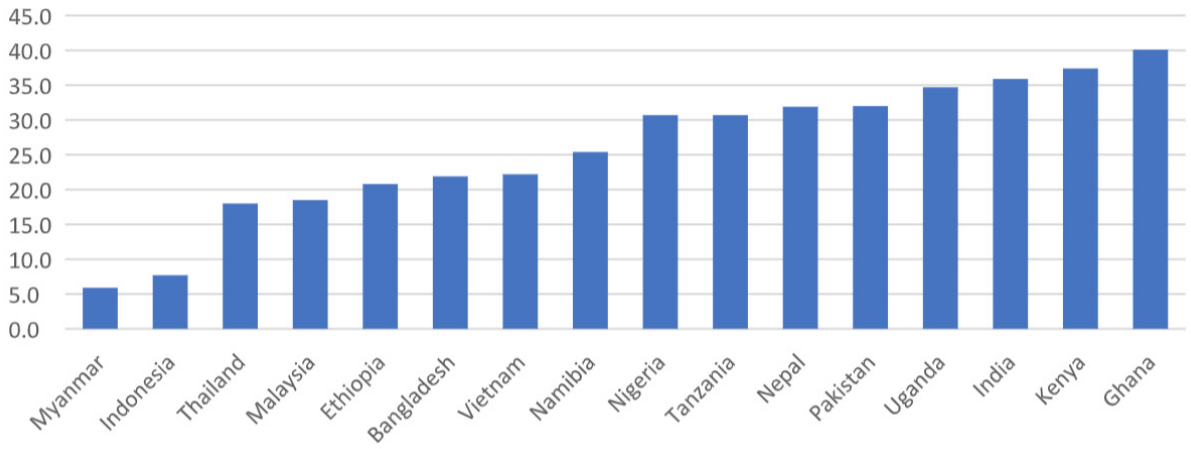
Cross-sector data from the World Business Environment Survey (WBES) reveals that less than 50% of firms surveyed across several developing countries are offering *any* sort of formal training to workers. Ghana, Kenya and India rank higher in terms of percentage of firms that are provided training, while the Asian economies of Myanmar, Indonesia and Thailand rank low (Figure 3). A number of demand- and supply-side considerations may be contributing to low employer-led training in developing countries.

While upskilling workers may be good for the economy as a whole, it may not be in the interest of each employer to invest in training, particularly in African countries with low labour retention rates. Other supply-side problems include lack of awareness among firms about the kind of training available and how this can be provided, and the risk of some firms 'free-riding'[7] (Saraf, 2017).

[7] Theoretical literature suggests that firms that provide on-the-job training are not able to fully appropriate the rents to training, while empirical literature documents evidence of productivity benefits for future employers profiting from hiring workers trained in the previous firm (Saraf, 2017).

A number of studies have also noted that training provision, and the impact of incentives on training, is usually greater in large and medium enterprises, with SMEs lacking the required capacity and resources (Banga and te Velde, 2018b for Kenya, Cedefop, 2011 for Europe). Demand-side constraints include information gaps – that is, uncertainty in the firms about returns to skills-training – and digital divide across firms. Low adoption of new technologies in some firms reduces the demand for better skills (Saraf, 2017).

Figure 3: Percentage of firms offering formal training to workers



Source: WBES, data is for different years in the period 2013–2018.

The WBES data used in Figure 3 does not provide any further information on what type of skills are taught in this training. Focusing on Malaysia and the type of training providing, Frost and Sullivan (2018) reveal that digital skills training is mainly provided in ICT companies. The authors' survey of 435 companies in 2017, of which 64% are technological enterprises (for example, e-commerce and cybersecurity companies) and 36% are non-tech companies (for example, companies in manufacturing, banking and financial services, retail and so on).[8] The authors report that, overall, 47% of firms are providing training in technical skills,[9] 25% in digital[10] and 28% in soft skills.

In non-tech companies, only 11% of companies are providing training in digital skills. Also focusing on Malaysia, in the petrochemicals sector, Wan Hooi (2010) analyses training conducted by four multinational corporations and concludes that foreign ownership does not necessarily mean better training strategies. The authors find that a techno-savvy joint-venture company uses software for correctly matching training needs with available programmes. The company also places more importance on training in the era of globalisation and digitalisation, compared to a wholly foreign-owned company.

[8] Among tech companies, 25% of respondents are mainly involved in software/hardware development, followed by 24% from global business services. In non-tech companies, 29% are from manufacturing and 13% in banking and financial services.

[9] Technical skills are related to mathematical, engineering and scientific abilities and knowledge required for specific tasks relating to technology.

[10] Digital skills are directly related to the use, development or creation of technologies.

