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Chapter 11

Building e-skills in Africa

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Abstract: This chapter discusses what kind of strategies are needed to improve people's e-skills in Africa. A hybrid between technological and organizational skills, e-skills are becoming the cornerstone of human development in the 21st century. They allow ICT to be used to its full extent— fostering economic growth, social inclusion, health and education services, and poverty reduction. Hence, significant progress in e-skills development is possible in Africa, but it will require system-wide changes. Small-scale programs and local reforms often fail to achieve the desired large-scale effects. More equitable access, quality, relevance, and effectiveness of e-skills development cannot depend solely on scaling up "best practices." Attention needs to be paid to the governance environment in which e-skills programs take place.

Keywords: ICT use, e-skills, economic impacts, employability, socioeconomic inclusion, Africa.

1. Introduction

The opportunities and reach of information and communications technology (ICT) in Africa are expanding rapidly. If the ICT market continues its impressive double-digit growth, expenditures in ICT within Africa could exceed USD150 billion by 2016 (Yonazi el al., 2012).

ICT is now widespread, with the continent bridging the digital divide by riding on the crest of the explosion of mobile phone communications that enabled Africa to leapfrog to contemporary technology without going through the mill of older technologies. Falling costs of ICT equipment and deregulation in telecommunications have been the main drivers of change. The next challenges now focus on the use of these technologies and on their impact on social and human development.

Across the world ICT is increasingly fundamental to a nation's socioeconomic development. This is causing major changes in our societies by transforming the ways of consuming, working, producing, training and occupying leisure time. ICT even played a crucial role in the Arab Spring. Virtually all international development organizations refer to ICT as critical for economic and social development.

For the last decade increasing competition in the ICT sector, technological change (like cloud computing or open source) and public policies, such as free public Internet access areas and free access to Internet in schools, have heavily reduced the cost of ICT and helped bridge the digital divide. Most African countries are doing this through expanding access, with new projects and investments geared toward improving infrastructure.

The key focus in this chapter is on how best to improve the uptake and use of ICT in Africa. It is a contemporary challenge based on the knowledge that ICT's transformative impacts on societies have come to parallel the role that basic education or literacy played in earlier times. Knowledge of ICT has become both a basic skill in modern society and a pathway to other endeavors. It is basic because most commercial, educational and social services are increasingly delivered through ICT, and a pathway to new employment opportunities because most employers now require ICT skills as some minimum condition for effective functioning in the modern enterprise.

Inequalities between countries and people are becoming more and more related to people's own ability to use these technologies — and how efficiently they use them (as seen in the E-readiness Index and the Research ICT Africa survey [EIU, 2009]).

Africa needs e-skills (digital literacy or ICT skills) — a core set of skills equipping all citizens for a knowledge-based economy and society — to benefit fully from the "digital dividend" and ICT.[1] Empirical studies have demonstrated their crucial role in education, the job market and social inclusion. Insufficient digital literacy among citizens is a barrier to growth, employment and social inclusion in Africa. A strategy toward e-skills in Africa is a step to linking Africa to the global economy and to the benefits of its growing and youthful population.

This chapter discusses what kind of strategies are needed to improve people's e-skills. A hybrid between technological and organizational skills, e-skills are becoming the cornerstone of human development in the 21st century. They allow ICT to be used to its full extent —

[1] The terms e-skills, digital literacy and ICT skills are often used interchangeably.

fostering economic growth, social inclusion, health and education services, and poverty reduction.

2. E-skills: Definition and scope

The last decade and more has seen many attempts in the academic literature to define e-skills in terms of "technological literacy" (Carvin, 2000), "digital literacy (Larsson, 2002)", "technological proficiency (Soby, 2003)", "self-assessment (Kwan, 2001)" and "disorientation in hypermedia (Danielson, 2003; Park and Kim, 2000)". According to the European Commission, e-skills means "the efficient and critical use of information and communication technologies." Several attempts have been made by scholars since the seminal work of Gilster (1998) and subsequently Steyaert (2002) to define the scope and the aims of e-skills. There is no universal definition of e-skills, but in practical terms they are acquired through self-learning, education, heavy use of ICT and cooperative learning.

