Fostering digital skills in developing countries – what works?

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Archita Misra[1]

Executive summary

As the world becomes better connected, marked by the increased access to and use of the internet, the need for competencies to navigate it digitally have never been more urgent. These capabilities include skills and knowledge to adapt to the changing nature of the economy and demands of the workforce (such as illustrated by the popularity of coding bootcamps and hackathons), but also civic participation in societies (such as by media and data literacy) more broadly. More recently, as the COVID-19 pandemic accelerated the pace of digital transformation, it also revealed the disparities in the adoption of digital technologies: between developed and developing countries, rural and urban households, men and women, among other areas. Digital upskilling has emerged as a key area of interest and policy intervention to harness the gains from digitalisation equitably, and mitigate the challenges of the growing digital divide, which risks leaving vulnerable populations behind in the digital and datafied information landscape.

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[1] Blavatnik School of Government, University of Oxford. Email: archita.misra@bsg.ox.ac.uk, or architamisra@hks.harvard.edu. We are grateful for funding from the German Federal Ministry for Economic Cooperation and Development through GIZ which has allowed the author to work on this policy brief. Many thanks to Elizabeth Stuart and Stefan Dercon (University of Oxford) for their helpful guidance and supervision, as well as Gordian Frey and Leonie Kellerhof (GIZ) for their comments and feedback. The author would also like to thank Prateek Sibal (UNESCO) for sharing helpful information on UNESCO's digital skilling programmes for the note.

However, scanty evidence on effective ways to implement and invest in digital skills development poses a critical barrier in realizing the promise of inclusive digital transformation, particularly in the context of low- and middle-income economies. This policy note – intended for audiences interested in applied policy research and practice – draws out 'what works' from the limited existing literature on interventions that seek to enhance digital literacy and skills in some form. Sections 1 and 2 explain what we know about digital skills development (rationale and definitions), elaborating a few features and capabilities associated with the term and summarizing popular measurement approaches. Section 3 highlights the main findings about what we know about digital skills development and 'how' some of the effective interventions have been implemented effectively – focusing on developing country contexts. The findings here are clustered along two main types of skilling efforts: 1) those that enhance **access to technology;** and 2) those that focus on **curated training and tutoring.**

Finally, Section 4 concludes by proposing the following takeaways for policy research and effective implementation:

(for policy research)

1) Empirical evidence on digital skills development needs to be expanded and strengthened at large.
2) Specific evidence on how digital skills acquisition intersects with other demographic parameters is required to design effective, targeted interventions.
3) Measurement efforts should reflect the dynamic nature of digital skills.

(for policy implementation)

1) Digital skills interventions should go beyond a narrow set of computing capabilities.
2) Digital skills development is part of lifelong learning, including upskilling as adults.
3) Digital skills development targeted at specific populations typically requires holistic interventions designed collaboratively with a range of experts.

1. Bridging the digital divide: the promise of digital skills in unequal societies

1.1 Why advancing digital skills matters

As the world rapidly undergoes digital transformation, accelerated by the COVID-19 pandemic, the fault lines of the current ecosystem have also come to light. While about 800 million people across the globe came online for the first time between 2019 and 2021, about 2.9 million still remain offline – most residing in developing countries. Around 87 per cent of people in Europe use the internet, while the figure is as low as 33 per cent in Africa. However, addressing the digital divide is not just a matter of connecting the unconnected, it cuts across multiple dimensions such as access, skills, language, and gender. For instance, women in developing countries are 15 per cent less likely than men to use the mobile internet and have lower levels of digital literacy (OECD, 2021a).

Lack of digital literacy and skills has been cited as one of the key barriers in leveraging the benefits from digital transformation – both at the individual and firm levels. It is one of the central reasons reported in South Asia and sub-Saharan Africa (GSMA, 2021) for insufficient mobile internet adoption and use, despite the expansion in internet infrastructure (like mobile broadband coverage).[2] Less than 50 per cent of the Latin America and Caribbean population has enough experience using digital tools to carry out basic professional tasks, and so were effectively excluded from remote activities during the pandemic (OECD, 2021a). For firms (irrespective of size), the lack of capabilities, including overall technical skills and

[2] GSMA's study from eight low- and middle-income countries finds that about 25 per cent of survey respondents (particularly rural and female) are "unaware of mobile Internet and how it can benefit them" (GSMA, 2020). Even among those who are aware, a dearth of literacy and digital skills – for instance, about setting up accounts or using applications – is often reported as the most significant barrier to mobile internet adoption. This is further pronounced for women and people with disabilities (GSMA, 2021; 2020)

know-how to implement new technologies is one of the key internal obstacles to technology adoption, hindering productivity and growth (World Bank, 2022).[3] Concomitantly, the benefits of acquiring digital skills have been linked to increased job security, as work shifts online or becomes increasingly automated, and better prospects in employment and earnings as occupations and economies adapt to digital trends (ILO, 2021). Beyond labour market outcomes, digital literacy and skills is a key factor in building financial resilience (Kass-Hanna, Lyons and Liu, 2022), being a discerning consumer of information and media in the age of dis/misinformation (Guess et al., 2020) and can enable meaningful participation society as a digital citizen. A digitally literate workforce and citizenry constituting a majority with basic digital skills and a critical mass of digitally advanced people is key for developing economies to reap the benefits from digital transformation and distribute the dividends equitably. (Bashir and Miyamoto, 2020).