Training, however, may not be equally distributed among employees; workers with less education and skills, and older workers, tend to receive less training (Hansson 2009; Leuven and Oosterbeek 2004). For a large panel of Portuguese firms, Almeida and Carneiro (2009) show that the workforce in firms that provide training is already more educated than in those that do not provide training. More specifically, the proportion of workers with bachelors' or college degrees is 6% in high-training firms as compared to 3% in low-training firms, and 1.3 % in non-training firms. Moreover, the workforce in firms that offer training tends to have a higher proportion of male workers. If workers with low digital literacy, or female workers, have a lower access to digital training, then this is likely to exacerbate the digital divide.

In developing country firms that do provide on-the-job training, models of training differ from those in developed countries. For instance, economies of Austria, Denmark, Germany and UK provide formal work-based training, which comprises a formal apprenticeship that offers young people a programme of structured on-the-job learning, coupled with structured off-the-job learning in a TVET institution (ADB, 2018). In contrast, in Asian and African economies, employer-led training exhibits structured training, but without certification or informal apprenticeships. As discussed in the context of TVET, the quality of training is also crucial for skills development, particularly in the digital economy where technologies are fast changing. While, at the sector and national levels, developing countries can make efforts towards defining minimum competence requirements for trainers and aim at providing professional development opportunities, this is challenging at the firm level, where training is often provided by employees themselves who are not professional 'trainers' but rather skilled workers.

5. Policy priorities for skills development in the digital economy

The previous section analysed channels for delivering skills in developing countries through formal and non-formal TVET and employer-led training. This section focuses on policy implications for strengthening the supply of skills, as well as complementary policies for boosting the demand for skills and creating linkages between the two. The sections below identify cross-cutting issues in skills supply and identify associated priorities under education and skills development policies. We also discuss policies on fostering greater demand for skills and facilitating skills diffusion.

5.1 Updating education and skills development policies

Overall, Section 4 suggests that a more STEM-focused formal TVET can be effective in delivering digital skills to in-school youth. Appropriate policies are needed to increase access to formal TVET, particularly at the secondary level, by addressing both demand- and supply-side problems, including improving the cultural perception of TVET, reassessing TVET accreditation, developing a national skills framework that recognises prior learning, and smoothening the transition between TVET and academic education.

As the global economy is becoming increasingly digitalised, having basic digital literacy is considered as a foundational skill. There is thus a need to incorporate digital literacy and basic ICT skills at the primary level and lower-secondary level, followed by TVET at the upper-secondary and tertiary level for provision of intermediate to advanced digital skills. Frost and Sullivan (2018) highlight that, in Australia, Taiwan, Sweden and Singapore – countries often used as a benchmark for digital talent – soft skills such as critical-thinking have been incorporated in the formal school curriculum, from primary education through to tertiary education.

Learning frameworks in developing countries need to be revised to better embed digital and soft skills. This is currently being done in several OECD countries through mapping transformative competencies and other key concepts into a specific set of constructs (e.g. creativity, critical thinking, responsibility, resilience, collaboration) to be included in the formal curricula. A key way of equipping students with practical problem-solving skills, procedural knowledge and soft skills is also through introduction of team projects, particularly ICT projects, in formal education.

Approaches to TVET accreditation also need to be reassessed in many developing economies. Instead of focusing efforts to develop new TVET institutions, efforts need to be re-directed towards standardising and harmonising the curriculum in existing vocational educational institutions, which can help to increase enrolment into TVET and boost youth employability. In Kenya, for instance, where there are already more than 2,000 TVET organisations, there is a need to harmonise and co-ordinate programmes, by standardising the quality and relevance of training in TVET institutions (Republic of Kenya, 2019). To address this challenge, and others around ineffective co-ordination and synchronisation of TVET, and inadequate planning data due to weak mechanisms for conducting tracer studies, the government is adopting the policy of assuring quality in TEVT on

all aspects of competency-based education and training (ibid). Many other developing countries are in the process of developing NSQFs, which are competency-based frameworks. These need to organise qualifications according to a series of levels of knowledge, digital skills and aptitude.

Particularly for digital and soft skills, there is need for developing countries to establish standard-setting bodies that can provide skills certification, recognised by employers and higher education institutions. Digital and soft skills will need to be graded as per different levels, and defined in terms of outcomes achieved through formal or non-formal TVET. Some developing countries, such as India and Nigeria, already have an RPL framework, which is an outcome-based framework that assesses and certifies prior learning. Introducing digital and soft skills in the RPL framework and linking RPL, in both formal and non-formal TVET, with qualification frameworks can expand access to digital and soft skills for youth who are in-school, out-of-school or marginalised.

In addition to providing certification of knowledge and skills, the demand of TVET can be increased through facilitating transitions from TVET back into higher education. For example, in South Africa, it was found that there is a disconnect between the entrance requirements of higher education programmes and the Computer Applications Technology subject offered in secondary schools (Mdlongwa, 2012). In many higher-income countries, there is a trend of greater flexibility between secondary and tertiary academic education and TVET (OECD et al., 2016). This has partly been accomplished through development of an overarching NSQF (Cedefop, 2017).