We will use a combination of definitions proposed by scholars and go further to suggest a new definition with a broader sense: e-skills are related to the general skills needed to use ICT and fully exploit the opportunities of the digital world (Steyaert, 2002; van Dijk, 2005; van Deursen and van Dijk, 2010). They are linked to the ability to use the technologies (devices), to understand their purposes and their functionalities and to exploit their potential for learning, working, informing and enjoying leisure time. These skills are general cognitive abilities and skills, as well as behavioral skills.

E-skills are sometimes categorized into three often related levels on a sliding scale of increasing sophistication. First at the bottom are the basic skills required to participate in a modern society where social and economic services are increasingly delivered through digital media. Second are the technical skills required to effectively operate in the modern enterprise and business where the disruptive paradigm of e-commerce by Amazon, among others, and an increasingly proliferation of e-governance by government agencies have spawned a new generation of virtual service outlets to achieve faster delivery and greater and least-cost reach to the general population while eliminating the constraints of physical boundaries. Third at the top are the sophisticated technical e-skills required to develop new services and solutions, to redesign existing and older services and content and to enhance the knowledge and skills sets — as well as tools required to continually advance the boundaries of the digital society.

Several of the skill types further discussed below fall into one or a combination of these three levels. Other emerging trends, as with the application of ICT in education, often require a full spectrum of all the three types of e-skills depending on whether the application is for formal or informal education. For example, informal education may require the teaching of basic e-skills by trainers who have just similar level of skills or by more advanced trainers who go beyond the basic training to also develop the required pedagogical digital materials themselves. The various levels of e-skills are also often analyzed in combinations of behavioral patterns related to standard communities of literacy practices, as follows.

2.1. Literacy and language abilities as basic e-skills

Since these technologies induce intense reading and writing of documents and messages, most scholars agree that literacy is one of the basic foundations of e-skills. Literate people are better able to use these technologies. Despite significant technical progress, however, most of the Internet's content is still in written form, therefore excluding that part of society without reading skills. At the same time, language skills are becoming fundamental e-skills. Most Internet content is in English. Speaking and reading English gives one an advantage as it allows access to more content. Knowledge of several languages therefore permits access to more content and increases the opportunities of the Internet. Progress is being made toward content translation, however. Nonetheless, people with multiple language skills remain better favored.

2.2. Instrumental e-skills

These are linked to the ability to use devices. These skills are not related to content but rather to how to use a computer, software, applications, or a smartphone. While these skills were highly important in the early generation of PC and ICT devices and only managed to persuade a fringe of the population to use them, they are becoming increasingly foundational skills required to operate in an ever-more digital world. This means that there is limited specific learning required— rather, intuitive self-learning sometimes by trial and error has become the basic driver. People can now engage in easy self-learning by doing. In most cases digital devices need people to invest time. The economic value of this learning process (the opportunity cost of time dedicated to these activities over other uses) is the main barrier. Mobile technologies seem more appropriate for Africa, not only in infrastructure but also in the needed skills.

2.3. Content-related skills

Alone, access to the digital world and the ability to access mass information and data are insufficient for critical use of these technologies. As society migrates from predominantly a manufacturing to a service economy, the ability to collate, evaluate and analyze on a large-scale volume of information to decipher patterns and linkages and to make deductive conclusions based on available information demands a more formal skill set. Thus, informational skills are needed to search for and extract information, verify its source, compare it with other similar information and have the critical posture. These skills are not easy to acquire, they need a learning process and the cognitive ability to do so. Education system needs to put critical thinking and ethics in use of these technologies as fundamental skills to help students have better informational skills. In France a recent study indicates that more than 80% of the population is unable to conduct adequate research on the Internet. This gives an idea of the massive challenges and investment needed for these skills.

Box 11.1 The 4Cs: creativity, critical thinking, communication and collaboration

Creativity: The tendency to generate or recognize ideas, alternatives or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others.