1.2 The rising interest in digital skills development

There is growing recognition of the need to foster digital skills, which is framed as a key solution to bridging digital inequality. Theoretical literature on digital inclusion has widened from the initial focus on access and usage rates to include "quality of access/use, affordability and digital skills" (Sharp, 2022). Digital literacy and skills are recognised as important components of emerging frameworks enabling whole-of-society digitalisation, such as the World Bank's Digital Economy for Africa (DE4A) initiative, and also features as one of the thematic indicators in the UN Sustainable Development Goals Monitoring Framework (Indicator 4.4.2: Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills).

The urgent need and demand for digital skills is reflected in the surge in policies and programmes focusing on digital literacy and skill development – among countries as well as part of development co-operation (Bashir and Miyamoto, 2020; ITU, 2021). For instance, South Africa has a national commission to advise on information and

[3] This insight is from the Bank's new data collection instrument, the Firm-level Adoption of Technology (FAT) survey.

communications technology (ICT) development and support it in education, and digital skills are introduced at the secondary level. Ghana's ICT in education policy framework (2015) highlighted teacher training in digital skills and the introduction of ICT as a subject from primary school through high school (IFC/LEK, 2019). Uganda's Communications Commission has sought to integrate ICT skills into education (UCC, 2014). The government of Rwanda's national Digital Ambassadors Programme (DAP) launched in 2017, seeks to "increase the digital literacy of five million Rwandan citizens, and their resulting access and use of online systems and services".

Among donor agencies, the European Union (EU) Digital for Development framework (2017) aims to promote digital literacy and skills as one of its four priority areas to advance and mainstream digital technologies in its development interventions. Several Development Assistance Committee members, including Norway, Sweden, Germany and Japan, have also identified digital skills and literacy as an important priority (OECD, 2021a). For instance, the German Federal Ministry for Economic Cooperation and Development is supporting the development of Digital Transformation Centres in partner countries of which Digital Skills comprises as one of its 9 modules. As of December 2021, its associated digital learning and skill acquisition platform Atingi, which supports courses in over 40 languages, has reached over 400,000 registered users (Atingi, 2022).

1.3 From interest to implementation and impact: the evidence gap in digital skills development

The increasing interest in digital skills development policies and programmes has not been matched by commensurate evidence on what works well in implementing such projects. At the global level, there is insufficient standardised data on the levels of digital skills,[4] in part due to the difficulties in conceptualizing and measuring digital skills (Sharp, 2022; Bashir and Miyamoto, 2020). Further, while there is some literature related to the effects of ICT skills or educational technologies (edtech) on different education and labour market outcomes, there is an acute dearth of

[4] SDG indicator 4.4.1 (Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill) is classified as tier 2 as of 2022, i.e. indicator which is conceptually clear but countries do not produce data on it regularly (UN, 2022).

reliable evidence on past and ongoing interventions focused on developing digital literacy and skills. It remains unclear what delivery approaches would work to advance digital literacy in specific contexts. This is somewhat echoed in the synthesised evidence on human capital by Deming (2022), which notes "we know how to build foundational skills such as literacy and numeracy" but the technology for producing higher-order skills is not well understood (these can arguably include some elements of digital literacy and skills).

2. Understanding digital skills: conceptions, definitions, and measurement

The digital and data revolutions have catalysed the need for a range of new and complementary sets of skills beyond basic literacy and numeracy – such as data literacy, information literacy, technical and technological skills, and digital skills. These are often hybrid notions with an overlapping set of capabilities and relevance in conjunction with each other. Some of the central capabilities and features encapsulated by 'digital skills' that are recurrent in the literature are summarised below:

1) **Digital literacy and skills comprise of a broad and dynamic set of capabilities, involving the use of ICT tools and ability to navigate the internet.**

A vast amount of literature captures the different conceptions of digital skills and literacy, along with numerous frameworks (put forth by international organisations in particular) delineating core competencies. While there is a growing consensus to forge a common understanding of the notion, some popular definitions presented in the table below illustrate marginal differences in scope:

Organisation/ study	***Conceptions and definitions***
UNESCO /UIS (2018)	"Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent

	jobs and entrepreneurship. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy and media literacy."
UNESCO (2018)	"Digital skills are defined as a range of abilities to use digital devices, communication applications, and networks to access and manage information. They enable people to create and share digital content, communicate and collaborate, and solve problems for effective and creative self-fulfilment in life, learning, work, and social activities at large."[5] Key competence areas: communication and collaboration, critical thinking, data literacy, ICT familiarity, device security, and personal security.
EU DigComp 2.2 (2022)	Digital competences are conceptualised as a combination of knowledge, skills and attitudes in five areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem solving.
OECD (2019)	Conceptualises skills for a digital world as a holistic set of skills for a digital society, and skills for a digital world of work and learning in a digital environment. Digital skills are framed complementarily to socio-emotional and cognitive skills.
World Bank (2020)	Digital skills are separately conceived for a digitally competent workforce and digitally literate citizens. A digital competent workforce part includes skills for ICT professions and skills for a broad range of occupations. Being digitally literate citizens includes having the skills to leverage digital technologies and services in daily activities and the skills to facilitate learning, civic engagement, and health outcomes.
ITU Digital Skills Toolkit (2018)	Digital skills are defined as a spectrum of basic skills (referring to "foundational skills for performing basic tasks and cover hardware, software and basic online operations", intermediate skills (" skills that enable the use of technologies in more meaningful and beneficial ways… like to perform work-related functions and they expand to account for changes in technology"), and advanced skills ("related to emerging technologies, such as artificial intelligence, big data, cybersecurity, the Internet of Things and app development …needed by specialists in ICT professions such as computer programming and network management")

These digital capabilities are fundamentally dynamic – "as the internet and other digital technologies develop, the list [of activities encapsulated under digital skills] tends to get longer." (Sharp, 2022)

[5] This framework builds on EU DigComp 2.1 and is adapted to developing country contexts, providing the methodological foundation for the Sustainable Development Goal indicator on digital literacy.

2) **Digital skills are relevant for different purposes, in a continuum of proficiency levels**.

Depending on the complexity of the task and level of digital engagement, digital skills often have gradations ranging from basic to intermediate and advanced. The EU has frameworks for different purposes, such as the e-Competence Framework pertaining to specialised skills for ICT professionals, or the EU DigComp 2.2 relevant for a wider range of occupations. For general digital literacy among citizens, the EU DigComp 2.2 and the UNESCO/UNESCO Institute for Statistics (UIS) Digital Literacy Global Framework (both have four proficiency levels) include digital skills to participate in socio-economic and civic lives. The World Bank framework for Digital Economy for Africa ranks digital skills in three proficiency levels based on ICT intensity, as many non-ICT professions have started to require more specialised digital competencies. (Bashir and Miyamoto, 2020). Box 1 below provides examples of a range of digital skills required in different sectors based on task types.

Box 1: Digital skills examples: different proficiencies for different purposes

The table below elaborates on how purposes and proficiency levels interact, based on IFC/LEK (2019).

Sector	Task types	Illustrative examples
Basic digital skills		
Agriculture	• Internet research • Mobile communication	• Farmers using government websites to check crop prices • Farmers using WhatsApp to exchange photos and other informative videos
Industry	• Online communication • E-learning	• Workers sharing photos of their work with managers to update them on progress • Workers watching tutorials/videos on how to operate new tools/machinery
Services	• Internet research • Online communication Online government services • E-banking	• Small businesses accessing online banking or government tax portals • Drivers using mobile apps to connect with passengers and to read online maps

Intermediate digital skills		
Agriculture	• Use of simple spreadsheets for accounting	• Farmers/agricultural workers or managers using financial software for income and expense tracking
Industry	• Use of professional software	• Engineers using modelling software like AutoCAD • Workers using software for project management, making presentations, and spreadsheets
Services	• Use of professional software	• Tourism operators using digital marketing to reach a larger client base • Small business owners designing websites to attract business
Advanced digital skills		
Agriculture	• Use of big data analytics • Development of specialised automated equipment	• Data analysts in agrobusinesses leveraging big data to analyse yield, chemicals and biomass index for future predictions • Engineers developing robots to pick fruit or harvest
Industry	• Computer programming • Network management • Automation • Digital manufacturing	• Specialists using advanced robotic equipment in manufacturing plants • Engineers running computer simulations to understand physical processes
Services	• Computer programming • Cloud computing • Machine learning and artificial intelligence (AI)	• Animators using specialised software to make films • Developers using AI to power language learning apps

Source: IFC/LEK, 2019.

3) **Measuring digital skills remains a challenging endeavour with no current standardised and scalable measure.**

The measurement of digital skills is a complex undertaking and currently there is no direct, standardised or scalable way of doing so, even in high-income countries. Digital skills are typically estimated in three ways: by self-reported measures; task-based computer tests; and use of proxies. Sharp (2022) provides a useful overview of the limitations of these methods, briefly summarised below.

- Self-reported measures are often not reliable and may lack validity. They may have inherent biases (such as women tend to underestimate their online skill levels relative to men).
- Task-based computer tests can be obsolete if they adopt a narrow view of digital skills (that is, 'computer skills') and are heavily PC-centric, where the skills tested for are not transferrable to more prevalent handheld devices such as mobile phones or tablets.
- Proxies used, such as possession of devices or levels of educational attainment, are not the same as digital skills attainment.

Moreover, Bashir and Miyamoto (2020) note that the demand and supply for digital skills are difficult to assess, particularly in the informal sector. They emphasise the need to explore non-traditional digital data sources (like online platforms and job-search engines) and AI-enabled approaches for "real time and predictive guidance".