This flexibility makes TVET more appealing, and is particularly important in the digital economy, where rapid technological changes are increasing the role of lifelong learning (Oketch and Lolwana 2017; ILO 2018). In line with this, the European Commission's 2016 report on skills and transparency, argues that TVET needs to be more attractive, and demonstrate the capacity to progress to 'higher vocational or academic learning' (European Commission, 2016). In some developing countries such as Bangladesh, Botswana, Chile, Mexico, Sri Lanka and Tunisia, NSQFs remain exclusively concerned with vocational education (Allais, 2010), while others are now in the process of adopting more overarching NSQFs.

Beyond TVET, employers can be incentivised to invest in skills development through training levies, as is being done in several Asian economies (ADB, 2014). Sri Lanka, for example, boosted the incentives for enterprise-based training in 2011 by allowing enterprises to deduct the costs of staff training up to 2% of net income to stimulate greater incidence and volume of enterprise-based training. In Bangladesh, three industry associations in the garment and textile sectors have established their own training institutions to meet the demand for a higher level of technical skills. Financed through fees from trainees and contributions by the associations, these programmes offer a broad range of courses, including in manufacturing and technology, industrial engineering and lean manufacturing and fashion design.

Developing levy models, sensitive to the type of training (i.e. digital and soft skills) may be a key tool in incentivising manufacturing firms to provide relevant digital skills training to their workforce. The UK, for instance, has a significant IT skills gap, needing 134,000 new technology specialists every year (Gradvert, 2019). To address skills gaps, the government introduced the Apprenticeship Levy in 2017 in an effort to bring 3 million new apprenticeships into the workforce by 2020 (Gov.UK,

2019). All employers with a pay bill over £3 million each year are required to pay the apprenticeship levy – 0.5% of the value of the employer's pay bill, minus an apprenticeship levy allowance of $15,00 per financial year. Employers use a digital account on the Apprenticeship Service online portal, through which they can receive the funds to spend on apprenticeship and pay for training providers. This service pays for training and assessment for apprentices who spend at least 50% of their time working in England.

5.2 Addressing the gender divide in digital technologies and skills development

The existence of a gendered digital divide, particularly in developing countries, has been noted in several studies. Gender-biased beliefs and value systems that exclude women are among the main reasons for the current gap in access to education and digital skills. Due to the lack of exposure, women are often not familiar with ICT and do not realise their value and empowering potential (Gurumurthy and Chami, 2014).

Lower levels of education for females, limited availability of ICT content in local languages, and discriminatory attitudes against women's access to technology and relevant education, further contribute to the gender divide (Geertsema Sligh, 2006). There are also inequalities in access to training, particularly for the low skilled and for women workers.

STEM fields also remain dominated by men. For example, in Chile, while men and women are enrolled in equal proportions in secondary TVET, men are more likely to be found in industrial programmes, such as electricity, construction and metalworking. Women tend to pursue personal service programmes which include childcare and healthcare (UNESCO, 2018). This pattern is repeated at post-secondary level, where about 50 per cent of male students enrol in programmes in STEM fields, compared to only 15 per cent of their female counterparts (ibid).

Multilevel policy interventions are therefore needed to increase women's access to and enrolment in formal and non-formal TVET, as well as in developing gender-sensitive employer-led training models. Ensuring equity in initial STEM-focused TVET can ensure that opportunities to benefit from pathways of further learning are open and equitable for women, while access to skills training at later stages can be addressed through collective bargaining at sectoral and company levels (Martinez-Fernandez and Choi, 2013).

Important lessons can be drawn from Bangladesh's approach towards developing a gender-sensitive TVET model. Women's participation in TVET in Bangladesh has been strikingly low – ranging from 9–13% in public institutions and 33% in private institutions (ILO, 2012). To address this challenge, the National Strategy for Promotion of Gender Equality in TVET in Bangladesh, with support from ILO targets:

- equality of access and opportunities for women
- gender-sensitive policies in TEVT institutions to ensure that women are not discriminated again in terms of participation in TVET training or by the content
- gender mainstreaming as a cross-cutting principle in different aspects of TVET, such as recruitment of teachers and development of curriculum
- flexibility in terms of accommodating different demands of women and men (ibid).

5.3 Putting in place complementary policies for skills development

In addition to education and skills development policies, other policies that affect skills demand and create linkages between demand and supply of skills, also play a critical role in developing countries moving out of the low-skill trap.

On the demand side, skills development can be facilitated through a competitive domestic market, R&D culture and exposure to international competition and foreign buyers. This can create incentives to innovate and upgrade through technological development, creating demand for skills upgrading. Government policies on strengthening national innovation and knowledge systems can help firms to develop product marketing strategies, move into more sophisticated products, boost technology uptake and implementation and innovation.

