Digital Skills: Frameworks and Programs

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Preface

This paper was prepared as a background paper for the World Bank's Digital Economy for Africa (DE4A) initiative, in which digital skills is one of the five foundational pillars, and which was launched in January 2019. Presenting a digital skills framework was considered the first step in preparing the digital skills pillar of the: (a) ***DE4A Country Diagnostic Tool,*** to be used by the World Bank's country teams to present strategies to foster and leverage digital skills for the emerging digital economy, and (b) ***DE4A Scorecard***, which is being used by the World Bank to monitor progress towards achieving the DE4A targets for the African continent to be achieved before 2030. These targets are aligned with the strategic orientations of the World Bank Group as well as the global development agenda (i.e., SDG 4).

Earlier working drafts of this paper have informed ongoing work of the World Bank on digital skills and have been revised as this work evolved. An early draft formed part of the technical background work for the 5th Forum of the Partnership for skills in Applied Sciences, Engineering and Technology (PASET), which is facilitated by the World Bank. The Forum ("Destination Digital Africa: Preparing our Youth for the Future) was held in May 2019 in Kigali and attended by 21 African countries and many partner countries. Subsequent revisions of the draft (July 2019 and November 2019) were used as World Bank's inputs for the ***African Union's Digital Transformation Strategy for Africa.*** The paper and the proposed digital skills frameworks were also used to revise the Digital Skills pillar of the DE4A Country Diagnostic Tool, to prepare the DE4A Scorecard and for the Digital Skills Country Action Plan Technical Assistance provided to PASET countries. The Digital Skills pillar of the DE4A Country Diagnostic Tool and Scorecard, which incorporate the digital skills framework outlined in the paper, were reviewed and endorsed by the Education Global Practice in early 2020, and subsequently, all the 5 pillars of DE4A Country Diagnostic Tool and Scorecard were formally reviewed and endorsed by the World Bank's Africa region in May 2020. The present version incorporates revisions made in concepts and descriptions of programs, measurements and indicators, in line with the above work, and further elaborates the advanced and highly specialized digital skills using the EU's e-Competence Framework for ICT Professions.

Summary

This paper presents a framework for digital skills, based on a review of international frameworks. It discusses the demand and supply of digital skills as well as a mapping with formal education programs at different levels of the system that could produce these skills. It also gives examples of programs outside of formal education programs that could be used for imparting skills training. Finally, it suggests indicators (Annex 1) that could be used to better measure progress towards the objectives of the DE4A initiative. The paper does not cover the question of connecting schools and universities to broadband, the types of technologies that could be used in education or the issues that need to be addressed in implementing the use of technology – these are covered in other background papers.

The paper highlights the following issues:

(i) Digital skills for citizens and non- ICT professions: One of the most comprehensive frameworks of digital skills for citizens is the European Union (EU)'s DigComp 2.1 Digital Skills Competence Framework and/or its adaptation by UNESCO UIS in the Digital Literacy Global Framework (DLGF). The DigComp framework has 5 competence areas, while the DLGF framework has seven competence areas to better address developing country contexts. Both have four proficiency levels – basic, intermediate, advanced and highly specialized, which can be further broken down into 8 levels depending on the level of task complexity. The framework is especially useful for defining basic and intermediate skills that need to be broadly acquired by the youth population. Adaptation of this framework to the local contexts of countries is required, in order to develop relevant education courses, training programs, and assessment frameworks. Countries will need assistance to do this.

(ii) Digital skills for the ICT professions require a separate framework that describes the highly technical content and composition of skills applied in the ICT workplace. The EU's e-Competence Framework 3.0 provides a useful reference which includes 5 competence areas and 5 proficiency levels associated with 40 competencies required and applied in the ICT professions.

(iii) While the demand for digital skills is difficult to assess, especially in the informal sector, the requirement for basic digital skills is likely to become ubiquitous. This is also the case for intermediate level skills in most formal sector jobs. New approaches to assessing labor market demand, including data from online job search platforms and Artificial Intelligence (AI) based analysis, can help to identify the skills that are in demand at levels above the basic level.

(iv) While the supply of digital skills is equally challenging to assess, self-reported measures suggest a large proportion of those living in some of the African countries do not even possess the most basic digital skills, which reflects their lack of familiarity with using a broad set of digital devices and services.

(v) For non-ICT professions and citizens more broadly, digital skills can be developed though formal learning in educational institutions, as well as informal and nonformal learning programs:

a. *Basic digital skills* should be provided to all high school students. While the content of many of these courses is readily available, there is important work to be done to adapt these to local contexts and to use local content. Further, implementation challenges of delivering at scale have to be addressed. In North Africa, where primary schools are better equipped, basic digital skills can be provided at this level as well.

b. *Basic and, in some cases, intermediate digital skills* should also be provided outside of school settings, especially as the majority of young people in regions such as Africa are out of school. These skills would need to be provided together with foundational literacy and numeracy programs. While a variety of learning contents associated with basic and intermediate digital skills are already available, public-private partnerships would need to be explored for efficient delivery to this population.
c. *Intermediate digital skills* should be provided to students in upper secondary schools and to all students in technical-vocational and undergraduate non-ICT programs, as these students will enter occupations that require increasing use of technology. At the technical-vocational and undergraduate level, students in non-ICT courses that are more technology intensive can also to be taught *advanced digital literacy skills*.
d. In order to develop intermediate, advanced and specialized skills for the ICT professions, TVET and higher education institutions need to develop and reform courses that are benchmarked to international frameworks. At the TVET level, these include hardware and software related courses for IT technicians, while at the university level, they include the core engineering programs such as electrical and computer engineering/science programs. At present, both TVET and university courses in these disciplines are too theoretical and outdated. Considerable and sustained efforts to reform these programs are essential for African countries to assimilate and diffuse digital technologies. Bootcamps and rapid skilling/coding courses can also help to produce advanced digital skills, especially when there are spikes in demand for particular skills/programming languages. These can be delivered through universities in partnership with companies, or by the latter on their own. Highly specialized digital skills will be imparted through postgraduate programs in applied mathematics, computer engineering courses of high quality to train faculty and to introduce new courses. These may have to be done at the regional level due to the shortages of highly skilled instructors who could handle such technical courses.

1. The Importance of Digital Skills in Driving Digital Transformation

Digital skills constitute one of the five foundational pillars of the Digital Economy for Africa initiative, launched by the World Bank, and are needed to mobilize digital innovations to transform economies, societies and governments in Africa. The other foundational pillars are digital infrastructure, digital platforms, digital financial services and digital entrepreneurship. African economies require both a *digitally competent workforce* as well as *digitally literate citizens* who could reap the benefits that the digital society brings.

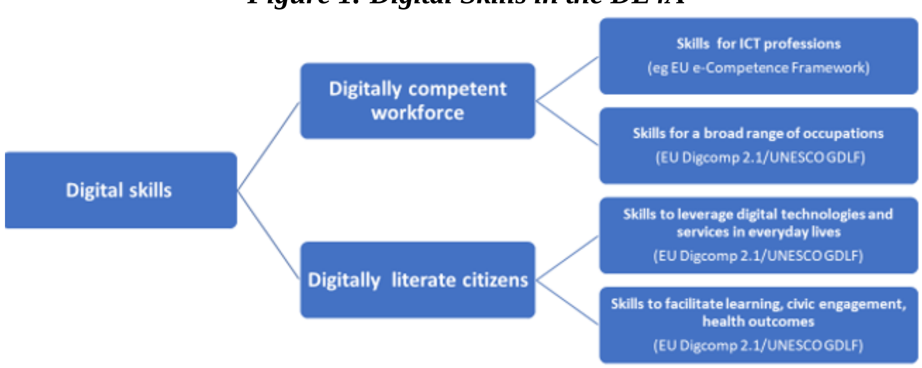
A digitally competent workforce can help strengthen the foundational pillars: the installation of the *digital infrastructure* (for example, connectivity and data repositories) that is most relevant for Africa, the growth of *digital entrepreneurship* (for example, incubators and e-commerce, that shapes digital industries, and the development and use of *digital platforms* and *digital financial services* (for example, e-signatures and digital payments). Moreover, a digitally competent workforce, comprising a large majority with basic digital skills and a critical mass of skilled personnel and advanced specialists, can help to extend the application of digital tools and processes in a wide variety of sectors, such as the informal service sector, agriculture, energy, transportation, health and education, to name a few.

Digitally literate citizens can better reap the benefits of the digital economy by gaining access to more, better and safer information ranging from e-government services, commercial products and news, as well engage with the wider community. In contrast, citizens who lack the capacity to digest complex and competing source of digital information and make appropriate judgements may fall into the traps of the digital economy, including financial fraud and (especially for young people and children) physical and other forms of abuse and exploitation.

The extent to which the spread of the digital economy is inclusive and broad-based will depend on the inclusiveness of the five foundations. Equity in digital skills across the population is likely to play a particularly important role in sharing the prosperity promised by the digital economy. A concerted effort is required to equip the young population with digital skills.

Digital skills is one of the five foundational pillars in the World Bank's Digital Economy for Africa (DE4A) initiative, which includes Country Diagnostics on the state of the digital economy, a Scorecard to set targets and monitor progress, and World Bank investments and technical support (See Box 1). As the term "digital skills" came to be used loosely across different pillars and strands of work, this paper starts with the framework that can help to define these skills and the programs/courses that could help to achieve them.
Broadly speaking, the digital skills for citizens and the general workforce and digital skills for the ICT professions involve different domains and competences and require different frameworks which specify the relevant competences and proficiency levels. These are summarized in *Figure 1* and further detailed in the next section.

Figure 1: Digital Skills in the DE4A



Box 1: The Digital Economy for Africa (DE4A) Initiative

Prepared to support the implementation of the AU Digital transformation Strategy for Africa, the World Bank's Digital Economy for Africa (DE4A) Initiative sets out a bold vision to ensure that every African individual, business, and government is digitally enabled by 2030. The goal is to drive the digital transformation of Africa and ensure its full participation in the global digital economy.

The DE4A takes the approach of strengthening the enabling foundations that help advance a digital economy that promotes social inclusion and poverty reduction. In case a country has good enabling foundations, it is on the path of developing a robust digital economy. The reverse may also be true. Based on the examination of the experiences of successful companies and public sector institutions that form digital economies, those foundations are taken to be: the availability of internet or broadband which brings people online, the ability to identify and authenticate people digitally, and the ability to pay or transact digitally. Digital economies further energize when there is sizeable population of tech-savvy workforce, and an ecosystem that supports firms to enter or scale up in ways that brings about digital transformation across sectors. Once those foundations are in place, a wide array of use-cases can emerge, mostly driven by the private sector, in a digitalizing economy, bringing new products, services, and delivery channels.

Measurable goals for 2021 and 2030 have been proposed with a DE4A Scorecard covering High-Level Indicators and Targets as well as pillar specific High-Level Indicators (**Annex 1**).