3. What works: Key findings from current evidence

In general, there are a limited number of studies that directly seek to understand effective development of digital skills, particularly among low- and middle-income countries. However, even within the selected empirical evidence presented in Table 1 of the Appendix, the quasi-experimental or randomised evaluations mostly pertain to computer skills and literacy (a subset of digital skills). Arguably these interventions contain some relevant transferable insights and have been broadly grouped in two categories: studies that **evaluate the impact of increased access and exposure to technological inputs** on digital skills development; and studies that **pertain to provision of targeted training or tutoring and curated instruction or information** of some kind to develop relevant digital skills. Studies that leverage technology to evaluate standard learning outcomes (such as language and math) have been excluded from this analysis.

3.1 Access and exposure to technology

The first type of intervention leading to digital skills development pertains to increase in **access to technology**. With the rise of edtech literature, a number of studies assess the impact of increased access to technology on learning in core subjects like math or language and find mixed results. For instance, most One Laptop Per Child policy evaluations report negative to null results on educational or scholastic outcomes. However, emerging evidence in this area finds promising effects of increased technological access and exposure on digital skills development, especially basic computer skills and familiarity with technology (Rodriguez-Segura, 2021).

In particular, studies find that increased access to laptops – whether shared between children (as in Bet, Cristia and Ibarrarán, 2014) or via provision at home (Malamud and Pop-Eleches, 2011; Fairlie, 2012; Beuermann et al., 2015) – lead to increased computer skills and fluency in operating relevant hardware and software. The studies often contain components of self-learning via interactive user manuals or audio-visual aid, and at times accompanied by parental and teacher supervision. Most studies pertain to primary school children, though Fairlie (2012) assesses the impact of a programme for college students and finds a 17-percentage point increase in self-reported computer mastery. Finally, these studies typically use a mix of self-reported measures of computer skills, along with administering a simple task-based test to perform relevant operations and other parameters such as time-use patterns. See Table 1 in the Appendix for details.

Apart from increased access to laptops, a couple of studies also assess the effect of increased provision of internet services on digital skills and literacy. Malamud et al (2019) study the effect of increased access to laptops and high-speed internet at home among Peruvian children. It found substantial improvements in digital skills after just five months: children who were offered internet access scored 0.3 standard deviations higher on a test of internet literacy than those who were not offered internet access, whether they had laptops or not. Further, children who were offered laptops (with or without internet) had significant improvements on a

Windows-based computer test, suggesting that gains in computer literacy were transferable for using other types of computers. Alongside self-reported measures on computer and internet literacy, the study also investigated time-use patterns such as use of the laptop and internet logs for a varying set of activities such as entertainment (watching videos, online games, social media), learning and education, and so on. Similarly, Okyere (2020) finds that the distribution of free internet services by a private provider in Kenya significantly increased students' internet use and training, receipt of information on educational content, and participation in ICT education programmes.

However, this set of literature suffers from a dearth of evidence of increased access to technological inputs beyond laptops. While Amer (2020) finds that using interactive boards has positive and significant effects on the learning outcomes of Egyptian secondary school students in a computer skills course, there is scant evidence on increased access to handheld devices such as mobile phones and tablets on digital skills. The different interfaces of these devices shape how people interact with information, navigate the internet and experience the digital world at large. As noted by Clark, Coward and Rothschild (2017), mobile-specific tendencies require different digital and information literacy skills, currently not present in frameworks and evaluations that illustrate a PC-centric orientation. More attention needs to be paid to mobile channels, given that handheld devices like smartphones are often the entry point for most people in resource-constrained contexts in developing countries, and the interventions can be more cost-effective and scalable.

3.2 Targeted training, tutoring and information

Private or non-profit digital skills training programmes in the form of coding hackathons and bootcamps[6] have emerged over the last decade to address the growing digital skills divide (Cathles and Navarro, 2019). This burgeoning industry provides alternate and complementary pathways to promote digital upskilling

[6] See organisations like Girls Who Code, Africa Code Academy, Code to Inspire for a few examples.

outside formal educational channels, yet there isn't extensive or systematic evidence on its effectiveness for learning and educational outcomes. Findings from the review of coding bootcamps in World Bank (2018) for youth employment in Colombia (RCT), Lebanon (qualitative) and Kenya (qualitative) primarily focuses on labour market outcomes of these trainings and does not explain the impact on digital skills acquisition.

However, a recent study by Aramburu, Goicoechea, and Mushfiq (2021) sheds light on this important question. The authors evaluate the short-term causal effects of a high-quality, intensive, part-time computer coding bootcamp on digital skills and tech sector employment outcomes for a sample of high motivation, high potential women from Colombia and Argentina. The bootcamps had three important features: the coding courses were provided by well-established coding schools with a proven track record and experience; participants were provided with substantive scholarships to cover costs; and gender specialists were closely consulted to develop strategies to make bootcamps more gender inclusive. Local Average Treatment Effect (LATE) estimates of the above study found that the treatment group scores 0.6 bootcamp higher on the coding test relative to the control. Notably, the bootcamp increases the probability of passing the coding exam by 20 percentage points, which represents a 0.4 standard deviations increase relative to the control. The programme also reported a higher likelihood of finding a job in tech for the treated group, and increased resilience to a downturn in the labour market (owing to the COVID-19 pandemic).