Critical thinking: Among other things, to be fair and open-minded while thinking carefully about what to do or what to believe. If you are a critical thinker, you will assess the reasons for and against doing something and then make your decision based on a fair assessment.

Communication: The exchange and flow of information and ideas from one person to another.

Collaboration: Working together to achieve a common goal.

2.4. Behavioral skills

Behavioral skills are linked to the nature of these technologies, but also to sociopsychological abilities. They are known as the 3Cs, 4Cs (box 11.1), 5Cs or even 8Cs. Several scholars have stated that these technologies need people to be able to collaborate, cooperate, coordinate tasks, communicate, make content contribution and so on.

This particular set of skills needs a behavioral shift. These skills are learned by intensive use of ICT and by acquiring new reflexes in the digital world. We need to insist on the fact that e-skills are linked to the way of behaving in the digital world. Training people to cooperate and collaborate in the real world does not mean that they will have the ability to transfer these skills in the digital world and vice versa. These skills are fundamental for enterprises and for social life. Building social capital needs these skills in the digital world. They are needed for social networks and for corporate network use. They need specific training. One of the ways of linking the education system to the private sector is the fact that students need to acquire these skills during their training and education. Most of the education systems in Africa ignore such skills and the need to develop them.

2.5. Content-development skills

The ability for some people to generate content and contribute to the digital society needs a specific set of skills. These skill sets belong to the top of the rungs of the ladder in the e-skill world. As indicated in the seminal work of Rogers (1995) only small proportions of innovators can make contributions to world knowledge. For example, the diversity of Africa needs people to develop local content in different languages for different ethnicities and communities. Every nation in Africa therefore needs a critical mass of skilled persons with the ability to develop such content.

One of the main characteristics of these technologies is the fact that users sometimes have to produce the content. The user-producer model implies the ability to generate sustainable content and traffic (von Hippel, 2005). Some of these user-information producers are transforming their activities into real jobs (webmarketing, community manager). These jobs did not exist 15 years ago, and these skills are not learned through the education system. The rapid evolution of technologies implies that most of the new jobs are now linked to the ability

to use these technologies. As such, building content-development skills is a reservoir of new jobs that Africa needs to exploit to resolve its youth unemployment problems.

2.5. High level, applications-development skills

Another set of skills is even more sophisticated: skills for development of applications and e-commerce (see annex 11.1). These skills need specific training in engineering schools and high profiles for mastering ICT. Most of these skills are costly and developed by the private sector for commercial purposes. They are also linked to innovation and the ability to innovate. Africa is investing to build these skills by fostering technoparks and attracting the most advanced universities to Africa.

One of the main concerns is the wage differential that is causing a major brain drain: most of Africa's most skilled IT people are abroad working for European, North American and Asian companies. This drain is hindering Africa's ability to develop a competitive industry in the world market, despite strong political commitment. Most African countries have an ICT technopark, meaning that they are trying to concentrate a critical mass of their limited skills in this particular domain, but no country has a city that has become the next Bangalore. Lack of skills, small size of technoparks and weak higher education remain strong barriers.

3. Users and uses of ICT

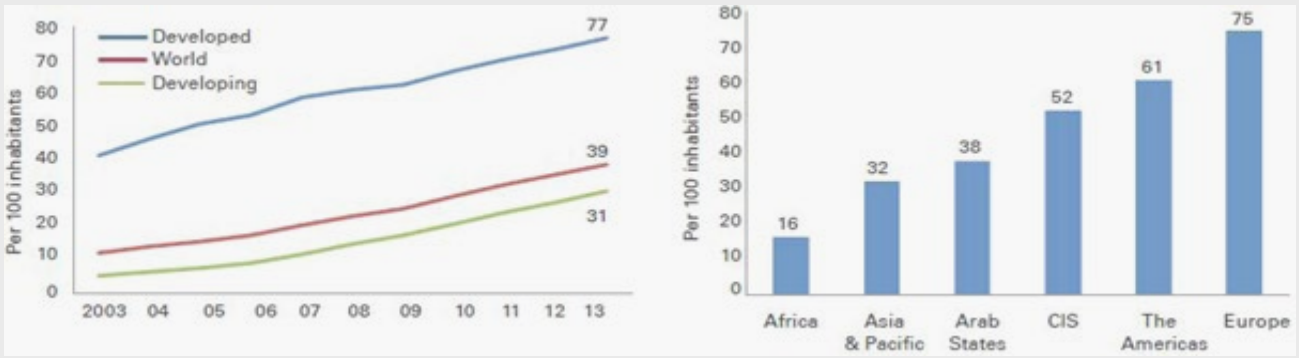
3.1. Bridging the divide thanks to the new generation of ICT— the late-adopter advantage