For example, in the case of Cambodia, Martinez-Fernandez and Choi (2013) show that the garments industry needs to deploy new technologies to ensure longer-term sustainability of the sector. This can be done by developing an industrial policy that strengthens economic growth, provides a good regulatory environment to carry out business, and incentivises local industry to adopt higher-order product market strategies. Integrated skills and labour strategies are therefore needed to support local skills upgrading and employment initiatives and, at the same time, develop the required infrastructure for employment and training programmes (Eddington 2012). This is also how Singapore used its skills development fund (te Velde, 2005).

The importance of getting the incentives right to encourage firms to undertake R&D and skills development is highlighted in the case of South Korea. Despite huge state investments in education and public research and technology organisations during the 1960s and 1970s to increase the supply side of technology, the industrial sector continued to have very low R&D. To fix this shortfall, the government introduced new policies designed to strengthen industry's need for R&D (Kayal, 2008), including import-substitution policies. The government designated specific target machinery, parts, and new materials that should be localised for import substitution. It then offered tax incentives, preferential financing, and R&D subsidies to those who develop the designated items (Kim and Dahlman, 1992).

Other policies that can foster a competitive domestic market, and thereby increase technology adoption and skills development, include those on trade facilitation, increasing participation and upgrading in global value chains, facilitating FDI, regulatory reform, and building digital capacities in hardware and software, and so on.

In a fast-digitalising economy, policies on FDI, technology transfer and data are also key policy instruments in closing the digital divide, and facilitating knowledge and skills spillovers between developed and developing countries. As production becomes increasingly digitalised – that is, products become embedded with source-code and data (e.g. pacemaker or smart cars), the tacit nature of knowledge flows is likely to increase. This means that technology and skills transfer will increasingly depend on complementary policies on private sector development, data, R&D, source-code sharing and digital trade. Essentially, these policies will shape incentives for skills development and spillovers between foreign firms and their subsidiaries. It is therefore important for developing countries to attract the 'right kind of FDI' – that is, FDI in more skill-intensive and higher value-added production, that will encourage local skills development.

To facilitate technology and skills spillovers, Rodrik (2018) further stresses the need for policies that support domestic integration between the more productive digitalised firms and the less productive firms in the domestic economy. In line with this, Banga and te Velde (2018b) and Were (2016) argue for the need of the manufacturing sector in African economies to better articulate its needs to the domestic technology sector. This can help bridge the skills gap by matching the new demands of the manufacturing sector, such as skills to repair and maintain digital machinery, with locally existing skills in the ICT sector.

A third set of policies is therefore needed to facilitate linkages between the demand and supply of technology, both within and across national boundaries. For example, policies that support the formation and expansion of digital information platforms between large firms and local suppliers might help reduce the information asymmetry in the market. In so doing, it could increase the demand for skilled labour among SMEs, and reduce information gaps regarding certification of local suppliers by providing these data online. Makerspaces, hubs and technology parks are also important channels for skills development and diffusion; many have their own curriculum centred on the future of the workforce, and training is given in the relevant fields of robotics, artificial intelligence, digital fabrication, 3D printing and blockchains. Effective public–private collaborations are important for supporting hubs and makerspaces that are well integrated and linked with the rest of the domestic economy. Banga and te Velde (2018a) discuss the makerspace, Gearbox in Kenya, which provides manufacturing equipment, tools, machines, training, mentorship and networking to its startups.

6. Conclusion

Digital technologies are rapidly changing the landscape of work and skills. This paper has drawn on an NIS approach towards building key skills for the digital economy, focusing on: job-specific digital skills; job-neutral digital skills; and soft-skills.

Skills development in this framework is a dynamic and interactive process that requires government policies for increasing the supply of technology and skills (e.g. policies on education and skills development) and their demand (e.g. policies on standard setting, imports and R&D) and the linkages between the two (e.g. institutional intermediates and information platforms).

Complementary actions at these different levels can help developing countries close or reduce the skills gap in the digital economy. However, limited budgets mean that difficult trade-offs will need to be made by countries between different age- groups. For instance, some countries may choose to reorient secondary and tertiary education towards STEM subjects to support work in dynamic sectors, while other countries focus on skills for inclusivity, such as basic ICT skills (ACET-MCF, 2019). Another trade-off is between today's workers – a large percentage of whom lack basic digital and soft skills – and the future labour force for which early investments into digital and soft skills should be prioritised given the relatively higher returns (World Bank, 2019).

The relative weight placed on different trade-offs and education policy priorities will ultimately depend on a country's cultural, political and geographic context. For instance, countries with very low basic education attainment and fragile economies may want to place a much higher weight on improving basic education access and quality rather than investing in inclusion of basic digital skills within primary education.