The DE4A Initiative is also fully embedded in the IDA 19 Commitments. Key commitments include support to ensure: i) To help close the digital infrastructure gap, IDA will support 25 IDA countries to double their broadband penetration (16 on the African continent), including eight in landlocked countries, by 2023; ii) 50 percent of entrepreneurship and Micro, Small and Medium Enterprises (MSME) projects will incorporate digital financial services and/or digital entrepreneurship elements – and ensure they address particular constraints facing women and people with disabilities ; iii) At least 60 percent of IDA19 financing operations for digital skills development will support women's access to higher productivity jobs, including online work; iv) All IDA19 financing operations for Digital Development will support women's increased access to and usage of digital services; v) Support at least 12 IDA countries to adopt universally accessible GovTech solutions; and vi) Support building client capacity in 50 percent of IDA FCS countries to use field appropriate digital tools for collection and analysis of geo-tagged data; and apply this technology to enhance project implementation and coordination.

The DE4A initiative has prepared a Country Diagnostics Tool to guide the World Bank's multisector task team in carrying out an assessment of the five pillars of the digital economy, as well as cross-cutting areas. This tool is currently in the process of being deployed in a large number of African countries.

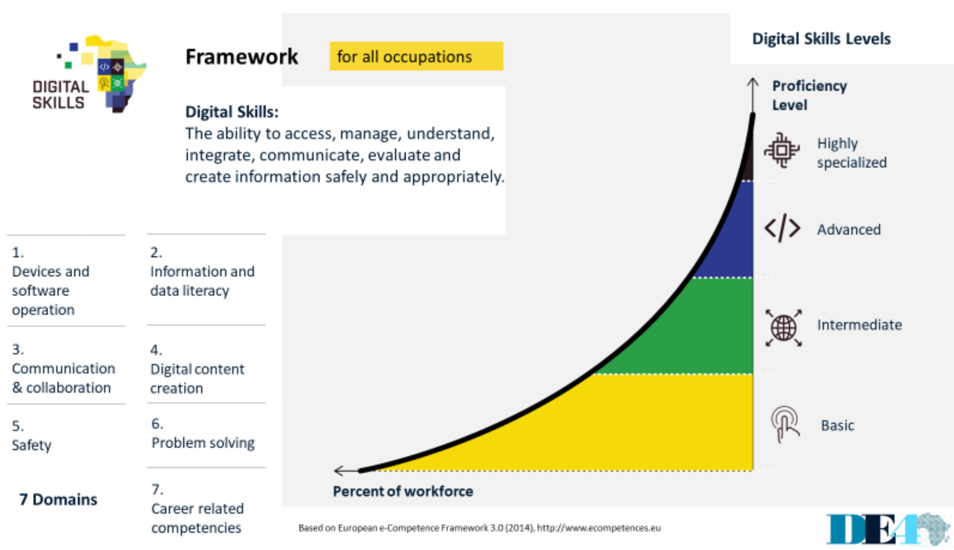
Source: Adapted from World Bank (2020), *Digital Economy for Africa Country Diagnostic Tool and Guidelines for Task Teams,* Version 2.0.
https://www.worldbank.org/en/topic/digitaldevelopment/brief/digital-economy-country-diagnostics-for-africa

2. Frameworks for Digital Skills

Africa still lacks a comprehensive framework for digital skills, although some countries have developed broad frameworks. Many OECD countries and some Asian and Latin American nations have developed frameworks to guide measurement of digital skills in the population and support the development of education and training materials[2]. A thorough review of existing Digital Skills Frameworks was undertaken as part of the background work for this paper. The list of the frameworks is given in *Appendix Table A.*

The most comprehensive and widely used framework for general digital skills is the European Union's DigComp 2.0 and its more recent update DigComp 2.1[3,] which identifies five areas with 21 competences. The five areas are: (i) information and data literacy; (ii) communication and collaboration; (iii) digital content creation; (iv) safety; and (v) problem solving (Carretero *et al.* 2017). For each competence, there are eight proficiency levels (in DigComp 2.1) grouped into four broad headings—Foundational, Intermediate, Advanced and Highly Specialized. UNESCO's Institute of Statistics (2018) has built on this framework to adapt it to developing country contexts, as part of its goal to develop a methodology that can serve as the foundation for the Sustainable Development Goal for digital literacy.[4] As part of this adaptation, UIS has proposed adding two more competences to the EU DigComp 2.0 framework, to include competences related to devices and software operations, and career-related competences. A detailed explanation on the competency areas and proficiency levels is given in *Table 1*.[5] *Figure 2* indicates that while the proportion of the workforce that has the basic level of proficiency in multiple competences should ideally be large, this proportion will decline for those with higher levels of proficiencies.

Figure 2: Digital Skills Framework for General Workforce and Population- 7 Competencies and 4 Proficiency Levels



[2] Existing frameworks can be grouped into two broad categories: (a) *Digital competence frameworks*, which identify key components of digital competence, at different levels of proficiency and (b) *User skills level frameworks*, which indicate digital skills needed by different types of digital users.
[3] DigComp 2.1 contains no conceptual updates to DigComp 2.0 competence areas and competences but it includes updates to proficiency levels and examples of use.
[44] Sustainable Development Goal Thematic Indicator 4.4.2: "Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills".
[5] *Appendix Table B* provides more details.

The proficiency levels reflect "the cognitive challenge, … the complexity of the tasks as well as … autonomy in completing the tasks" (Carretero et al. 2017). At the lowest levels (1-2), a person is able to carry out a simple task with help; at levels 5-6, the person is able to apply knowledge, solve problems and helps others; while at levels 7-8, the person is a professional who is contributing to technical-scientific knowledge in that domain. Box 2 provides examples of competencies and proficiency levels for different uses.

***Table 1.* Summary of Digital Competences, based on EU DigComp 2.1 and Digital Literacy Global Framework (DLGF)**

<table>
<tr><th>Competence Areas</th><th>Competences</th><th>Proficiency Levels</th></tr>
<tr><td rowspan="2">0. Devices and software operation [a]</td><td>Identify and use hardware and software tools and technologies.</td><td rowspan="14">Foundation (Levels 1 and 2)- Can deal with simple tasks that involve remembering content and instructions but also requires some guidance to execute.
●●●●●●●●●●
Intermediate (Levels 3 and 4) - Can independently deal with well-defined, routine and nonroutine problems that involve understanding content.
●●●●●●●●●●
Advanced (Levels 5 and 6) - Can deal with and provide guidance to others on different tasks and problems that involve applying and evaluating content in complex situations
●●●●●●●●●●
Highly specialized (Levels 7 and 8) - Can resolve complex problems with few or several moving pieces, guide others, contribute to professional practice and propose new ideas to the field.</td></tr>
<tr><td>2 competences involving physical and software operations of digital devices.</td></tr>
<tr><td rowspan="2">1. Information and data literacy</td><td>Search for, judge the relevance (including its source) and organize digital content.</td></tr>
<tr><td>3 competences involving browsing, evaluating, and managing digital content.</td></tr>
<tr><td rowspan="2">2. Communication and collaboration</td><td>Interact and engage in citizenship through digital technologies while adhering to netiquette and managing one’s digital identity.</td></tr>
<tr><td>6 competences involving communicating, collaborating, and engaging in citizenship through digital technologies as well as netiquette and digital identity management.</td></tr>
<tr><td rowspan="2">3. Digital content creation</td><td>Create new or modify existing digital content while correctly applying copyright and licenses as well as programming.</td></tr>
<tr><td>4 competences involving developing and integrating digital content as well as understanding copyrights, licenses, and programming.</td></tr>
<tr><td rowspan="2">4. Safety</td><td>Ensure security measures while safeguarding against risks threatening devices, privacy, health, and the environment.</td></tr>
<tr><td>4 competences involving protecting devices, personal data, privacy, and health as well as the environment.</td></tr>
<tr><td rowspan="2">5. Problem-solving</td><td>Solve problems in digital environments and use digital tools to innovate and keep abreast of the digital evolution.</td></tr>
<tr><td>5 competences involving resolving digital issues, creatively using digital technologies, bridging personal gaps in digital skills as well as computational thinking.</td></tr>
<tr><td rowspan="2">6. Career-related competences*</td><td>Use specific career-related digital technologies and content to have access to opportunities in the digital economy.</td></tr>
<tr><td>2 competences involving operating specialized digital technologies as well as working with digital content for specific career-related fields.</td></tr>
</table>

Source: Based on Carretero *et al.* 2017, and UIS 2018.

Note: a. Proposed by UIS as additions to the DigComp 2.0 framework, which was subsequently updated to DigComp 2.1.

Box 2 Examples of Competencies and Proficiency Levels Required by Different Users

Farmers: A mobile phone can help farmers to improve their earnings through their decisions regarding crops to grow, and markets to sell their produce. However, the degree to which this happens will depend partly on the technology (sophistication of the phone, connection to the Internet) and partly on the digital skills of the famer. The competence related to "*devices and software operations*" means that the farmers can input a SIM card into their phones, turn it on and charge it. Foundational "*information and data literacy*" skills would allow the farmer to receive text messages on their phone regarding weather forecasts, market prices of products, and effective farmer practices. With a high level of proficiency in the competence area of "communication and collaboration," a farmer could learn about connecting to an irrigation system and to program it by using online resources or tapping into an online community (UIS, 2018).

Students: At the foundational level of proficiency in "*creating digital content,"* a student can create a digital presentation to showcase their work using, for example, a simple video tutorial from YouTube to animate the presentation. In "*collaborating through digital technologies,"* a student at an advanced level should be able to co-create data and content for making a video, and be able to differentiate between appropriate and inappropriate digital resources (Carretero *et al.* 2017).

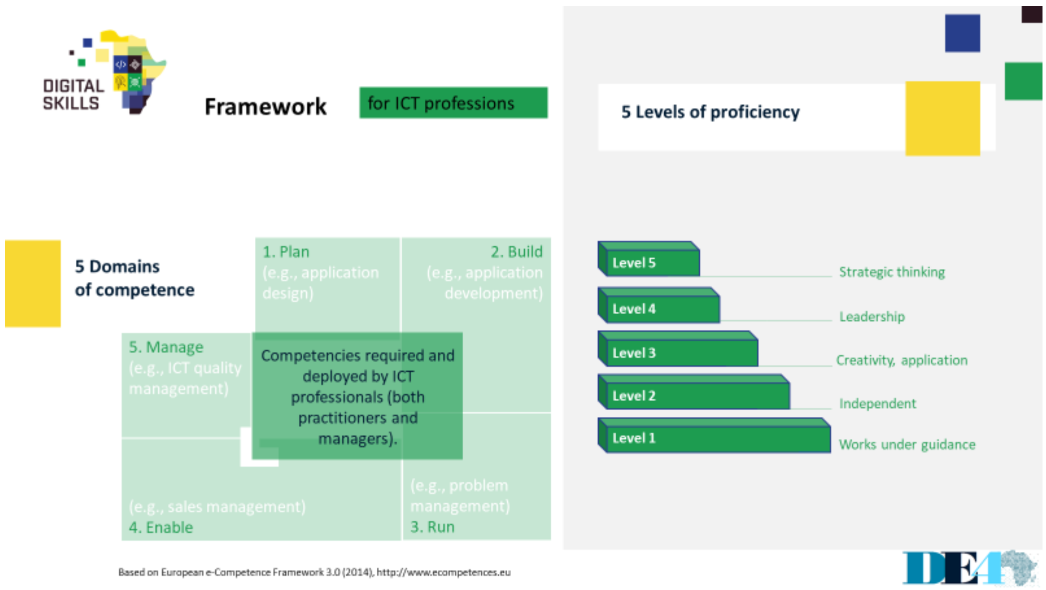
Employee: A person who is seeking to improve their career opportunities would be able to use the tools of a massive open online course (MOOC) to enhance their learning experience. This would require intermediate level proficiency in the competence area of problem solving ("*creatively using digital technology*") (Carretero *et al.* 2017).