In 2013 more than 2.7 billion people were using the Internet, or 39% of the world's population. Europe and Africa were the regions with the highest and the lowest levels of household Internet penetration — 77% to 7% (figure 11.1).

Between 2009 and 2013 Internet penetration in households has grown fastest in Africa, with annual growth of 27%, followed by 15% in Asia and the Pacific, the Arab States, and the Commonwealth of Independent States (figure 11.2).

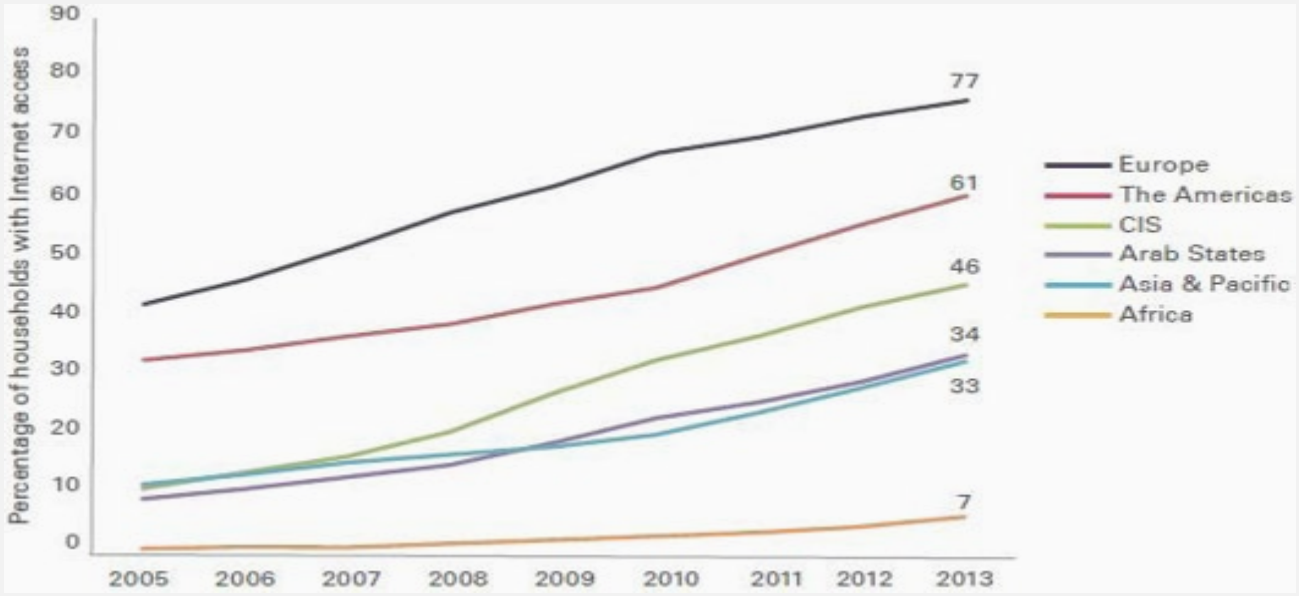
Mobile-broadband subscriptions have climbed from 268 million in 2007 to 2.1 billion in 2013. This reflects an average annual growth rate of 40%, making mobile broadband the most dynamic ICT market. In developing countries, the number of mobile-broadband subscriptions more than doubled from 2012 to 2013 (from 472 million to 1.2 billion) and surpassed those in developed countries in 2013. Africa is the region with the highest growth rates over the past three years when mobile-broadband penetration increased from 2% in 2010 to 11% in 2013 (figure 11.3).