Moving away from a typically teacher-centred to a learner-centred approach, Bakare and Orji (2019) find that there were significant effects of reciprocal peer tutoring (RPT) over direct instruction in delivering electronic and computer fundamentals education. The study, conducted with more than 100 Nigerian university students via two of the leading federal technical and vocational education (TVET) institutions, consisted of an experimental/treatment group that was taught with reciprocal peer tutoring lesson plans, while the control group was taught with direct instruction (face-to-face) lesson plans. The authors found that the main effect of RPT on academic achievement, interest and retention of learning of students in electronic and computer fundamentals was higher than the main effect of direct instruction. Furthermore, the difference between the main effect of RPT and direct instruction was also statistically significant. Also, the difference in the mean achievement scores of experimental and control groups could be attributed to treatment given and the nature of the instructional approaches. The authors show that this is further reflected in student interest and retention: students with RPT exhibited more interest in the subject and learnt faster and better when allowed to engage actively in class with peers and interact with lecturers.

Even though digital skills acquisition and application is highly contextual, few studies capture the impact of interventions and trainings that focus on digital skills development among particular groups, sectors or specific applied contexts. For instance, Jouparinejad et al (2020) finds that a targeted training on nursing informatics (which includes computing and digital skills relevant for nursing care) for nurses in Iran, significantly improved Nursing Informatics competency and its dimensions in the intervention group compared with the control group, with a large effect size. Similarly, Guess et al (2020) study the impact of a particular digital media literacy intervention and finds it to be an effective way to fight misinformation in the US and India. This intervention consisted of informing the treatment group with simple tips (adapted from Facebook and WhatsApp's 14-country media literacy campaign) on distinguishing 'fake news' from mainstream news stories, and reported improved discernment between mainstream and false news headlines among both a nationally representative sample in the US (by 26.5 per cent) and a highly educated online sample in India (by 17.5 per cent).

Overall, there is significant scope for improving the evidence base on targeted digital skills trainings for specific professionals and population groups, especially in contexts of on-the-job upskilling or adult learning – where the literature is particularly wanting, and the need for digital literacy is prevalent.

4. The way forward: Takeaways for policy research and implementation

Based on the discussion and findings above, this section presents recommendations to address some of the gaps observed in what we know about (Sections 1 and 2) and how we achieve (Section 3) digital skills development.

Takeaways for meaningful policy research

1) Empirical evidence on digital skills development needs to be expanded and strengthened at large:

Scarce empirical evidence on effective ways to implement and invest in digital skills development threatens to constrain collective efforts in harnessing an equitable digital transformation. As the policy note observes, the primary concern with digital skills development is the absence of impact evaluations or other empirical studies associated with interventions that seek to foster digital literacy and skills. With a few exceptions, several studies (noted in Section 3) are a subset of the wider edtech literature which observe the effects of provision of technological access on learning outcomes (skills or literacy in ICT, computers, etc.)

Interventions that focus on digital upskilling such as coding bootcamps and hackathons are on the rise and so deserve fuller attention from the research community. Further, various larger questions about digital skilling remain unanswered – for instance, what are the optimal pathways to support different proficiencies in digital skills? How is digital skills acquisition related to formal education? What are the reasons for some differing returns to digital skills acquisition in different across countries (educational curriculum, quantity and quality of ICT infrastructure, teacher quality)? (Sharp, 2022) How long do the benefits from a digital skills intervention last? That is, what are the short-term vs the long-term impacts on skill levels, and different labour market outcomes?

2) To design effective, targeted interventions, specific evidence is needed on how digital skills acquisition intersects with other demographic parameters:

The association between digital skills and socio-economic (income, age, gender, ethnicity etc.), spatial (rural, urban) and other factors (occupation) remains acutely understudied. While a few studies mentioned in Section 3 present disaggregated effects of digital skilling interventions on men and women, much more needs to be done to understand the different strategies that work for different population groups. Moreover, self-reporting surveys that are often used to measure digital skills also suffer from bias, since women's self-perception of skills differs from men, regardless of ability (Hargittai and Shafer, 2006). More research is also needed on what strategies and interventions work best for different occupational groups (journalists, policymakers, primary school teachers) at different proficiency levels. Bashir and Miyamoto (2020) recommend using formal educational channels as well as informal and nonformal programmes for "non-ICT professions and citizens", whereas advanced and specialised skills for "ICT professionals" are best developed via TVET and higher education institutions. Given the contextual nature of digital skills acquisition and application, as well as how broad the above categories are, research efforts studying digital skills development could be directed towards specifying what works, for whom, and at what level of expertise.