Digital skills for the Information and Communication Technology (ICT) professions require a separate framework that describes the highly technical content and composition of skills applied in the ICT workplace. The EU's e-Competence Framework 3.0 provides a useful reference that covers 41 competencies required and applied in the ICT professions, using a common language for skill levels that can be understood across Europe (see *Figure 3*).[6] A similar framework exists in the US called the Skills Framework for the Information Age (SFIA). In East Asia, Japan's ICT Dictionary is most commonly used as a reference framework for digital skills for the ICT professions.

The e-Competence framework articulates competences required and deployed by ICT professionals (including both practitioners and managers). It was created for managers and human resource (HR) departments, for education institutions (universities, technical training institutions) and training bodies, policy makers and other organisations in public and private sectors. It can therefore be used (with necessary adaptations) to assess the quality of ICT and engineering programs at the university and TVET level, as well as those provided outside the formal education system.[7]

[6] http://ecompetences.eu/wp-content/uploads/2014/02/European-e-Competence-Framework-3.0_CEN_CWA_16234-1_2014.pdf
[7] The e-Competence levels can also be related to the levels of the broader European Qualifications Framework.

Figure 3: E-Competence framework for the ICT Professions



Source: Adapted from European e-Competence Framework (2014).

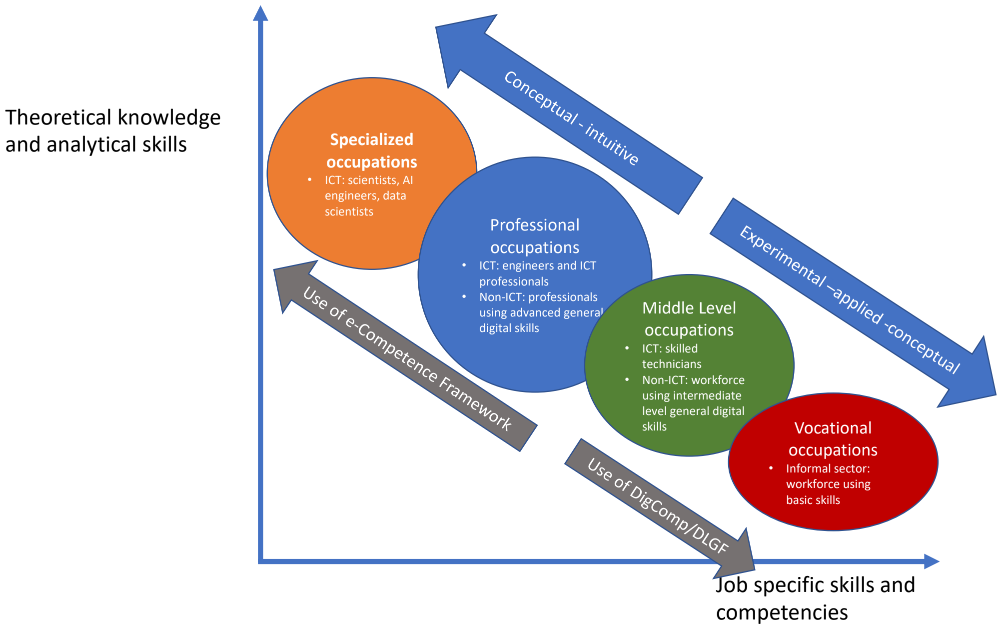
As digital technologies penetrate an increasing number of sectors and occupations, sections of the workforce that are in "non-ICT professions and occupations" will also require more specialized digital competences characteristic of ICT technicians and specialists. Hence, there is not a strict one-to-one mapping between the two frameworks and the two broad groups of professions. Nevertheless, this distinction is useful especially in the African context where the majority of workers are in non-ICT professions and occupations but will increasingly require basic or intermediate level digital skills as enumerated in the UNESCO DLGF/EU DigComp 2.1 framework. The digital skills proficiency levels in this framework provide an indication of the complexity of the tasks that can be undertaken by non-ICT specialists. For example, *foundation or basic level of proficiency* in digital skills represents abilities required to carry out simple tasks using simple digital technologies, such as the capacity to use basic digital devices or applications. Basic digital skills are typically used in vocational or informal sector occupations and occupations involving routine tasks – for instance, Uber drivers, grocery delivery personnel, etc. *Intermediate level proficiency* would typically be required in middle-level occupations such as the general workforce in formal small and medium enterprises (SMEs) that are using a range of digital technologies – small firms and shops engaging in e-commerce and using digital payments, journalists who can use digital tools for collecting, searching and analyzing information. *Advanced level proficiency*, which requires greater analytical skills as well as theoretical knowledge, is typically required in occupations with a high level of ICT intensity. *Figure 4* presents a rough mapping of broad categories of occupations according to two education-related dimensions – the theoretical and analytical dimension and job-specific competences [8]– and the use of the two frameworks presented in this section.

Digital competences, apart from the most rudimentary ones—such as using a mobile phone for voice calls or simple messages—cannot be developed without *foundational literacy and numeracy skills*. Certain competences, such as communication and collaboration, as well as higher levels of proficiency in all areas of competence, also require *socioemotional skills*. These include characteristics such as perseverance, empathy, trust, self-control and self-esteem, among others. However, even foundational skills are lacking in majority of the population, including among young people after several years of schooling, particularly

[8] Mikhail (2007)

in SSA. Hence, developing even basic digital skills will require ensuring a minimum level of literacy and numeracy.

Figure 4: **Types of Digital Skills and Occupations**



Note: Adapted from Mikhail 2007.

3. Demand for Digital Skills

The spread of digital technologies may change the demand for skills in two opposing ways. First, there could be an increase in demand for basic and intermediate digital skills which help workers deploy these technologies, as well as advanced digital and higher-order cognitive and socioemotional skills which allow workers to leverage digital workplaces to engage in nonroutine tasks. Second, there could be a decrease in demand for routine skills or manual labor due to automation.

There is little systematic data on how the demand for digital skills or skills more broadly is changing in Africa. However, analysis presented in a background paper for the World Development Report 2016 on Digital Dividends indicates that "employment in occupations intensive in ICT use at work in developing countries has increased by 10 percent between 2000 and 2012, almost two times the increase in developed countries" (Monroy-Taborda *et al*, 2015).

The emergence of new industries and services in the digital economy, as well as the spread of digital technologies in many traditional manufacturing and service sectors, is likely to stimulate demand for digitally intensive occupations. The ICT sector itself and ***emerging ICT intensive sectors*** such as e-commerce, Internet enabled offshoring and online work, bioengineering, and so on, will require a workforce with a range of digital competences from intermediate to advanced and highly specialized levels. Moreover, demand will also emerge from the ***traditional sectors*** which are increasingly using digital technologies, such as, agriculture, construction, transportation and logistics, manufacturing, banking and finance, health and government sectors), in which the different categories of occupations, ranging from scientific to the professional, middle-level and vocational occupations, will require new digital skills. Further, while the ICT and ICT-intensive sectors are not in themselves labor-intensive, they generate low-skilled and medium-skilled jobs in services such as retail, food preparation, and cleaning.[9]

Box 3: The demand for digital skills will be ubiquitous in the formal sector

The World Economic Forum (2018) global survey of companies provides a glimpse of the forthcoming transformations across industries, including Africa. The vast majority of companies in each of the 12 industries surveyed will adopt one or more of the 19 new technologies listed in the survey.[10] the highest level of adoption will be in user and entity big data analytics (85 percent of all companies), app and web-enabled markets (75 percent), internet of things (75 percent), machine learning and cloud computing (73 percent). Skills in these areas will be demanded by over 65 percent of all industries—with ICT, professional services, global health, and financial services demanding these skills the most.

The other technologies that would have the biggest level of adoption include: digital trade (e-commerce), augmented reality, encryption, new materials, wearable electronics, 3D printing, blockchain, and robotics. These technologies overall will be introduced in over 37 percent of all companies, with digital trade adopted in 59 percent.

The WEF survey also defined the new jobs and new roles of workers. Top jobs that are expected to be in high demand moving forward are: data analysts and data scientists, Artificial Intelligence (AI) and machine learning specialists, general and operations managers, big data specialists, digital transformation specialists, sales and digital marketing professionals, software applications developers and analysts, and innovation professionals. Based on these surveys, the redundant roles are likely to be data entry clerks, accounting, bookkeeping and payroll clerks, assembly and factory workers, client information workers. Analysis by LinkedIn in 2019, using its global database reveals a trend of rising demand for jobs such as data scientists, AI and machine learning specialists, listing them on top of global demand including demand in Africa. Further, even where earlier jobs continue, workers and professionals would need to have hybrid skills—not only the skills of their core profession, butalso digital skills.

[9] The World Development Report 2016 notes that "Kenya's mobile money service M-Pesa uses more than 80,000 agents … Hormuud Telecom—the largest operator in Somalia—employs 5,000 staff but supports 25,000 agents." (p 106).

[10] The 19 technologies are: 3D printing, Aerial and underwater robots, App- and web-enabled markets, Augmented and virtual reality, Autonomous transport, Biotechnology, Cloud computing, Digital trade, Distributed ledger (blockchain), Encryption, Humanoid robots, Internet of things, Machine learning, New materials, Non-humanoid land robots, Quantum computing, Stationary robots, User and entity big data analytics, Wearable electronics.

For instance, an accountant would not only need the usual accounting knowledge, but also skills in spreadsheets, databases, etc. A marketing director needs to also have skills in digital marketing, social media, and content marketing and using search engine optimization.

[a] *Note*: Only cities with 100,000 LinkedIn members were included in this estimation, which uses the skills and employment listed on the LinkedIn profiles of people.

However, the effective demand for digital skills from the informal sector, especially agriculture and services where the majority of people are employed in Africa, is likely to be constrained. This is because of high levels of income volatility, precariousness of employment, and high opportunity costs that reduce participation in training or skills upgrading. This may constrain the spread of digital technologies in these sectors. Yet, it is precisely in these labor-intensive sectors where relatively simple technologies such as mobile phones can help to improve productivity in, for example, agriculture through better information on weather and prices, as well regular technical advice on operations. Small service providers—food sellers, tailors, and so on—can expand markets through the use of social media. The informal manufacturing sector may also benefit from digital technologies such as 3D printing which allows for small scale and customizable tools.

Finally, ensuring that all citizens, especially young people, have basic digital skills is crucial for the extension of e-government services and for inclusion in the new economy.

The extent to which disruptive technological change is labor saving in Africa will depend on the number of routine tasks in jobs, that might make them susceptible to automation, relative wages and the lags in adoption of technology. In general, with lower wages and slower rate of technological adoption, the risk of automation drastically reducing jobs is lower, which gives time for governments to put in place policies for upskilling the population (World Bank 2016). However, each country needs to do this analysis to assess the demand for digital skills.

Artificial intelligence enabled approaches can provide real-time and predictive guidance on in-demand skills and identify skills gaps, especially for the formal sector or for employers and workers engaged in the digital economy. Traditional methods of assessing demand (employer surveys, industry consultations, focus groups) can take a long time, and results can become quickly outdated when the job market is rapidly changing. Further, the skills assessed are not granular enough to provide guidance to training providers to change their courses. An example of such a platform is JobKred, which has developed algorithms to predict the top job occupations, and top skills within these jobs which are demanded by the local area market. Careers and skills recommendations engine is built by these methods to yield actionable, relevant and accurate career and employment data.