Figure 11.1 Internet users by development level



Source: ITU World Telecommunication/ICT Indicators database 2012.

Figure 11.2 Households with Internet access



Source: ITU World Telecommunication/ICT Indicators database 2012.

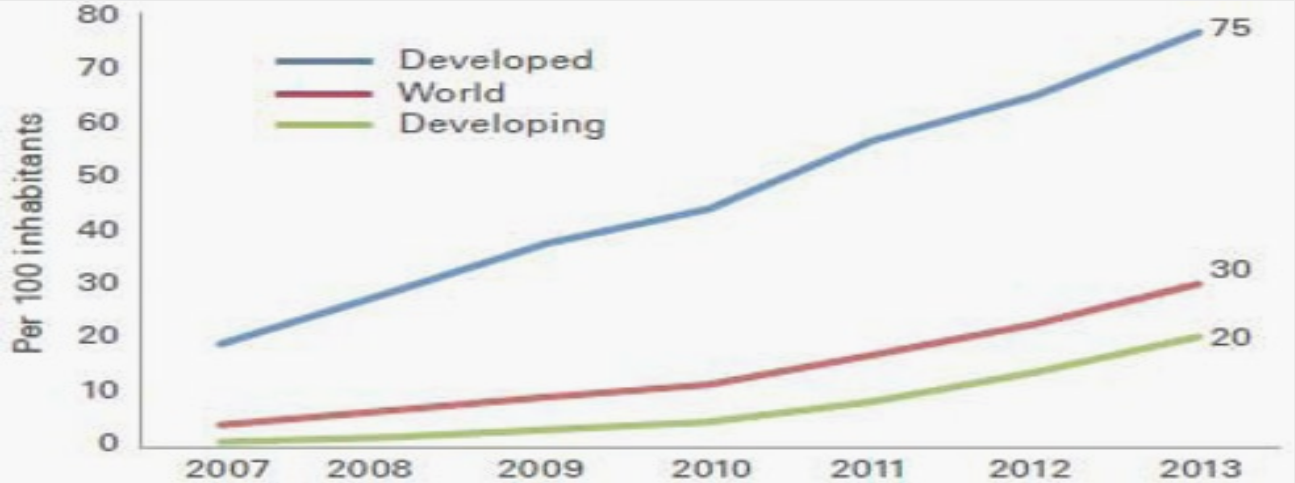
Poor performance in equipment in Africa relates mainly to old technologies (fixed phone, computers, and Internet). But mobile technologies are better adapted, easier and quicker to deploy on a large scale and thus seem more appropriate to Africa—giving it the late-adopter advantage. According to Aker and Mbiti (2010), in Sub-Saharan Africa mobile phone technologies can improve access to and use of information, thereby reducing search costs, improving coordination among agents and increasing market efficiency; improve corporate productive efficiency by allowing for better management of supply chains; create new jobs to address demand for mobile-related services, thereby providing income-generating opportunities in rural and urban areas; facilitate communication among social networks in response to shocks, thereby reducing households' exposure to risk; and facilitate the delivery of financial, agricultural, health and educational services.

3.2. Africa's ICT uses

The E-readiness Index shows Internet and ICT global diffusion for a set of 70 countries (including four African countries, see EIU, 2009). While the 2006, 2007 and 2008 editions do not contain use indicators, the 2009 version includes three indicators of use. They measure the use of the Internet by consumers, the use of online public services by citizens and the use of online public services by business.

Four African countries saw their scores drop in the 2009 version from 2008 (table 11.1). This shows that, beyond the question of access and availability of the technology, there is an issue of use and ability among citizens and businesses. Moreover, the scores are very low relative to other world regions. On use alone, performance is below average (5 out of 10), except in South Africa.