Even within TVET, which reforms work best, may depend on the socio-economic environment – that is, what works best in one country may not work best in others (World Bank, 2019). For example, attempts to introduce the German dual system in South Africa are being hampered by a lack of private sector engagement, possibly due to firms not seeing skills training as an investment that they benefit from. Similarly, Frost and Sullivan (2018) note that Malaysia's initiatives in TVET development have been similar to the ones in Taiwan. However, the latter appears to enjoy more success, likely due to its requirement for schools to link up with industry players to ensure that students and graduates gain industry exposure. In Malaysia, both industry and academia are open to partnerships, but schools do not have the resources to leverage such opportunities.

The success of different pathways will also depend on political commitment and co-ordination across institutions in countries. In China, for example, the government has made targeted and committed interventions into skills development at all levels. Under the National Plan for Medium and Long-Term Education Reform and Development: 2020, efforts have been made for greater collaborations with the industry in TVET programmes and apprenticeships. The policy aims for 80% of medium and large enterprises participating in running vocational education schools by 2020. There is no universal prescription for training interventions: much depends on country-specific characteristics such as the nature of labour and production, availability of information, size of country, credit markets, industrial policies, and so on.

It is imperative that educational institutions and training programmes avoid the pitfalls of traditional TVET training. They must also recognise that the kinds of skills required by industry can change rapidly with technological progress. Therefore, skills training needs to be more flexible to adapt to the fluidity of skills required in the digital age. Coherence between education, skills development and other policies also requires solid institutional structures with clear mapping of responsibilities, better dialogue and effective co-ordination.

References

Acemoglu, D. and Restrepo, P. (2017). Robots and jobs: Evidence from US labor markets. Cambridge, MA, USA: National Bureau of Economic Research (NBER).

ACET-MCF (2019). The Future of Work in Africa: Implications for Secondary Education and TVET systems. Ghana, Africa: African Center for Economic Transformation (ACET). [online] Available at: http://acetforafrica.org/acet/wp-content/uploads/publications/2019/04/FOW-SecEdu-Study-MCF-Dec-2018-Final_Download-1.pdf [Accessed 17 October 2019]

ADB (2014). Innovative Strategies in Technical and Vocation Education and Training for Accelerated Human Resource Development in South Asia. Manila, Philippines: Asian Development Bank. [online] Available at: https://www.adb.org/publications/innovative-strategies-tvet-accelerated-hrd-south-asia-sri-lanka [Accessed 17 October 2019]

ADB (2018). Work-Based Learning for Skills Development. [online] Available at: https://development.asia/explainer/work-based-learning-skills-development [Accessed 17 October 2019]

Adidas Group (2010). Human Resource Management Systems Training. [online] Available at: http://sustainabilityreport.adidas-group.com/en/SER2010/suppliers/training-our-suppliers/hrms-training/Default.aspx [Accessed 17 October 2019]

Allais, S. (2010). National Qualifications Frameworks: Solving the education/labour market 'mismatch'? Education and Employers Taskforce Inaugural Research Conference, University of Warwick, Friday (Vol. 15).

Almeida, R. and Aterido, R. (2008). The incentives to invest in job training: Do strict labor codes influence this decision? Social Protection Discussion Paper No. 0832. Washington DC: The World Bank.

Almeida and Carneiro (2009). The return to firm investments in human capital. Labour economics, 16(1), pp.97-106.

Banga, K and te Velde, D.W. (2018a). Skill Needs for the Future. Background Paper Series; no. 10. Oxford, UK: Pathways for Prosperity Commission.

Banga, K. and te Velde, D.W. (2018b). Digitalisation and the Future of Manufacturing in Africa. London, UK: Overseas Development Institute.

Banga, K. and te Velde, D.W. (2018c). How to Grow Manufacturing and Create Jobs in a Digital Economy: 10 Policy Priorities in Kenya. London, UK: Overseas Development Institute (ODI).

Beaudry, P., Green, D.A. and Sand, B.M. (2016). The great reversal in the demand for skill and cognitive tasks. Journal of Labor Economics, 34(S1), pp.S199-S247.

Bell, M. (2007). Technological Learning and the Development of Production and Innovative Capacities in the Industry and Infrastructure Sectors of the Least Developed Countries: What Roles for ODA. Division for Africa, Least Developed Countries Specialised Programme, Brighton, Science Policy research. Brighton, UK: UNCTAD.

Brynjolfsson, E. and McAfee, A. (2012). Race Against the Machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy. Lexington, Massachusetts, USA: Digital Frontier Press.

Bughin, J., Manyika, J. and Woetzel, J. (2017). A Future that Works: Automation, Employment, and Productivity. New York USA: McKinsey Global Institute.