However, in the informal sector, there are many knowledge and information failures that prevent the matching of demand and supply of skills. Many small firms, where the owners themselves have low levels of education, are often not aware of new technology and new skills needs. As in the case of other skills, matching the supply with the demand for digital skills is best done in the context of programs that offer technical, financial and marketing services to the informal sector.

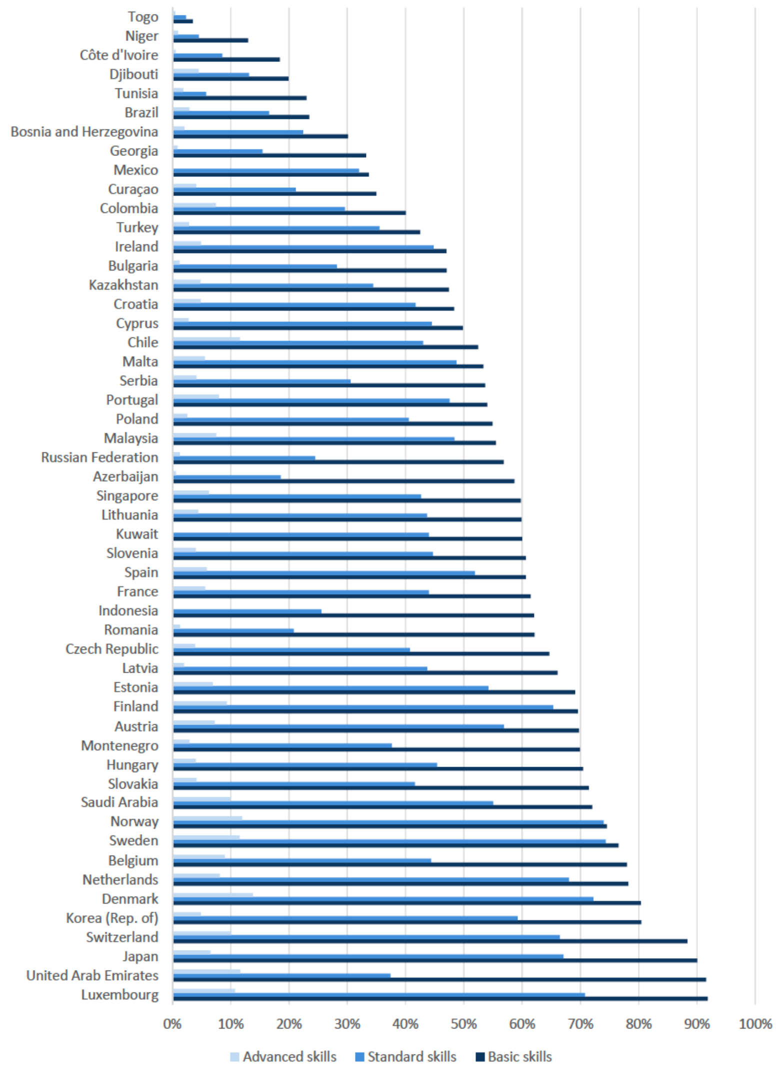
4. Supply of Digital Skills

While a large proportion of the population in Africa has some familiarity with using mobile phones, their capacity to handle a broader set of digital devices and services are likely to be very limited. Information about the current status of basic digital skills in the population is sparse. The rapid spread of mobile phones and mobile Internet services, in particular, means that a large proportion of the population has some familiarity with devices (mainly phones), some digital services (government services and payments), as well as social media. However, with the limited penetration of fixed broadband, computers and laptops, both in homes and educational institutions, it is highly unlikely that there is even basic familiarity with broader digital services. Access to digital devices does not necessarily translate into acquiring digital skills, except the most foundational. Although many countries have introduced ICT as a subject in school education, in practice, most schools are not able to teach even basic skills because of the lack of electricity, devices, and access to digital materials or the Internet. Only a few have introduced computer-assisted instruction.

Cross-national task-based measures of digital skills suggest that the share of the population with basic digital skills is very low in a number of countries in Africa. *Figure 5* presents the proportion of the population with basic, standard (which roughly corresponds to intermediate level in *Figure 2*) and advanced digital skills based on self-reported behavioral measures of digital skills. The figure suggests that there are considerably lower proportion of people in Africa (Togo, Niger, Cote d'Ivoire, Djibouti and Tunisia) with basic, standard and advanced digital skills compared to countries in Europe, Asia and South America. It also points to a large within region differences whereby selected Northern African countries have a higher proportion of the population with basic, standards and advanced digital skills.

Generally speaking, information about the levels of digital skills is very limited. This is partly due to the lack of reliable metrics of digital skills as well as limited availability of any data on digital skills in Africa based on a representative sample. Many of the existing measures of digital skills are based on self-reports or proxies based on possession of devices or tasks performed (see Annex 1). Many of the existing large-scale household or labor force surveys in Africa do not systematically collect information on digital skills.

Figure 5: Proportion of the population with basic, standard and advanced skill levels (2017)

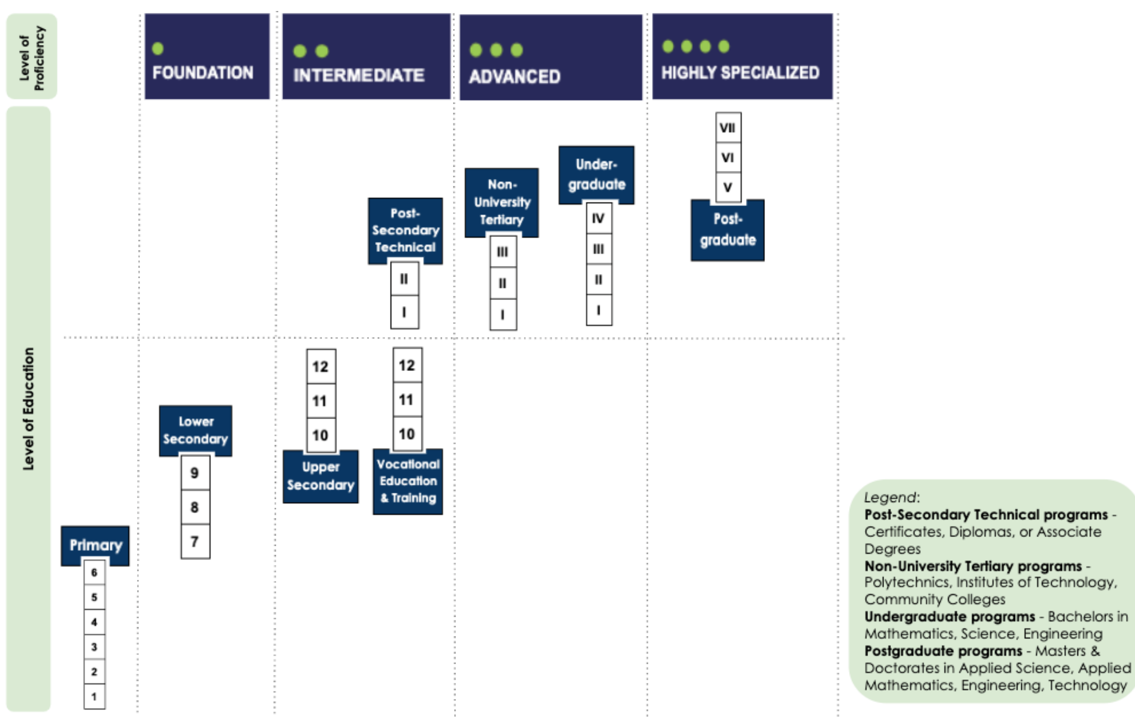


Note: Measuring the Information Society Report (2018). ITU's figures are based on Botswana (2014), Cabo Verde (2015), Côte d'Ivoire (2017), Djibouti (2017), Niger (2017), Egypt (2016), Morocco (2017), Sudan (2016), Togo (2017), Zimbabwe (2014). ITU's figures also assume that an individual has basic digital skills if he/she has engaged in at least one of the following four computer-based activities during the last 3 months: (1) copying or moving a file or folder, (2) using copy and paste tools to duplicate or move information within a document, (3) sending e-mails with attached files, and (4) transferring files between a computer and other devices. These task behaviors broadly correspond to DigcComp2.1/UNESCO's proficiency levels 2 in the Competency areas '0: Devices and software operations', and '2: Communication and collaboration', and proficiency levels 1 and 2. The assumption is that individual's proficiencies in DigComp2.1/UNESCO's Competence areas 0 and 2 are correlated with those in other 6 Competence areas. Another assumption is that the data from 10 of countries represent data from the African continent. ITU's figures also assume that an individual has advanced digital skills if he/she has engaged in the following computer-based activities during the last 3 months: writing a computer program using a specialized programming language. This task behavior broadly corresponds to DigcComp2.1/UNESCO's proficiency level 5 in the Competency areas '0: Devices and software operations', and '3: Digital content creation. The assumption is that individual's proficiencies in DigComp2.1/UNESCO's Competence areas 0 and 3 are correlated with those in other 5 Competence areas. Another assumption is that the data from 10 countries are representative of the African continent.

An alternative way to assess the supply of digital skills is to use information on the completion of education, assuming that some form of ICT training[11] is provided in education institutions (see *Figure 5*). Knowing the state of provision of school education, it is likely that students in high schools in the majority of African countries acquire only basic digital skills (if ICT is included in the curriculum and actually delivered). Intermediate level skills may be provided at the upper secondary level. A more careful assessment would require matching the ICT curriculum with the competences and proficiency levels in the UNESCO/EU DigComp framework. Digital skills for the ICT professions could be delivered at the upper secondary level and in TVET institutions and technology programs in short-cycle tertiary institutions (at the technician level), in university undergraduate programs in engineering, sciences, mathematics and related fields and postgraduate programs in the same fields. Again, an assessment of the curriculum of these courses against international frameworks such as the EU e-Competence framework would provide a better estimation of the skills of the students in these courses.

Hence, using the proportion of students at different levels of education and in different types of ICT related courses could provide a rough estimate of the supply of digital skills through the formal education system. This mapping should be taken as indicative as because much of the learning in SSA schools, including in technology related courses at the school level, tend to be theoretical and focused on rote learning which do not develop the competences listed in the above-mentioned frameworks.

Figure 6: Digital Skills and Levels of Education



[11] We use the term "ICT training" here as this term is currently more common in African education systems, rather than the term "digital skills training"

5. Provision of Digital Skills through Formal Education and Training Institutions

5.1 Fostering digital skills through the formal education system

The digital competencies listed in Table 1 can be acquired through formal education and training institutions for young people and on-the-job formal training and informal training (such as peer-to-peer learning) for those in the workforce. Increasingly, online learning and blended learning are supplementing traditional training methods and vastly increasing the potential for enhancing access.

Universalizing basic digital skills

Basic digital skills refer to the proficiency levels 1 and 2 in the framework outlined in *Table 1*. A person who is proficient at this level would be able to do simple tasks that involve remembering content and instructions but also requires some guidance to execute.