Figure 11.3 Active mobile-broadband subscriptions



Source: ITU World Telecommunication/ICT Indicators database 2012.

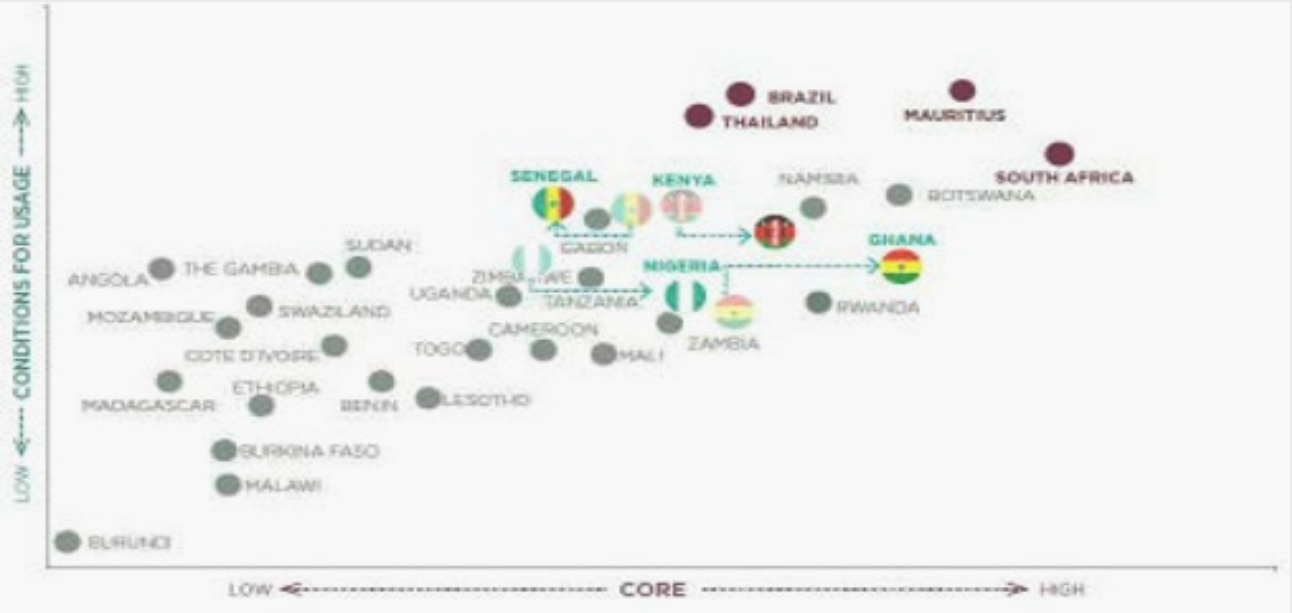
Table 11.1 The 4Cs: creativity, critical thinking, communication and collaboration

Country	Ranking (out of 70)	2008 (global)	2009 (global)	2009 (ICT use score)
South Africa	41	5.95	5.68	5.93
Egypt	57	4.81	4.33	3.05
Nigeria	61	4.25	3.89	3.50
Algeria	67	3.61	3.46	2.33

Source: ITU World Telecommunication/ICT Indicators database 2012.

The survey results of the Research ICT Africa (2007/2008) on 17 African countries shows that many respondents who do not use the Internet identified their lack of computer knowledge as a reason (Schmidt and Stork, 2008). In 9 of the 17 countries, lack of skills was the most commonly cited reason for non-use.

Figure 11.4 ICT core (equipment) and use



Source: Dalberg 2013.

There is a strong relationship between core (equipment) and use factors, suggesting that countries that perform well on one dimension also tend to perform well on the other (figure 11.4). Importantly, the pattern also suggests that, in the absence of a minimum amount of investment in core infrastructure, there is a clear ceiling to progress on use conditions. None of the countries achieved strong use conditions without a commensurate investment in core conditions.