3) Measurement efforts should reflect the dynamic nature of digital skills:

Most current measurement efforts – whether in surveys, correlational analysis or causal studies – have important methodological and operational limitations, which has implications for those it is deployed on. Many of the task-based measures in studies quoted in the Appendix are also outdated (for instance PC-centric skill measures are no longer relevant for smartphones or tablets), and educational attainment proxies used are not the same as digital upskilling. Bashir and Miyamoto (2020) note that both demand for and supply of digital skills are challenging to assess, particularly using current, largely non-scalable methods such as consultations, focus groups and surveys. Sharp (2022) recommends that future approaches to measuring digital skills should mirror direct standardised skills seen in numeracy and literacy tests, where "subjects' command of internet skills are observed during particular assignments, usually in a controlled environment." Measurement approaches also need to pilot frontier and creative approaches, deploying big data and emerging computational techniques. Online job-search portals and social media data from platforms like LinkedIn are an exciting data source being tapped into to understand demand and supply for new types of occupations, skills and competencies (Verkroost et al. 2020, OECD 2016, OECD 2021b, Sharp 2022). While these methods also have their own shortcomings (such as coverage of the formal economy, which excludes large portions of developing and emerging market economies which are informal), they are closer to reflecting the dynamic nature of digital occupations and skills in the contemporary labour market, and so are worth exploring further.

Takeaways for effective delivery and implementation

1) **Digital skills interventions should go beyond a narrow set of computing capabilities:**

Engendering digital skills has tremendous practical value in today's digital society, to equip people to navigate a wide spectrum of its prevalent features such as misinformation and disinformation in social media and news sites (deep fakes, fake news, fact-checking), datafication of internet services and apps (and consequent vulnerability to cybersecurity issues, personal data breaches, and so on), interaction with artificial intelligence (AI) systems, and emerging work contexts such as remote or hybrid work. However, most of the interventions (see Table 1 in the Appendix) tend to be concentrated at improving 'computer skills'. As noted in Section 2, digital skills encapsulate a broad range of capabilities that go beyond technical skills and knowledge about hardware and software. They include various operational skills requiring critical thinking and creative problem-solving. Also, digital skills today are largely manifested by the use of handheld devices such has smartphones or tablets and require agility in transferring knowledge between different online environments. Guess et al (2020) provide an example of an intervention that goes beyond computing and coding skills, looking specifically at media digital literacy (see Section 3).

2) **Digital skills development is part of lifelong learning, including upskilling as adults:**

Digital skills interventions have often received significant attention in the context of upskilling children and youth (as noted by the sample in most studies of Table 1 in the Appendix). However, the pace of diversification in the digital economy and ever-changing jobs skills profile requires focusing proportionate efforts to promote digital skilling as a lifelong learning endeavour. According to OECD (2016), more than half of the adult population "have no ICT skills or have only the skills necessary to fulfil the simplest set of tasks in a technology-rich environment." The figure is likely to be starker for non-OECD countries. The OECD (2021b) emphasises the importance of lifelong learning, particularly in the context of the COVID-19 pandemic, where fewer adults were upskilled as work-related training shifted online. Much more needs to be done to bolster learning among adults – not just as a matter for adapting as part of the workforce, but also to participate digitally in the broader society.

3) **Digital skills development targeted at specific populations typically require holistic interventions designed collaboratively with a range of experts:**

Effective digital skills development is not just a matter of putting together generic programming curricula and conducting one-size-fits-all bootcamps. From the limited evidence on what works, apart from the increased provision of ICT infrastructure (internet or device access), well-targeted interventions are likely to be effective. These interventions are often designed collaboratively with experts familiar with the learning needs or styles of the specific target population. For instance, an important feature of the computer coding bootcamps in Colombia and Argentina noted in Aramburu, Goicoechea, and Mushfiq (2021) was the clear target audience (high potential, high motivation women) with a specific purpose (tech sector employment). Further, the training materials were carefully curated and developed in conjunction with an interdisciplinary set of experts – ICT specialists and gender specialists for a holistic and gender-inclusive experience. A similar feature was noted in Jouparinejad et al (2020) where the Nursing Informatics workshops were conducted with specific learning materials developed with the support of interdisciplinary experts, which had substantive effects on learning.

UNESCO has recently launched a unique intervention that reflects (to some degree) the above three takeaways for digital skills implementation – see Box 2 below for details.

A final observation on digital skills development relates to the enabling environment and broader efforts in policy planning to ensure the sustainability of investment and interventions in digital skills development. Typically, the policy impetus for digital upskilling at the national level can come from several places: national socio-economic development plans, ministry of education's strategy, ICT ministry plans, newly emergent digital planning strategies or combinations of these. While there is no one-size-fits-all governance model to advance digital skills development – co-ordinating, aligning and standardizing initiatives on digital skills development are increasingly recognised as a cross-cutting and whole-of-government imperative. More importantly, there is a need to move beyond ad-hoc programming (such as those primarily catalysed by international actors) towards mainstreaming and scaling-up of digital skilling endeavours that are owned and supported by concerted and inclusive networks in the civil society, private sector, and national, state and local governments within countries.

Box 2: Training on artificial intelligence (AI) and the Rule of Law for judicial operators by UNESCO and partners

As of April 2022, more than 4,400 participants from over 140 countries registered for an 'Artificial Intelligence and the Rule of Law' course exploring AI's impact on justice. The course was recently launched by UNESCO and The Future Society with the support of the National Judicial College, CETIC.br/NIC.br, and IEEE SA. The Massive Open Online Course (MOOC) aims to strengthen the capacities of judicial operators worldwide on AI and the Rule of Law. The course is available in seven languages, and was accompanied by interactive sessions around the digitalisation of justice systems (UNESCO 2022a) and data protection, AI-based judicial decision-making and the role of human oversight (UNESCO 2022b). There was also a pilot phase with an active online forum for peer exchange among judicial operators worldwide.