In sub-Saharan African, basic digital skills programs can be offered in high schools (lower secondary schools), covering grades 7-9/10 approximately and also at higher levels of education for those students who have not had access to digital skills training. Apart from a few more advanced countries in Southern Africa, Kenya etc., it is unlikely that primary schools have the minimum required infrastructure to provide digital skills training. In Northern Africa, on the other, basic digital skills training can be provided in primary schools as well.

An important decision is whether to provide “stand alone” basic digital skills training to students or to integrate the use of digital technology across the curriculum. Experience shows that the latter takes a long time, as teachers need to become confident in the use of technology and digital content. A promising way to start is to introduce basic digital skills training as a “subject” for high school students. Essential steps in this process are definition of a curriculum, selection of digital content teaching methods, and assessment; the provision of devices that can be used by students in sequence but in such a manner as to allow equitable access; stable source of supply; connectivity to the internet and regular, frequent training of all teachers (not just the ICT teacher).

An extremely important aspect is ensuring that there is adequate and consistent technical support for teachers and students to troubleshoot issues with hardware, software, internet connection and use of content.

Adaptation of existing basic digital skills curricula training such as the International Computer Driving License (see below) is one quick way to introduce basic digital skills training.

Intermediate digital skills for the general workforce and for ICT professions

Intermediate digital skills refer to proficiency levels 3 and 4 in the framework outlined in *Table 1*. The student is able to independently perform simple tasks and well-defined and routine tasks, and straightforward problems, and where he/she is able to remember and to understand.

Intermediate digital skills programs can be offered in lower and upper secondary schools and should be made available to all undergraduate students in universities. Because intermediate digital skills require a greater understanding of content in different situations, they are best provided as part of teaching other courses. This means that use of digital technology needs to be integrated across several subjects. To begin with this could be done, in language and mathematics, as well as science subjects.

Integrating digital technology into teaching is far more complex than providing “stand alone” digital skills training at the basic level of proficiency. It is ideal if the school has a plan for the use of technology, and a heavy emphasis on teacher development and continuous support is required. Careful selection and curation of digital content appropriate to each subject is time consuming and requires technical expertise.

For the ICT technicians, courses at the level of e-1 and e-2 of the EU e-competence framework (*Figure 3*) are appropriate and these need to be provided in technical upper secondary schools and post-secondary TVET institutions.

Advanced digital skills for non-ICT and ICT professions

Advanced digital skills refer to proficiency levels 5 and 6 in the DigComp 2.1/DLGF outlined in *Table 1*. For those in engineering and ICT professions, advanced digital skills refer to the proficiency level 4 in the e-Competence for ICT Professions framework (*Figure 3*). A person who is proficient at this level would be able to deal with and provide guidance to others on different tasks and problems that involve applying and evaluating content in complex situations. Advanced digital skills are required for African countries to diffuse and adopt new digital technologies across many sectors of the economy.

Advanced digital skills programs for ICT courses require greater theoretical content and would typically be provided in relevant undergraduate courses in universities and other tertiary level courses. Typically, these would cover:

- Engineering courses, specifically electrical and computer engineering courses (4-year courses) - these would constitute the core of the advanced digital skills programs
- Mathematics, science and related undergraduate courses (3-year courses) in universities and technology courses in tertiary institutions

The discipline of electrical and computer engineering is fundamental to the technologies of the 4^{th} industrial revolution when artificial intelligence systems will be ubiquitous. Hence, reforming the content, pedagogy and assessment of these courses should be a priority (*Box 4*).

***Box 4:* Advanced digital skills for the ICT professions require reform of core engineering courses in universities**

Given the rapid advances in scientific knowledge, it has become impossible to *fully* train an engineer in the four years typically allotted for a baccalaureate degree at a university, or even in the cumulative total of eight to nine years typically considered adequate for an advanced (Ph.D.) degree. The implication is that no engineering curriculum should set out to provide a student with all the technical knowledge (s)he needs for a lifetime career. What is required is to structure a training program that focuses on imparting the fundamentals of the field, and on providing the students with the skill to learn how to learn on their own.

The typical electrical and computer engineering curriculum at an African university differs significantly from that of a university in a developed country, for example in Korea or Singapore. While most electrical and computer engineering curricula in the developed world are four-year programs, some African universities have five-year curricula for a baccalaureate degree. The key differences are:

- A heavier course load in each year
- The type of courses included in the curriculum, some of which are not directly relevant to core subject material for electrical and computer engineering
- The content of the courses, which do not sufficiently emphasize the fundamentals, breadth and depth.
- Lecturing as the dominant mode of instruction; no recitations and rare tutorials with small groups
- Very large class sizes, ranging from 80-150 students.
- No capstone project by students
- Almost exclusive reliance on the final examination (no weightage to homework or continuous assessment)

Engineering curricula and syllabi are not regularly revised in African universities and the lack of widespread accreditation of engineering programs in sub-Saharan Africa by international bodies has serious implications for the quality of engineering programs in Africa.

Modern engineering curricula are typically structured to fit within a four-level scheme that emphasizes certain skills and core knowledge. At the base of the scheme are courses that impart foundational knowledge in the sciences (physics, chemistry, and biology), mathematics, and computing (computer literacy). The foundational background is followed by a set of courses considered to constitute the core subject matter of the particular engineering discipline. Next, the student is exposed to the breadth of the subject after which (s)he can select one or two areas for an in-depth study. In addition to the coursework, a typical four-year undergraduate program generally offers the student an opportunity to work on a capstone design project during the third or fourth year of their study. Such projects usually have a minimum duration of at least one academic semester but could also extend to a full academic year. Capstone projects are intended to help students assimilate and internalize core engineering concepts learned in the course of their study. Most capstone projects at world-class universities are generally team projects intended to develop and impart interpersonal skills for working in teams; this is in addition to learning how to manage and cope with unknown factors as well as known (resource and time) constraints on projects that are designed to closely emulate real-world working conditions.

Note: Adapted from Towe (2019), consultant report.

Highly Specialized Digital Skills for the ICT professions

Although the UNESCO/EU DigComp framework outlines highly specialized digital skills (proficiency levels 7 and 8 in *Table 1*), which could in theory be available to citizens and the general workforce, in practice this would be difficult to provide in the African context in most educational or other institutions. For the ICT professions, these skills, representing e-4 and e-5 levels of the EU e-Competence framework in *Figure 3*, are typically provided at the postgraduate level (Masters and doctorate level) focusing on advanced computer science/ engineering, applied mathematics and related fields, and cater to occupations such as data scientists and AI engineers. The availability of high-quality postgraduate programs in these areas is very limited, especially in sub-Saharan Africa, outside of South Africa. This has an impact on the quality of undergraduate training and also on the limited ability to develop new solutions and applications of digital technologies. Development of high-quality postgraduate programs requires a high concentration of resources and alignment with international benchmarks for quality ; for smaller countries or those with weaker capacity, this is likely done best at the regional level, and for all countries, high quality regional programs can supplement national efforts.

5.2 Fostering digital skills outside the formal education system

A few case examples are provided to show how different levels of digital skills are being provided outside the formal education system. However, it must be noted that these levels may not exactly correspond to the frameworks mentioned in this paper and they are given for illustrative purposes.

Basic Digital Skills programs – case examples

The **International Computer Driver's License (ICDL)** offers courses that are for beginners with no prior computer or internet experience (intermediate level courses are also offered – see below). The ICDL is a computer literacy program which is based entirely on the European Computer Driver's Licence (ECDL) program, operated by the EDCL Foundation, and its syllabus, content and assessment methods have not been adapted to country contexts. Its syllabus is divided into modules and standardized tests are taken by the student after completing a module. It is administered by accredited test centers operated by course vendors, educational establishments, large organizations or companies, using guidelines provided by the ECDL Foundation. ICDL appears to be the world's leading computer skills certification organization. According to its website, more than 14 million people in over 150 countries have engaged with the ICDL program through a network of over 24,000 ICDL Accredited Test Centers (ATCs). ICDL is present in almost all African countries. For instance, in South Africa, there are more than 50 ATCs, in Kenya more than 80, in Uganda 14 and in Rwanda 8.

***Box 5:* ICDL in Kenya**

Kenya is an interesting example of full-scale adaptation (not adaptation!) of ICDL. Based on a government decision in 2009, ICDL has become the standard offering for organizations across the public and private sector. Recently, ICDL Africa signed a Memorandum of Understanding (MoU) with the Kenya School of Government, to offer ICDL to public sector workers across the KSG campuses throughout Kenya. Each year, over 10,000 new candidates register for the program, taking over 50,000 certification tests annually. ICDL Africa operates through an office in Nairobi, with a team of 4 full time staff, providing support to the large network of ATCs. Organizations wishing to become an ATC, must first be accredited by the Technical Vocational Education and Training Authority (TVETA). The network of ATCs covers wide variety of sectors, including schools, technical training institutions, universities, Government institutions, NGOs and commercial training organizations. Every autumn, ICDL Africa hosts its annual ATC Forum, bringing together all ATCs, as well as key stakeholders in the ICT and education sector to discuss updates to the ICDL program and share best practice from around the world.

ICDL was adopted into national law in Kenya in 2009 when the Information and Communications Act recognized the ICDL Certification as 'the entry level computer certification designed to demonstrate competence in computer use'. (Thailand has also officially recognized ICDL as an education standard. However, to our knowledge no European country has adopted ECDL into its legislation.)

As a result, all training courses in Kenya meet the ICDL standard (earlier some computer literacy courses were of low quality) and employers can easily compare (formal) IT qualifications of applicants and employees. Unfortunately, no sources indicate how far the substance of the ICDL, which basically is PC-based, would benefit from including more on skills related to the use of mobile phones, which have been the important drivers of the digital economy in Kenya. It would be important to get an assessment of the appropriateness/need for adaptation of the ICDL from members of the business community in Kenya.

Given the extremely low level of literacy especially in SSA countries, even the introductory courses of ICDL may need to be adapted for use in schools. *Box 5* provides information about the implementation of ICDL in Kenya.

The **Digital Doorway (DD) project,** launched in 2002, provides freely accessible ICT centers in the form of "containers". They encourage digital upskilling and computer literacy in rural areas of South Africa through unassisted- and peer-assisted learning. Container DDs are placed in disadvantaged localities to improve the digital and informational literacy of disadvantaged children, youth and adults through experimentation and exploration by allowing them to "learn without formal training and minimal external input"[12]. Based on the open-source software Ubuntu Linux, the content of container DDs includes the OpenOffice suite, educational programs and content including interactive scientific simulations, an introduction to computer terminology, scientific software, 10 000 books, Wikipedia, etc. This allows for "varying computing activities ranging from entertainment to independent research." (Gush, 2011) DDs come equipped with internet and local wireless hotspots for the content to be accessible to anyone with a browser. A joint initiative of the government and private sector in South Africa, more than 240 systems have been deployed across all 9 provinces of South Africa as of 2013 with the latest installation being in 2019. Each DD has the potential of reaching hundreds of users. 70% of users are below the age of 21 years. They have also been deployed across other African countries like Ethiopia, Lesotho and Uganda while also being deployed in Australia and Solomon Islands. Each container houses a multimedia computer system with three or four user terminals. Container DDs are solar-powered and hence self-sustainable "robust and vandal-proof" units designed to thrive in areas without power or shelter.