Box 11.2 Connect Africa Strategy, 2007

Building e-skills in Africa has the aim of deepening the strategy defined at the Connect Africa Summit of 2007 in Kigali. The fourth goal of this strategy states that African countries must support the development of a critical mass of ICT skills required by the knowledge economy, notably by establishing a network of ICT centers of excellence in each subregion and ICT capacity building and training centers in each country, with the aim of achieving a broad network of interlinked physical and virtual centers, while ensuring coordination between academia and industry by 2015.

The strategy's fifth goal states that African countries must adopt a national e-strategy, including a cyber-security framework, and deploy at least one flagship e-government service as well as e-education, e-commerce and e-health services using accessible technologies in each country by 2012, with the aim of making multiple e-government and other e-services widely available by 2015. The project seeks to understand how these e-services will be used in the near future by studying actual patterns of use and the needed skills for efficient use.

Source: AfDB 2013.

For policymakers this suggests that poor performance on core conditions, measured by indicators on physical infrastructure and general business environment, cannot be leapfrogged. No vibrant Internet economies—or the positive development impacts that come with them — have been built atop poor business environments (box 11.2).

4. Economic impacts of e-skills

E-skills development is increasingly considered to be a factor in economic growth rather than a consequence of it (Tcheng et al., 2007). Three characteristics of ICT explain this view:

- ICT is omnipresent in most business sectors.
- ICT improves continuously and therefore reduces costs for users.
- ICT contributes to innovation and to development of new products and processes.

Both ICT development (increased infrastructure and access) and ICT for development (adoption of ICT applications) have contributed to advancing the process of development—facilitating the delivery of services, such as education, health, better governance (on the parts of both the leadership and the governed), enterprise and business development (Okpaku, 2006, p. 153). Some European Union officials claim that new ICTs constitute "time portals" that will bring modernity to the people of the developing world (Graham, 2011). Mobile phones are also thought to help promote democracy through delivery of voter education (Aker et al., 2011), and to reduce corruption (Bailard, 2009). Others argue that these technologies enable economic "catch-up" through technological leapfrogging (Okpaku, 2006).

Building e-skills in Africa has several socioeconomic impacts. Instead of listing them all, we discuss four main issues related to human capital formation.

4.1. Building e-skills improves youth employability

Today, most organizations require their employees to have a minimum level of e-skills. Economies in Africa, especially their private sectors, will have to be ready to deal with this, particularly as African countries are facing a mismatch in the labor market for these services (shortage of ICT and related skills, and surfeit of lower-quality skills). Ensuring plentiful e-skilled workers in Africa will both benefit from and contribute to the Internet and the knowledge economy more widely. Africa needs entrepreneurs able to create e-businesses. Labor market characteristics have changed in recent years, and e-skills are becoming fundamental to workers' employability, especially among the youth.

With a demographic boom over the coming years Africa will have the opportunity, if these youth are e-skilled, to benefit from ICT and to produce services linked to the sector. Although the continent is right now facing youth employment problems, ICT may become a key source of growth and fount of democracy if youth has not only access to ICT but also the necessary e-skills. Rapid training can also stimulate creativity among African youth, whether formal or informal.

Africa needs more ICT practitioners partly because Africa imports e-services at a high cost. According to the Organisation for Economic Co-operation and Development, advanced ICT users have many of the same skills of highly qualified ICT workers and may get jobs not just in their fields but also in ICT because of their e-skills. By fostering the e-skills of its citizens Africa will have a new means to fight high youth unemployment.

Having e-skills increases the probability of employment in Africa (table 11.2). "Agricultural contract workers in South Africa are, for example, often required to have a mobile phone" (Schmidt and Stork, 2008).