Carlisle, P. (2019). Siemens' commitment to foster digital skill to new generation in Myanmar. Thailand Construction News. [online] Available at: https://thailand-construction.com/siemens-commitment-to-foster-digital-skill-to-new-generation-in-myanmar/ [Accessed 17 October 2019].

Cedefop (2011). Learning While Working: Success stories on workplace learning in Europe. Luxembourg: Publications Office of the European Union. [online] Available at: http://www.cedefop.europa.eu/EN/Files/3060_en.pdf [Accessed 17 October 2019].

Cedefop (2017). National Qualifications Framework Developments in Europe 2017. Luxembourg: Publications Office of the European Union [online] Available at: https://www.cedefop.europa.eu/files/4163_en.pdf [Accessed 17 October 2019].

Choudhary, A. (2018). Skill India: 70% of Indian youth don't even know about government's skill development programmes, Financial Express, 12 November, 2018. [online] Available at: https://www.financialexpress.com/economy/skill-india-70-of-indian-youth-dont-even-know-about-governments-skill-development-programmes/1379262/ [Accessed 17 October 2019].

Draper, K. (2010). Understanding Science Teachers' use and Integration of ICT in a Developing Country Context. Pretoria, South Africa: University of Pretoria. [online] Available at: https://pdfs.semanticscholar.org/b8b8/50d39695aac9c032c271b9b984b047205853.pdf [Accessed 17 October 2019].

Eddington, N. (2012). Skills Labour Market Policy in Cambodia. A report for the OECD ESSSA Initiative, (unpublished).

Education Council (2015). National Stem School Education Strategy: A Comprehensive Plan for Science, Technology, Engineering and Mathematics Education in Australia. Carlton, Australia: Education Council [online] Available at: http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/National%20STEM%20School%20Education%20Strategy.pdf [Accessed 17 October 2019].

European Commission. (2016). A New Skills Agenda for Europe: Working Together to Strengthen Human Capital, Employability and Competitiveness. SWD (2016) 195. [online] Available at: https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-381-EN-F1-1.PDF [Accessed 17 October 2019].

Figueiredo, P. N. (2001). Technological Learning and Competitive Performance. Cheltenham, UK: Edward Elgar Publishing.

Frost and Sullivan (2018). Digital Talent Report 2017, Cyberjaya, Malaysia: Malaysia Digital Economy Corporation.

Geertsema Sligh, M. (2006). Gender and the digital economy: Perspectives from the developing world. Asian Journal of Communication, 16(4), 440–442.

Gov.uk (2019). Apprenticeship Funding: How it works. London, UK: Education and Skills Funding Agency [online] Available at: https://www.gov.uk/government/publications/apprenticeship-levy-how-it-will-work/apprenticeship-levy-how-it-will-work [Accessed 17 October 2019].

Government of India (2017). Integrated Skills Development Scheme. New Delhi, India: Ministry of Textiles. [online] Available at: http://isds-textiles.gov.in/ [Accessed 17 October 2019].

Gradvert (2019). Using the Apprenticeship Levy to Fill the Digital Skills Gap. [online] Available at: https://Gradvert.Com/Insights/Blog/Using-The-Apprenticeship-Levy-To-Fill-The-Digital-Skills-Gap/ [Accessed 17 October 2019].

Grijpstra, D. (2015). TVET Teacher Education in Africa Annex Report. Brussels: European Commission.

Gu, S. (1999). Implications of National Innovation Systems for Developing Countries. Netherlands: United Nations University.

Gurumurthy, A. and Chami, N. (2014). Gender Equality in the Information Society: a review of current literature and recommendations for policy and practice. DFID Briefing Note. Bangalore, India: IT for Change.

Hailu, E. T. (2012). Analysing the Labour Outcomes of TVET in Ethiopia: Implication of challenges and opportunities in productive self-employment of TVET graduates. Master's Thesis. Netherlands: Institute of Social Studies.

Hansson, B. (2009). Job-Related Training and Benefits for Individuals: A review of evidence and explanations. OECD Education Working Papers, No. 19. Paris, France: OECD Publishing.

IBM (2019). Training and Development [online] Available at: https://www.ibm.com/topics/training-development [Accessed 17 October 2019].

ILO (2012). National Strategy for Promotion of Gender Equality in Technical and Vocational and Education and Training. Bangladesh: National Skills Development Council Secretariat. Government of Bangladesh, in collaboration with ILO TVET Reform Project. [online] Available at: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-dhaka/documents/publication/wcms_222688.pdf [Accessed 17 October 2019].

ILO (2018). Global Skills Trends, Training Needs and Lifelong Learning Strategies for the Future of Work. 2nd Meeting of the Employment Working Group. Geneva, Switzerland: International Labour Organization. [online] Available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---inst/documents/publication/wcms_646038.pdf. [Accessed 17 October 2019].