PraDigi was launched in 2017 in rural India spearheaded by Pratham[13]. 10,000 Google tablets have been distributed to 50,000 children across 900 villages. Pratham, an influential non-profit, provides numeracy and literacy e-content and partners with Slam Out Loud, another non-profit which provides performance and visual arts-based educational content and training[14]. The goal is to provide a cross-disciplinary education and digital literacy in a non-formal setting through self-paced and personalized learning tools. The content caters to children aged 3 to 14 years but the rigor adjusts to each child's learning levels. The freely accessible tablets provide contextual and interactive content in regional languages. PraDigi, a spin on the word 'prodigy', encourages deeper mastery by promoting group-based learning and assignments through shared tablets. PraDigi staff visit villages once a week to assess student progress through qualitative observational data and to troubleshoot. This allows student progress to be measured holistically.

Intermediate digital skills programs – case examples

Various examples of intermediate digital skills training outside formal education are available, as described below and summarized in *Table 2*.

The **ICDL** also offers intermediate digital skills modules. Although the content was originally oriented at the skills a general office worker needs (word processing, spreadsheet, database and presentation), in 2013 ICDL was broadened when a number of modules were added like project planning, 2D computer aided design, health information systems usage, ICT in education, web editing, image editing and digital marketing. The ICDL Profile Certification allows candidates and organizations to decide on the combination of programs they wish to implement, according to individuals academic, business and job needs. The ICDL Profile Certificate is issued to the candidate to demonstrate the various modules he or she has successfully completed.

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[3] Digital Doorway (accessed June 20, 2019), http://www.digitaldoorway.org.za/multimedia/dd_brochure.pdf
[13] Pratham (accessed on June 20, 2019), http://www.pratham.org/programmes/hybrid-learning
[14] Slam Out Loud (accessed on June 20, 2019), https://slamoutloud.com/#section1

The **IC-3 Digital Literacy Certification** is another course which is provided by Certiport (a product of Pearson Virtual University Enterprises), a for-profit provider of certification exam. These are courses for students or employees seeking to pursue a career in IT or enhance knowledge in the use of technology. The course content includes areas related to online usage (internet, browsing, navigation, email communication, digital citizenship, computing fundamentals, managing computer files, computer devices, configuration etc. It also covers common applications like word processing, presentations, slide design. The course can be delivered online or online/offline training, and the certification requires passing three individual exams to validate competency.

The **Microsoft Digital Literacy Certification** is a popular course which is free and open-source. This is targeted to all users with basic reading skills who want to learn the fundamentals of using digital technologies, such as working with computers, accessing information online, communicating online, participating safely and responsibly online, creating digital content in word processing, collaborating and managing content digitally. The course can be delivered online self-paced individual study or face to face classroom delivery. To obtain the digital literacy certificate, users require to pass 70 percent or higher. The biggest advantage of this course is that it is free and is an open-source, unlike the first two examples where user fees are charged. However, a limitation is that the course is linked to a particular vendor's software and may not give sufficient breadth of understanding to the student.

Table 2: **Intermediate Digital Skills Programs**

Program	Beneficiaries	Delivery method	Ownership	Duration
Anudip	India (Low-income youth & women)	In-person skill development training course	Private (Non-profit)	3 months
Cisco Networking Academy	Worldwide (180 countries)	Online programs, In-person learning programs	Private (For profit) Free courses in some cases	30-70 hours (depending on course)
Digital House	Argentina, Brazil	Bootcamp	Private (For-profit)	4 months
Digital Village	Latin America	Courses, workshops, conferences	Supported by Carlos Slim Foundation, Telemex, Telcel	Varies based on course
Khan Academy	Worldwide (all countries)	MOOC	Private (Non-profit)	Self-paced, Varies based on course
Microsoft (4Africa Academy)	Africa (with offline presence in Nigeria, Ghana, South Africa, Egypt, Uganda, Kenya, Rwanda, Mauritius, Malawi, Ethiopia)	Online programs, Internships, Apprenticeships	Supported by private (non-profit initiative)	6 months
SkillsFuture for Digital Workplace by IBM	Singapore (working adults)	Blended learning course (online + in-person)	Private (For-profit)	4-hour (online learning) followed by 2-day (in-person workshop)
STEP Computer Academy	Across 18 countries	Blended learning course (online + in-person)	Private (Has free courses)	Varies (mostly 1 – 2.5 years)

Source: IFC 2019, https://www.netacad.com/; https://www.khanacademy.org/; https://webibmcourse.mybluemix.net/; https://itstep.org/en/about/

Advanced Digital Skills for ICT – case examples

Advanced digital skills training outside the education system (or in partnership with universities) are provided by a variety of for-profit providers through *on-line and blended programs*, and also through *rapid skills training* ("bootcamps").

Examples of *online and blended programs* are provided in *Table 3*. They range across topics like computer language programming, artificial intelligence (AI), big data analytics, data science and cloud computing to name a few. Due to a wide variety of courses and proficiency levels within these programs, courses are of varying lengths. These initiatives are provided in a mix of both formats from purely online programs (including paid courses and MOOCs) to in-person training programs.

Rapid training in advanced digital skills[15] outside the education system, particularly in the software industry, have recently become very popular. Such training sessions are usually on current topics that are in sudden high demand. Because the standard courses take more time to prepare graduates, universities, even in advanced countries, are unable to respond to spikes of demand in certain areas, particularly in coding. Universities can themselves offer such bootcamps over a summer session, but more recently many for-profit companies have become active in this type of training, especially when the need is in some of the most popular high-level computer languages such as Python, C++, PHP, Java, etc.

However, coding bootcamps work best for individuals who already have background in the structure of computer languages but who do not have any experience programming in the particular language that there is a demand for. For these individuals, having someone show them the gist of the language, immediately allows them to make connections to their mental (logical) concept of the syntax they expect for a computer language. Learning is then very fast, and within a short time, they are coding very well. For anyone lacking in the underlying structure of how high-level languages are constructed, the lessons can be confusing, and often frustrating.

Another area where bootcamps are popular is machine learning—a subarea of artificial intelligence; again, rapid training courses in this area tend to be more useful for individuals who have the mathematical background relevant to machine learning. This background is found in algebra, particularly in the field of matrices. Concepts in manipulating large (two and three dimensional) matrices are key to machine learning. The coding of algorithms (into software applications) for performing the manipulations can be meaningless if one does not have the conceptual framework on matrices.

The delivery of these programs is best organized in partnership with the private sector to ensure that the course meet the requirements of the specific jobs in current demand.

[15] Adapted from Towe (2019).

***Table 3:* Advanced Digital Skills Programs for ICT outside the formal education system**

Program	Beneficiaries	Type	Ownership	Duration
Andela	Kenya, Nigeria, Uganda	Fellowship	Private (For profit)	6 months training + 36 months on the job training
Cisco Networking Academy	180 countries	Online programs, In-person learning programs	Private (For profit) Free/ Depends on institutions	30 hours – 70 hours per course
Codeacademy	Worldwide	Online courses (Free courses with paid option for personalized learning)	Private (For profit)	6-10-week long courses
Code.org	180+ countries (K – 12 courses but includes advanced digital skills courses like coding)	MOOCs	Private (Non-profit)	Self-paced
Developing in Vogue	Ghana (Women/Girls over age of 6)	Coding bootcamp for women	Private (For profit)	3 months
Intel® AI Academy	Worldwide (18 years and above)	Online courses (Has courses on AI, Big Data Analytics, Machine Learning, etc)	Private (Non-profit initiative)	4-5 hours
Laboratoria	Peru, Mexico, and Chile (young low-income women)	Coding bootcamp	Private (Non-profit)	6 months instruction + 18 months of continuing education
Meltwater Entrepreneurial School of Technology	African Union (focus on Côte d'Ivoire, Ghana, Nigeria, Kenya, South Africa)	Incubator, Startup accelerator	Private (For profit)	12 months, full time
Microsoft (4Africa Academy)	African Union (with offline presence in Nigeria, Ghana, South Africa, Egypt, Uganda, Kenya, Rwanda, Mauritius, Malawi, Ethiopia)	Online programs, Internships, Apprenticeships	Supported by private (non-profit initiative)	6 months
Tunapanda	Nigeria, Kenya, Tanzania, Uganda (Aims to cover East Africa)	In-person training course, Bootcamp	Private (Non-profit)	3 months training, Robotics Bootcamp
Udacity	190 countries	MOOCs	Private (For profit)	4-6 months (Nano degrees)

Source: IFC 2019, ITU 2018, https://www.codecademy.com/; https://code.org/; https://software.intel.com/en-us/ai; https://tunapanda.org/; https://www.udacity.com/

5.3 Challenges in fostering digital skills in Africa

A special feature of SSA countries is the lack of basic literacy and numeracy skills in a huge section of the population, which are essential prerequisites for the acquisition of even the most rudimentary digital skills. Self-reported literacy rates among young people are high—for example, 70 percent of young people aged 15-19 report themselves as literate in most countries. But actual reading proficiency tests done in the two SSA countries show functional literacy rates to be much lower. Recent studies in SSA countries have found that the majority of fourth grade students cannot read a paragraph and close to ninety percent could not solve a mathematics world problem; for eighth and ninth-grade students in South Africa, close to half of the students did not have basic mathematical knowledge, including adding and subtracting whole numbers. Furthermore, over 50 million children under the age of 15 are estimated to be out of school (Bashir *et al.* 2018) .

The creation of advanced digital skills for the ICT professions, through engineering, computer science and related programs, is restricted by the low access to post basic education. Across the region, enrollment rates in upper secondary education (grades 10-12) are extremely low. In SSA, the average is about 28 percent, but in many countries, it is less than 15 percent. In higher education, the gross enrollment ratio is below 10 percent. Enrollments in technical-vocational education are below the average in other regions. Limited enrollment in mathematics and science streams in lower secondary and upper secondary and high failure rates in these subjects restricts the pipeline of those who could enroll in technical, professional, mathematics, and science courses in higher education. Estimates indicate that less than a quarter of the small number of students in higher education are in mathematics and science courses. Further, gender disparities become acute in upper secondary and higher education, with very few girls participating in the technical and professional courses that lead to high-end jobs in the digital economy.

Equally important is the poor quality of courses and teaching in technical-vocational and higher education, especially in the technical-professional and mathematics courses. Lack of qualified faculty is one major issue, with many university faculties in SSA not having a postgraduate qualification. Even more serious is the lack of industry experience, which is especially important in the fast-changing environment of digital technologies. Most universities still offer outdated courses in computer science courses, electronics, and telecommunications and information management systems. Key specializations that are considered necessary for a broad and deep digital economy are missing: these include cybersecurity, mobile computing, network and cloud technology, ICT hardware and service infrastructure, IT management (ITM), software development and engineering, storage and data, digital multimedia, big data, data analytics, artificial intelligence, and so on.

Formal education and training institutions are important for preparing the pipeline of young workers and citizens for the digital world. Training opportunities for those who are currently out of school or those in the workforce are equally important. For this enormous stock of the population, there are limited opportunities for training and few formal sector firms invest in the training of their workforce. Digital technologies may offer the chance to multiply the offerings of training on basic digital skills which are linked to their jobs.

Migration of high-skilled workers with digital skills can dampen the efforts made by countries to increase the supply of workers with advanced and highly specialized digital skills. African countries vary considerably in the levels of economic development as well as the size and maturity of the labor market. Some countries with a relatively underdeveloped labor market for advanced and highly specialized digital skills (e.g., Lesotho) face risks of their high-skilled worker with digital skills migrating to neighboring countries in search for a market that can reward those with such skills (South Africa). While there are clear benefits of brain drains (e.g., remittances), the efforts made by countries to foster digital skills may be dampened.