An internal evaluation document that assesses the design, development and implementation of the MOOC provides the following insights (among others), after the six-weeks pilot:

1) More than 3,600 course registrants were from outside Europe and North America, and 50% of total registrants were female.
2) More than 600 registrants completed 80–100% of the course, while more than 21% of registrants completed over 50%.
3) In the course feedback survey completed by 725 individuals, most participants strongly agreed that, after taking the course, they have a better understanding of AI, its implications in justice systems, and its impact on human rights. The average scores on all learning parameters of the course (on a scale of 1 to 7) were over 6.

The evaluation associated with the intervention does not isolate causal effects of the training which could have been extremely valuable to understand its impact accurately, but it reflects some of the key takeaways noted in Section 4. The course has been curated for a specific group of professionals and takes into account the contextual nature of digital upskilling. It caters to a broader set of capacities (beyond just technical or computing skills), imparting key lessons on critical thinking in the contexts of digital systems relevant for rule of law. The course has been designed, developed and conducted in a consultative and deliberative manner, with a range of stakeholders (21 diverse experts including AI practitioners, judges, and academics) engaged in various stages of its production. The MOOC also caters to an adult population that is already employed and seeks to retrain for digital challenges relevant to their profession.

The intervention is expected to have medium to longer term outcomes as the use of AI in justice systems matures and courts start receiving more cases related to the legal implications of AI. UNESCO will launch a follow-up survey after 6 months from the end of the course to better understand these outcomes.

Source: Artificial Intelligence and the Rule of Law, Massive Open Online Course, Final Evaluation Report – May 2022 (obtained on request)

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Appendix

Table 1: Selected evidence on effective digital skills development

Study	Intervention	Study type/time period/sample/country	Relevant digital skills measured	Main findings
Access and exposure to technology				
Malamud and Pop-Eleches (2011)	Programme that provided a computer voucher to low-income students enrolled in Romanian public schools	Quasi-experimental/2009/ 3300+ families, 4,600 child interviews mean age 12 years/Romania	Basic to intermediate digital literacy measured by computer ownership and use, time-use patterns, as well as an administered computer test (with relatively more technical/theoretical set of 12 questions) and self-reported computer fluency capturing a variety of computer, email and web-related practical tasks	Children in households who received a voucher were substantially more likely to own and use a computer than their counterparts who did not receive it. They also receive significantly higher (by 0.25 SD) scores in a test of computer skills and fluency.
Fairlie (2012)	Provision of free computers for home use to low-income community college students	Randomised experiment/280+ college students/USA	Self-reported computer skills on a 5-point scale. This was correlated with with several types of computer use, such as for work, searching for job opportunities, searching for health information, and searching for political information.	The treatment group has significantly higher levels of computer skills than the control group not receiving free computers. ITT estimates indicate an increase in high-level computer skills of 17% points, and LATE estimates

				indicate a range of 19–23% points. The benefits appear to be the strongest among young, minority, low-income, and female students.
Mo et al. (2013)	One laptop per child with one training session on using relevant software transmitted via audio-enhanced PowerPoint tutorials with extensive graphic illustrations and user manual. Less emphasis on internet connectivity.	Randomised experiment/2010–11/ 300 grade three students in 25 classes of 13 Beijing migrant schools/China	Basic computer skills measured using a customised survey. The questions ranged from: • Do you know how to turn on/switch off the computer? • Do you know how to use the keyboard? • Do you know how to use the mouse? • Do you know how to type Chinese? • Do you know how to cut/copy/paste/delete? • Do you know how to paint? • Do you know how to open/close files? • Do you know basic knowledge about hardware and software?	Improved student computer skills by 0.33 standard deviations and math scores by 0.17 standard deviations. Improved student self-esteem.
Bet, Cristia and Ibarrará n (2014)	Increased shared access to computers among school children (one more computer per 40 students)	Quasi-experimental/2008/ 202 secondary schools, including a survey of 4800+ third-graders/Peru	Technology competence test including basic skills and file management, word processing, operating spreadsheets, and information and communication using the internet.	Large improvements in digital skills (0.3 standard deviations), no effects on math and language skills.
Malamu d et al (2019)	Increased home internet and laptop access. The laptops included 32 applications	Randomised experiment/2011–13/laptops were given to a random sample of 540	Basic computer and internet literacy measured by an administered test and self-reported scores	Providing free internet access led to improved computer and internet proficiency relative to those without laptops and improved internet proficiency

	selected by the Ministry of Education of Peru for its national programme, and students with laptops and internet access were offered training and manuals on how to use them.	children enrolled in grades 3 to 5 in low-achieving public primary school, out of which 350 randomly selected children were given free high-speed internet access/Peru		compared to those with laptops only. No significant impacts observed on academic achievement and several cognitive skills.
Amer (2020)	Use of interactive boards	Quasi experimental/2019–20/40 secondary school male students /Egypt	Basic to intermediate digital skills based on secondary school computer curriculum, including components on operating system and internet, creating and processing audio and video files, etc. Measured by a test administered pre and post.	Interactive boards positively and significantly affect the achievement of students' learning in a computer course. Caveat is the very small sample size of the study.