IMF (2015). Africa Economic Outlook, April. Washington, DC: International Monetary Fund.

ITU (2018). Digital Skills Toolkit. Geneva, Switzerland: International Telecommunications Unit.

Jakubowski, M., Patrinos, H.A., Porta, E.E. and Wiśniewski, J. (2016). The effects of delaying tracking in secondary school: Evidence from the 1999 education reform in Poland. Education Economics, 24(6), pp.557-572.

Kayal, A.A. (2008). National innovation systems a proposed framework for developing countries. International Journal of Entrepreneurship and Innovation Management, 8(1), pp.74-86.

Kim, L. (1991). Pros and cons of international technology transfer: a developing country view, in Agmon, T. and Glinsow, M. (eds.): Technology Transfer in International Business, New York: Oxford University Press, pp.223–239.

Kim, L. and Dahlman, C.J. (1992). Technology policy for industrialization: An integrative framework and Korea's experience. Research Policy, 21(5), pp.437-452.

Leuven, E., Oosterbeek, H. and Van Ophem, H. (2004). Explaining international differences in male skill wage differentials by differences in demand and supply of skill. The Economic Journal, 114(495), pp.466-486.

Lim, Yet-Mee, Teck Heang Lee, Ching Seng Yap, and Chui Ching Ling. (2016). Employability skills, personal qualities, and early employment problems of entry-level auditors: Perspectives from employers, lecturers, auditors, and students. Journal of Education for Business 91, no. 4 2016: 185-192.

Makgamathe, K. (2019). Siemens launches digimine Incubator at Tshimologong Digital Innovation Precinct. [Media Release] Available at: https://tshimologong.joburg/2019/01/siemens-digimine/ [Accessed 17 October 2019].

Martinez-Fernandez, C. and Choi, K. (2013). Skills development pathways in Asia. In Maclean, R., Jagannathan, S., and Sarvi, J. (eds.) Skills development for inclusive and sustainable growth in developing Asia-Pacific, pp. 155-179. Dordrecht, Netherlands: Springer.

Mdlongwa, T. (2012). Information and Communication Technology (ICT) as a Means of Enhancing Education in Schools in South Africa. Policy Brief. South Africa: Africa Institute of South Africa.

Mohammed, D.S. and Ismail, S. (2018). A framework for the integration of goal setting skills in Electrical Technology Education Programme Curriculum. Advanced Science Letters, 24(5), pp.3697-3700.

Murgor T. K. (2013), Relationship between Technical and Vocational Acquired Skills and Skills Required in Job Market; Evidence from TVET Institutions, Uasin Gishu County, Kenya, Journal of Education and Practice, Vol.4, No.19

National Board of Technical Education (NBTE) (2019). Vocational Technical and Skills Development Department. [online] Available at: https://net.nbte.gov.ng/VTSD [Accessed 17 October 2019].

Newfarmer, R., Page, J. and Tarp, F. eds. (2019). Industries without Smokestacks: Industrialization in Africa Reconsidered. Oxford, UK: Oxford University Press.

Oketch, M. and Lolwana, P. (2017). Introduction Keynotes (Vocational Education and Training in Sub-Saharan Africa). Bielefeld, Germany: W. Bertelsmann Verlag GmbH & Co (WBV).

Organisation for Economic Co-operation and Development (OECD), International Labour Organisation and The World Bank (2016). Enhancing Employability. Report prepared for the G20 Employment Working Group. Paris, France: OECD [online] Available at: https://www.oecd.org/g20/topics/employment-and-social-policy/Enhancing-Employability-G20-Report-2016.pdf [Accessed 17 October 2019].

Organisation for Economic Co-operation and Development (OECD) (2017). National Innovation Systems. Paris, France: OECD [online] Available at: https://www.oecd.org/science/inno/2101733.pdf [Accessed 17 October 2019].

Republic of Kenya (2019). A Policy Framework for Reforming Education and Training for Sustainable Development in Kenya. Sessional paper no. 1. Kenya: Ministry of Education [online] Available at: http://www.knqa.go.ke/wp-content/uploads/2019/03/Session-Paper-No-1-of-2019.pdf [Accessed 17 October 2019].

Rodrik, D. (2018). New Technologies, Global Value Chains, and Developing Economies. Oxford, UK: Pathways for Prosperity Commission.

Saraf, P. (2017). On-the-job Training: Returns, barriers to provision, and policy implications. Policy Research working paper; no. WPS 8090; WDR 2018 background paper. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/215081496860711954/On-the-job-training-returns-barriers-to-provision-and-policy-implications [Accessed 17 October 2019].

Shyu, J.Z. and Chiu, Y.C. (2002). Innovation policy for developing Taiwan's competitive advantages. R&D Management, 32(4), pp.369-374.