5.4 Adaptation of existing courses/programs for basic digital skills – is this a feasible option?

Development of new curricula and digital content is expensive and time-consuming. In low capacity environments, a choice has to be made between development versus adaptation of existing curricula and resources. However, the costs and effort required for meaningful adaptation must not be underestimated, as apart from technical capacity requirements, issues related to copyright, intellectual property and licensing costs must be considered.

For instance, the provision of basic and intermediate digital skills could be based on the ICDL. However, a change or extension of the ICDL program is not straight forward because the European Computer Driving Licence (ECDL) program is owned and controlled by the ECDL Foundation. The Foundation could be approached to know on what terms is would consider collaboration with the Bank (or other actors) on developing new modules/subjects. The last update of the ECDL was in 2013, and adaptation could be included as part of the next update (the date is not yet known).

It would be preferable to collaborate with the ECDL Foundation and its network of national partners on changing and extending the ICDL program. The ICDL certificates seem to be widely recognized by private and public employers, and the infrastructure for teaching and testing is well developed in several countries. An alternative system would be costly to establish and to maintain, and (at least in the beginning) it would not be known by employers. Before the Bank teams up with the national ICDL system, it will however require an assessment of the capacity and credibility of the relevant national structures and partner organizations.

It would also be useful to undertake an independent evaluation of the de facto competences of the holders of the different levels of ICDL certificates and of the reliability of the testing system. This could be conducted by a qualified research institute.

In general, this would require a regional approach, as it would be expensive to conduct the exercise of adaptation on a case by case basis.

6. Measurement of Digital Skills at Basic and Intermediate Level

The measurement of digital skills in the population is not done extensively in SSA and is still at a nascent stage in most countries. Difficulties of designing and administering the survey, including access to devices, posed considerable challenges. Nevertheless, systematic assessment based on an accepted framework is required. *Annex 2* provides more details of the issues involved and *Appendix Tables C and D* indicate sample questions from surveys and aggregation of indicators by Eurostat.

Annex 1: Indicators and Scorecards for Digital Skills in the Digital Economy for Africa Initiative

The DE4A initiative proposes two high-level indicators to assess progress

- Percentage of lower-secondary schools with access to internet for pedagogical purposes (target: all lower-secondary schools by 2030)
- Proportion of youth and adults with advanced digital skills (target: 100% by 2030)

The frameworks used in this paper, the Digital Literacy Global Framework, based on DigComp 2.0/2.1 and the EU e-Competence frameworks, adapted to African contexts - can be used to define different levels of digital skills.

Basic digital skills
A large proportion of young people are still out of lower secondary school, especially in sub-Saharan Africa, but also in parts of North Africa, and it would be logistically difficult to provide the same level of basic digital skills training to all out of school children, many of whom will lack of foundational literacy and numeracy skills. Further, it is impossible to have one test that will measure the performance of all children. It is therefore better to consider two indicators for basic skills:

- <u>For children in lower secondary school</u>: Percentage of children in the terminal year of lower secondary education who acquire basic digital skills, equivalent to Foundation Level 2 in the DigComp Framework.

- <u>For current out-of-school children</u>: Percentage of children aged 15 years who acquire basic digital skills, equivalent to Foundation Level 1 in the DigComp Framework.

Provided that all basic digital skills programs for these children are based on the DigComp Framework, and assessments test this level of proficiency, the completion of these programs could be treated as an indicator of acquisition of very basic digital skills.

For the former group, it is better not to specify the age, as children will be of varying ages due to repetition and late entry in primary and lower secondary. Further, due to the high failure rate in the lower secondary examinations, it is preferable not to use “completers” but all those who are in the terminal year of the lower secondary cycle.

Integration of the basic digital skills program in the lower secondary curriculum and assessment based on this would allow collection of data on how many students acquire basic digital skills.

Advanced digital skills (ICT professions and occupations)
The purpose of this indicator is to identify how African countries are developing the capacity to drive the digital economy through ICT and ICT-enabled industries and services. Although it is desirable to assess the level of advanced digital skills in the workforce, it is not feasible to do so. It is feasible to measure the new entrants into this workforce, as represented by the number of graduates of undergraduate level programs in engineering, computer science, mathematics and physics. Ideally the programs would be assessed against the EU e-Competence framework (proficiency levels e-3 and e-4) or related framework. It would also include graduates of online, blended and rapid skills training programs provided such programs can also be assessed against the same framework.

Annex Table 1: High-Level Scorecard

PILLAR	GOAL	INDICATOR	BASELINE	INTERIM TARGET (2021)	FINAL TARGET (2030)
DIGITAL SKILLS[16]	5.1 Increase the number of digitally literate citizens	Percentage of lower-secondary schools with access to internet for pedagogical purposes (→SDG 4.a.1)	35%	55%	100%
	5.2 Increase availability of digitally competent workforce	Proportion of youth and adults with advanced digital skills (→SDG 4.4.1)	2%	3%	6%

Annex Table 1.2: Lower-Level Scorecard

KEY RESULTS	RESULTS INDICATOR	DEFINITION	ASSUMPTION	DATA SOURCE	BASELINE	INTERIM TARGET (2021)	FINAL TARGET (2030)
OUTCOMES							
Increased access to basic digital skills	Proportion of youth and adults with basic digital skills	Basic digital skills is equivalent to Proficiency Level 2 in DigComp2.1/UNESCO Framework.	ITU's figures are based on Botswana (2014), Cabo Verde (2015), Côte d'Ivoire (2017), Djibouti (2017), Niger (2017), Egypt (2016), Morocco (2017), Sudan (2016), Togo (2017), Zimbabwe (2014). ITU's figures also assume that an individual has basic digital skills if he/she has engaged in at least one of the following four computer-based activities during the last 3 months: (1) copying or moving a file or folder, (2) using copy and paste tools to duplicate or move information within a document, (3) sending e-mails with attached files, and (4) transferring files between a computer and other devices. These task behaviors broadly correspond to DigcComp2.1/UNESCO's proficiency levels 2 in the Competency areas '0: Devices and software operations', and '2: Communication and collaboration', and proficiency levels 1 and 2. The	International Telecommunication Union (ITU)	25%[17]	40%	75%[18]

16 These indicators are aligned with IDA19 commitments to support IDA countries to improve skills and employability under HCP (commitment #7 under Jobs and Economic Transformation (JET) pillar).
17 Source: Measuring the Information Society Report, Volume 1 (ITU, 2018). Chart 1.28.
18 Based on, "World Economic Forum (2017). Internet for All An Investment Framework for Digital Adoption. White Paper", the following target is set: achieving universal internet penetration (>75%).

			assumption is that individual's proficiencies in DigComp2.1/UNESCO's Competence areas 0 and 2 are correlated with those in other 6 Competence areas. Another assumption is that the data from 10 of countries represent data from the African continent.				
	Percentage of lower secondary-school students in the terminal year of the cycle with basic digital skills	Basic digital skills is equivalent to Foundation Level 2 in DigComp2.1/UNESCO Framework.	- All basic digital skills programs for lower secondary-school students are based on the DigComp Framework, and assessments test this level of proficiency. - All lower-secondary school curriculum will include basic digital skills programs. - Completion of these programs can be treated as an indicator of acquisition of basic digital skills.	National skills assessment or HH survey (sample based) [19] ITU	50%[20]	60%	100%
	Number of lower secondary-school graduates produced annually with basic digital skills	Basic digital skills are equivalent to Foundation Level 2 in DigComp2.1/UNESCO Framework.	- All basic digital skills programs for lower secondary-school students are based on the DigComp Framework, and assessments test this level of proficiency. - All lower-secondary school curriculum will include basic digital skills programs. - Completion of these programs can be treated as an indicator of acquisition of basic digital skills. - The baseline target assumes 25% of those enrolled in the programs have skills in 2017 (ITU). - The interim target and final targets assume 60% and 100% of those enrolled in the programs will complete (or have skills) in years 2021, and 2030.	UNESCO-UIS National EMIS	6 million	8 million	30 million
	Percentage of out of school children aged	Basic digital skills for out-of-school-children are equivalent to	- All basic digital skills programs for out-of-school children are based on the	National skills assessment or HH	25%[22]	40%	75%

[19] Countries will be encouraged to include relevant measures in national assessments.

[20] Measuring the Information Society Report, Volume 1 (ITU, 2018). Charts 1.28 and 2.15. We assume 50% of 15 year-olds have basic digital skills.

[22] Measuring the Information Society Report, Volume 1 (ITU, 2018). The proportion of out of school children who have basic digital skills are assumed to be ½ of those 15 year-olds in school with basic digital skills.

	15 years-old with basic digital skills	Foundation Level 2 in DigComp2.1/UNESCO Framework.	DigComp Framework, and assessments test this level of proficiency. - The completion of these programs can be treated as an indicator of acquisition of basic digital skills.	survey (sample based) [21] ITU			
	Number of out of school children aged 15 years old produced annually with basic digital skills	Basic digital skills for out of school students are equivalent to Foundation Level 2 in DigComp2.1/UNESCO Framework.	- All basic digital skills programs for out-of-school children are based on the DigComp Framework, and assessments test this level of proficiency. - The completion of these programs can be treated as an indicator of acquisition of basic digital skills. - The baseline target assumes 25% of those enrolled in the programs have skills in 2017 (ITU). - The interim target and final targets assume 60% and 100% of those enrolled in the programs will complete (or have skills) in years 2021, and 2030.	UNESCO-UIS	1 million	3 million	1.5 million
Increased access to intermediate digital skills	Percentage of upper-secondary-school students in the terminal year of the cycle with intermediate digital skills	Intermediate digital skills are equivalent to Level 3 in DigComp2.1/UNESCO Framework.	- All intermediate digital skills programs for upper secondary-school and TVET students are based on the DigComp Framework, and assessments test this level of proficiency. - All upper-secondary school and TVET curriculum will include intermediate digital skills programs. - The completion of these programs could be treated as an indicator of acquisition of intermediate digital skills.	National EMIS, National skills assessment or HH survey (sample based) [23]	50%[24]	60%	100%
	Number of upper secondary-school graduates	Intermediate digital skills are equivalent to Level 3 in	- All intermediate digital skills programs for upper secondary-school and TVET students are based on the DigComp	UNESCO-UIS National EMIS	3.5 million	5 million	20 million

[21] Countries will be encouraged to include relevant measures in national assessments.
[23] Countries will be encouraged to include relevant measures in national assessments.
[24] [24] Measuring the Information Society Report, Volume 1 (ITU, 2018). 13% of age 15-74 in Africa have standard digital skills (ITU) which is equivalent to intermediate digital skills. 50% of those in the terminal year of upper-secondary cycle are assumed to have intermediate digital skills.

	produced annually with intermediate digital skills	DigComp2.1/UNESCO Framework.	Framework, and assessments test this level of proficiency. - The completion of these programs could be treated as an indicator of acquisition of intermediate digital skills. - The baseline target assumes 15% of those enrolled in the programs have skills in 2020 (ITU). - The interim target and final targets assume 50% and 95% of those enrolled in the programs will complete (or have skills) in years 2025, and 2030.				
Increased access to advanced digital skills	Proportion of youth and adults with advanced digital skills ***(High Level Indicator 2)***	Advanced digital skills is equivalent to Proficiency Level 5 in DigComp2.1/UNESCO Framework	ITU's figures are based on data from Botswana (2014), Cabo Verde (2015), Côte d'Ivoire (2017), Djibouti (2017), Niger (2017), Egypt (2016), Morocco (2017), Sudan (2016), Togo (2017), Zimbabwe (2014). ITU's figures also assume that an individual has advanced digital skills if he/she has engaged in the following computer-based activities during the last 3 months: writing a computer program using a specialized programming language. This task behavior broadly corresponds to DigcComp2.1/UNESCO's proficiency level 5 in the Competency areas '0: Devices and software operations', and '3: Digital content creation. The assumption is that individual's proficiencies in DigComp2.1/UNESCO's Competence areas 0 and 3 are correlated with those in other 5 Competence areas. Another assumption is that the data from 10 countries represent data from the African continent.	International Telecommunication Union (ITU)	2%[25]	3%	6%[26]

[25] Measuring the Information Society Report, Volume 1 (ITU, 2018). Charts 1.28 and 2.15.