[Okyere (2020)]()	poa! Internet interventio n: Installation of Wi-Fi routers, servicing of routers when faulty, provision of free advice on computer services (e.g. anti-virus software installation), unlimited internet bundle in schools	Quasi-experimental/2018/ 400 primary and secondary school students from 20 schools – 144 students, 7 schools under treatment / Kenya	Basic computer and internet skills (such as navigation skills, and exposure to online teaching and learning content), measured by surveying internet use and training, general ICT-related skills and knowledge, student participation in ICT education programme	Increased internet use among students in the intervention schools by 29 percentage points. Further, treatment students are 14.3 percentage points more likely than their counterparts in non-intervention schools to report increased used of online educational content. Also, the study finds that treated students are 25.2 percentage points more likely to report participating in an ICT education programme. Uptake and use of poa! Internet improves satisfaction among students on the current use of ICT in schools.
Curated training and tutoring				
[Arambur u, Goicoec hea, and Mushfiq. 2021]()	Provision of free advice on computer services (for instance, helping schools to deal with the installation of anti-virus software on school computers).	Randomised experiment/ 2020/400+ educated women in control and treatment group each, mean age 29 years/ Colombia and Argentina	Digital skills for an entry-level coding job. Courses had a computational training component and an optional soft-skill and career development module. The mandatory computational training component consisted of basic programming skills based on labour market demands, like JavaScript, Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and other platforms. Students were also required to	The programme has a strong positive impact on skills, measured by an exam that resembles a coding test that an employer would use during an interview to an applicant for an entry-level coding job. Authors also find positive and significant effects of the programme on the probability of getting a job in tech.

			complete various practical projects in a workshop setting.	
Bakare and Orji (2019)	Reciprocal peer tutoring	Quasi experimental/2015–16/107 undergraduate students/Nigeria	Electronic and computer fundamentals, measured by scores on specific instruments, i.e. the Electronic and Computer Fundamentals Achievement Test (ECFAT) and Electronic and Computer Fundamentals Interest Inventory (ECFII).	Treatment group's achievement on electronic and computer tests ($M = 23.17$, $SD = 2.68$, $n = 56$) was significantly higher than the control group ($M = 10.16$, $SD = 1.61$, $n = 51$). This result indicates that reciprocal peer tutoring (RPT) is more effective than direct instruction with respect to improving students' achievement in electronic and computer fundamentals.
Jouparinejad et al (2020)	A three-day workshop in an equipped informatics centre with targeted materials on Nursing Informatics (NI) developed with the support of interdisciplinary experts.	Quasi-experimental/2019/60 nurses with a bachelor's degree, at least 6 months of work experience in the critical care units /Iran	Context-specific digital skills ranging from beginner to proficiency levels in computer literacy, informatics literacy and information management skills applicable to nursing care, measured using the Nursing Informatics Competency Assessment Tool (NICAT).	In the post-test phase, a statistically significant difference was observed between the intervention (114.29 ± 20.68) and control (81.76 ± 17.99) groups in total score of the NI competency with $t = 6.54$, $p = 0.001$, Cohen $d = 1.57$ (with a very large effect size). All scores within the NI competency dimensions in the intervention group improved significantly in the post-test compared with the control group [computer literacy scores: $t = 6.05$, $p = 0.001$,

				Cohen d = 1.72 (a very large effect size), informatics literacy scores: t = 6.44, p = 0.001, Cohen d = 1.51 (a very large effect size), informatics management skills score: t = 4.55, p = 0.001, Cohen d = 1.13 (a very large effect size)].
Guess et al (2020)	Each respondent was randomly assigned to either the placebo or treatment condition for the media literacy intervention. Those assigned to the treatment condition were shown (online) or read (face-to-face) six tips for spotting false news adapted from the ads Facebook and WhatsApp published in Hindi-language newspapers in India.	Two-wave panel surveys/ US: wave 1 in 2018, N=4,900+ wave 2 in 2018–09, N=4200 (both online) India (online survey): national convenience sample of Hindi-speaking Indians. wave 1 in 2019, 3200+; wave 2 in 2019, N=1300+ India (face-to-face survey): representative random sample drawn from the	Digital media literacy measured by scores on a rating task (on a 4-point scale) where participants had to guess accuracy of a news headline. The main outcome of interest in all three surveys was the perceived accuracy of mainstream and false news headlines.	Overall, the intervention improved discernment between mainstream and false news headlines among a nationally representative sample in the US (by 26.5%) and a highly educated online sample in India (by 17.5%).

The second intervention (only in the India) invited respondents to receive updates about a topic via WhatsApp or other electronic means; respondents were randomly assigned to receive either an invitation to receive political fact-checks or placebo content about health and fitness.	public voter registration list wave 1 in 2019, N= 3700+, wave 2 in 2019, N=2690+