Siegel, D.S., Waldman, D. and Link, A., 2003. Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. Research Policy, 32(1), pp.27-48.

Simeon-Fayomi, B.C., Cheatan, B.S. and Oludeyi, O.S. (2018). Soft skills for young adults: Circuit in the formal, non-formal and informal models. Issues and Ideas in Education, 6(1), pp.99-112.

te Velde, D.W. (2002). Government Policies for Inward Foreign Direct Investment in Developing Countries: Implications for Human Capital Formation and Income Inequality. Working Paper No. 193. Boulogne-Billancourt, France: OECD Development Centre.

te Velde, D.W. and Mcgrath, S. (2005). Globalisation and Education. ODI briefing paper. London, UK: Overseas Development Institute (ODI).

Pichai, S. (2017). Google reaffirms commitment to digitally empower SMBs in India, 4 January, 2017. [online] Available at: http://www.uniindia.com/news/business-economy/google-reaffirms-commitment-to-digitally-empower-smbs-in-india/738986.html [Accessed 17 October 2019].

Tight, M. (2002). Key concepts in adult education and training. London/New York: Routledge Falmer/Taylor and Francis Group.

Tikly, L., Joubert, M., Barrett, A., Bainton, D., Cameron, L. and Doyle, H. (2018). Supporting Secondary School STEM Education for Sustainable Development in Africa. Bristol, UK: University of Bristol.

Timms, M.J., Moyle, K., Weldon, P.R. and Mitchell, P. (2018). Challenges in STEM learning in Australian schools: Literature and policy review. Camberwell, Australia: Australian Council for Educational Research. [online] Available at: https://research.acer.edu.au/cgi/viewcontent.cgi?article=1028&context=policy_analysis_misc [Accessed 17 October 2019].

Tripney, Janice S., and Jorge G. Hombrados. (2013). Technical and vocational education and training (TVET) for young people in low-and middle-income countries: a systematic review and meta-analysis. Empirical Research in Vocational Education and Training 5, no. 1 (2013): 3.

Turner, A. (2018). Capitalism in the age of robots: Work, income and wealth in the 21st-century. New York, USA: Institute for New Economic Thinking [online] Available at: www.ineteconomics.org/research/research-papers/capitalism-in-the-age-of-robots-work-income-and-wealth-in-the-21st-century. [Accessed 17 October 2019].

UNESCO-UNEVOC (2012). World TVET Database: Germany. Bonn, Germany: UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training [online] Available at: https://unevoc.unesco.org/wtdb/worldtvetdatabase_deu_en.pdf [Accessed 17 October 2019].

UNESCO-UNEVOC WTD (2018). World TVET Database – Country Profiles [online] Available at: https://unevoc.unesco.org/go.php?q=World+TVET+Database [Accessed 17 October 2019].

UNESCO (1984). Terminology of Technical And Vocational Education. [online] Available at: https://unesdoc.unesco.org/ark:/48223/pf0000029940 [Accessed 17 October 2019].

UNESCO (2015). Recommendation concerning Technical and Vocational Education and Training (TVET) [online] Available at: https://en.unesco.org/themes/skills-work-and-life/tvet-recommendation [Accessed 17 October 2019].

Wahab, A. and Binti, D. (2017). Graduate Labour Market Analysis in Malaysia (Doctoral dissertation). Leeds, UK: University of Leeds.

Wan Hooi, L. (2010). Technical training in the MNCs in Malaysia: A case study analysis of the petrochemical industry. Journal of European Industrial Training, 34(4), pp.317-343.

Were, A. (2016). Manufacturing in Kenya. Features, challenges and opportunities. International Journal of Science, Management and Engineering, 4(6), pp.15-26.

Wholey, D. (1990), The effect of formal and informal training on tenure and mobility in manufacturing firms, The Sociological Quarterly, Vol. 31, No. 1, pp. 37-57.

Wolter, S.C. and Ryan, P. (2011). Apprenticeship. In Hanushek, E., Machin, S. and Woessmann, L. (eds.) Handbook of the Economics of Education (Vol. 3, pp. 521-576). Amsterdam, Netherlands: Elsevier.

Wong, Poh-Kam. (1999). National innovation systems for rapid technological catch-up: An analytical framework and a comparative analysis of Korea, Taiwan and Singapore. Paper presented at the DRUID Summer Conference on National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, Denmark, June 9–12, 1999. [online] Available at: https://core.ac.uk/download/pdf/51181670.pdf [Accessed 17 October 2019]

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

World Bank (2019). World Development Report 2019: The Changing Nature of Work. Washington, DC, USA: World Bank Group

Yamada, S., Otchia, C.S. and Taniguchi, K. (2018). Explaining differing perceptions of employees' skill needs: The case of garment workers in Ethiopia. International Journal of Training and Development, 22(1), pp.51-68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