[26] World Economic Forum (2017). Internet for All an Investment Framework for Digital Adoption. White Paper (p19) suggest that advanced skills will reach 10% of the youth (18-35) population.

	Percentage of university undergraduate students in the terminal year of the cycle with advanced digital skills.	Advanced digital skills are equivalent to Level 5 in DigComp2.1/UNESCO Framework.	- The indicator will be limited to graduates of undergraduate level programs in engineering, computer science, mathematics and physics. - All advanced digital skills programs for university students are based on the DigComp Framework, and assessments test this level of proficiency. - The completion of these programs could be treated as an indicator of acquisition of advanced digital skills.	National EMIS, National skills assessment or HH survey (sample based) [27]	50%[28]	75%	100%
	Number of university undergraduates produced annually with advanced digital skills	Advanced digital skills are equivalent to Level 5 in DigComp2.1/UNESCO Framework.	- The indicator will be limited to graduates of undergraduate level programs in engineering, computer science, mathematics and physics. Inclusion of graduates of online, blended and rapid skills training programs is more problematic because of the differences in content and duration. - The baseline, interim target and final target assume at 50% (or less), 75% and 100% of those enrolled in the programs will complete (or have skills) in years 2017, 2021, and 2030.	UNESCO-UIS Ministries of Education	35,000[29]	50,000	100,000
Increased access to highly specialized digital skills	Percentage of university postgraduate students in the terminal year of the cycle with highly specialized digital skills	Highly specialized digital skills are equivalent to Level 7 in DigComp2.1/UNESCO Framework.	- The indicator will be limited to graduates of postgraduate level programs in engineering, computer science, mathematics and physics. - All highly specialized digital skills programs for students are based on the DigComp Framework, and assessments test this level of proficiency. - The completion of these programs could be treated as an indicator of	National skills assessment or HH survey (sample based) [30]	50%[31]	75%	100%

[27] Countries will be encouraged to include relevant measures in national assessments.
[28] Measuring the Information Society Report, Volume 1 (ITU, 2018). 2% of age 15-74 in Africa are assumed to have advanced digital skills (ITU). 20% of STEM students are assumed to receive advanced digital skills programs and that 50% of them graduate.
[29] 2.5 million undergraduate students are in STEM field in Africa (2017). For the baseline, 0.36 million students are assumed to be in terminal year of cycle, 20% of STEM students are assumed to receive advanced digital skills programs and that 50% of them graduate. In 2030, 7.0 million undergraduate students are assumed to be in STEM field in Africa, and 1.0 million students in terminal year.
30 Countries will be encouraged to include relevant measures in national assessments.
[31] 20% of STEM students are assumed to receive highly advanced digital skills programs and that 50% of them graduate.

			acquisition of highly advanced digital skills.				
	Number of university postgraduates produced annually with highly specialized digital skills	Highly specialized digital skills are equivalent to Level 7 in DigComp2.1/UNESCO Framework.	- The indicator will be limited to students in the terminal year of post-graduate level university programs in engineering, computer science, mathematics and physics. - The baseline, interim target and final target assume 50%, 75% and 100% of those enrolled in the programs will complete (or have skills) in years 2017, 2021, and 2030.	UNESCO-UIS Ministries of Education	4,000	5,500	12,000
INTERVENTIONS							
Increased connectivity in education institutions	Percentage of lower-secondary schools with access to computers for pedagogical purposes		- The baseline figure is acquired from the UIS database - The interim target and final target will be updated based on National EMIS	UNESCO-UIS National EMIS	50%	75%	100%
	Percentage of lower-secondary schools with access to internet for pedagogical purposes ***(High Level Indicator 1)***		UIS figures are based on data from Burkina Faso (2016), Cameroon (2016), Cabo Verde (2017), Egypt (2016), Eswatini (2016), Ghana (2018), Madagascar (2018), Mauritius (2018), Rwanda (2018), Senegal (2018), Sierra Leone (2018), Tunisia (2018), Burundi (2018). Average figures for Northern and Sub-Saharan Africa is 66.47% and 27.85% (respectively). We calculated the weighted average of these two figures based on enrollments. The assumption is that the data from the above 13 countries represent data from 54 African countries.	UNESCO-UIS National EMIS	35%	55%	100%
	Learners to computer ratio (LCR) in lower-			UNESCO-UIS National EMIS	50[32]	30	10

[32] Based on 2012 figure of 212 for 14 Sub-Saharan countries. In Nigeria this figure was 36 (public and private) in 2018.

	secondary schools						
	Percentage of upper-secondary schools with access to computers for pedagogical purposes		- The baseline figure is acquired from the UIS database which uses Learner-computer ratios (LCR). - The interim target and final target will be updated based on National EMIS	UNESCO-UIS National EMIS	50%	75%	100%
	Percentage of upper-secondary schools with access to internet for pedagogical purposes		[The baseline, interim target and final target will be updated based on information collected from the Ministry of Education]	Ministry of Education	35%	70%	100%
	Learners to computer ratio (LCR) in upper-secondary schools				50[33]	30	10
Policies, frameworks and curricular activities	Proportion of countries with designated ministries or agencies to foster digital skills		[The baseline, interim target and final target will be updated based on information collected from the Ministry of Education]	Global Partnership for Education 2019, UIS 2015 Ministry of Education	<75%	75%	100%
	Proportion of countries with a digital skills framework that guides policies and programs	A digital skills framework describes the definition and scope of different levels of digital skills to be fostered through national programs.	[The baseline, interim target and final target will be updated based on information collected from the Ministry of Education]	Ministry of Education	<25%	75%	100%

[33] Based on 2012 figure of 82 for 5 Sub-Saharan countries. In Nigeria this figure was 36 (public and private) in 2018.

	Proportion of countries with a digital skills curriculum in lower and upper secondary schools		[The baseline, interim target and final target will be updated based on National EMIS]	Ministry of Education	<25%	75%	100%

Annex 2: Measurement of Digital Skills at Basic and Intermediate Level

In this section, we cover only digital skills at basic and intermediate level, since the advanced and highly specialized skills are typically measured through assessment and certification by the formal education provider (university or online provider).

Currently, measures of basic/ intermediate digital skills constitute a small portion of large-scale surveys intended to understand ICT usage levels or adult skills of a population. The principal surveys are indicated in the following *Annex Table 2.1*.

Survey questions assess digital skills in two ways. The first method is based on self-assessment by the respondent and is the most commonly used approach. The second method is to use an indirect form of assessment, by posing questions about the types applications that the respondent can use.
For example, when an individual uses an application that is conceived to be difficult to use, this is held to be an indication of a high level of skills (Deursen *et al.* 2014). Sample questions from such indirect assessments can be found in *Appendix Table C.*

The DigComp 2.1 Framework is used to guide the identification of a limited set of indicators for the purposes of measurement of digital competence within the EU (and a number of other countries for comparative purposes) through an ICT survey about activities realized during the previous 3 months within four domains: information, communication, content creation and problem solving. It is assumed that persons having realized certain activities (e.g. copying or moving a file or a folder or using copy and paste tools to duplicate or move information within a document) have the corresponding skills. However, as the data is self-reported, they are likely to be positively biased.

The Eurostat indicators are simple (the indicators for all the domains are listed in *Appendix Table D.* At the overall level the digital skill indicator defines four levels of skills: no, low, basic and above basic; whereby:

- *'No'* refers to individuals who answered none in all categories, plus those who have not used the internet in the last 12 months or who have never used the internet;
- *'Low'* refers to individuals having one or more 'none' in three domains;
- *'Basic'* refers to individuals having one or more 'basic', but no 'none';
- '*Above basic'* refers to individuals with 'above basic' in all four domains.

A similar simple indicator for digital skills would be appropriate for measuring at the population level in Africa. Such an indicator could be inspired by the indicators and aggregation methods used by Eurostat to measure digital skills. However, the indicators must be 'Africanized' as some of them are more relevant to PC users in Europe than to users of smartphones in Africa (e.g. copying or moving files or using a formula within a spreadsheet).

Most of the basic and intermediate digital skills programs listed above administer performance tests with the purpose of certifying the level of digital skills. Examples of most commonly used certification programs include Microsoft Digital Literacy Standard Curriculum, CISCO Networking Academy, International Computer Driving Licence (ICDL), Internet and Computing Core Certification (IC^3) Digital Literacy Certification, etc.

***Annex Table 2.1*: Examples of large-scale questionnaires that measure digital skills**

Name of survey	**Geographic coverage**	**Target population**	**Method of measuring digital skills**
Eurostat Community Survey on ICT Usage in Households and Individuals	40 counties in Europe	• Individuals: aged 16 to 74 years • Households: with at least 1 member in the age group 16 to 74 years • Internet users: individuals who have used the internet within the last 3 months • Enterprises: with 10 or more persons employed in chosen activities[34]	Surveys (indirect assessment of skill-level) - Questions are posed regarding individual usage of digital tools and applications to indirectly assess their regularity and proficiency level with digital skills.
OECD Programme for International Assessment of Adult Competencies (PIAAC)	40 participating countries including non-OCED (not all OECD countries) [35]	Adults aged 16 to 65 years in their homes – 5000 individuals in each participating country	
World Bank STEP Skills Measurement Survey	16 developing countries so far	Individual - within the household (aged 15 to 64 years)	
International Computer and Information Literacy Study (ICILS) 2013/2018: Conducted by Australian Council for Educational Research (ACER)	Participating countries: Chile, Denmark, Finland, France, Germany, Italy, Kazakhstan, Korea, Luxembourg, Portugal, Russian Federation (Moscow), Uruguay, and the United States.	• Students in their eighth year of schooling. In most education systems, the eighth year of schooling is Grade 8, provided that the average age of students in this grade is 13.5 years or above. In education systems where the average age in Grade 8 is below 13.5, Grade 9 is defined as the ICILS target population. • Teachers and School Principals of these students are also surveyed	Survey (combination of indirect assessments and self-reporting questions for students & teachers) as well as Performance based tests for students

[34] Data for Round 2: Cycle 1 of PIAAC.
[35] Chose activities include: manufacturing; electricity, gas and steam, water supply, sewerage and waste management; construction; wholesale and retail trade, repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities; information and communication; real estate activities; professional, scientific and technical activities; administrative and support activities; repair of computers — since 2010.

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