4.2. E-skills for women's socioeconomic inclusion

The Millennium Declaration (2000) resolved to promote gender equality and empowerment of women as effective ways to combat poverty, hunger and disease, stimulate development that is truly sustainable and ensure that the benefit of new technologies, especially ICT, are available to all. The Agreed Conclusions in 2003 of the 47th session of the UN Commission on the Status of Women (on the participation and access of women to the media and ICT, and their impact on and use as an instrument for advancing and enhancing women) states that "ICT offer tools for enhancing women's full access to the benefits of information and new technologies."[2]

Table 11.2 ICT and employability in Africa (%)

Country	Using a mobile phone helps me find a job	Listening to the radio helps me find a job	Watching TV helps me find a job
Benin	51.6	13.0	6.5
Botswana	68.4	36.7	34.0
Burkina Faso	54.2	40.0	23.8
Cameroon	38.0	23.7	21.7
Côte d'Ivoire	5.2	6.7	6.3
Ethiopia	35.9	2.8	4.5
Ghana	58.3	5.1	6.0
Kenya	69.5	41.1	35.3
Mozambique	44.9	18.8	30.9
Namibia	74.7	50.0	13.2
Nigeria	37.7	6.0	6.7
Rwanda	50.7	19.5	34.3
Senegal	47.7	4.0	2.8
South Africa	55.3	35.5	27.3
Tanzania	52.3	22.5	19.5
Uganda	54.7	25.5	15.6
Zambia	38.3	22.4	27.0

Source: Schmidt and Stork 2008.

ICT provides tools that can provide women with access to lifelong learning, education and training. Neglecting to give women access to these tools not only deprives them and their families of income but also reduces the skills pool of the nation, limits productivity and bars a country from being competitive globally (Dlodlo, 2009).

[2] www.un.org/womenwatch/daw/csw/47sess.htm.

4.3. E-skills increase the health dividend

ICT provides a powerful opportunity to improve service delivery by overcoming the geographic and financial barriers that hinder service delivery in remote areas. E and m-health in most developed countries are improving health sector efficiency and people's health. It is also crucial in fighting epidemics and disseminating general information on public health and in managing health institutions more efficiently. Finally, ICT offers new ways of delivering health services online, cutting costs and keeping dispersed health workers abreast of the latest developments.

These developments may be summarized under patients and providers. Patients — African citizens — need basic e-skills to understand and use these e-health services. The Internet is a huge location for accessing medicines, drugs, health services and care. Yet people do not need a prescription to buy some drugs and medicines, which is worrying as they may harm health. Citizens must therefore have basic e-skills to benefit from these e-services. E-skilled citizens can also access a country's health strategy, use e-government services (such as online appointments), and discover information about sanitation in general.

Providers — African health staff — need the basic e-skills to update their knowledge and fully use the more technical aspects of ICT, once again pointing to the key issue of e-skills rather than access. As with patients, health staff and doctors may misuse the technologies if they lack e-skills. The performance of program managers, staff of health ministries and administrative personnel also depends on their e-skills.

4.4. Building e-skills helps Africa achieve economic transformation

ICT is a "general-purpose" technology — it has no specific purposes initially and is pervasive in that it can be used by any person or any sector (Bresnahan and Trajtenberg, 1995; Helpman, 1998). Later, it needs to be adapted to local contexts and to meet the needs of local populations (Antonelli, 2003). While most applications, software, hardware and other devices are produced in a few countries, their efficient use must be adapted to local populations, which requires people to have the ability to use them fully— they must be e-skilled, and integrating indigenous knowledge into innovation systems demands an e-skills strategy.

Africa needs to build its own capacity to create and manage e-services for its productive sectors but faces huge shortages and mismatches for three linked reasons. First, higher education is poorly oriented toward these e-skills and cannot produce the required number of graduates in the near future. Second, Africans who are qualified ICT specialists are leaving for better jobs in America, Asia, and Europe. The brain drain is particularly worrying among ICT specialists. Third, African enterprises are unable to carry out the required vocational training, and some multinationals are curtailing investment plans because of a poorly prepared ICT workforce (box 11.3). Training such a workforce is thus a priority for most African countries.

By extension, ICT has a major role in good governance and political involvement of citizens. E-skilled people are better able to access the latest (and often better) information, to blog and to take part in social media, expressing their opinions and giving feedback to politicians. ICT was fundamental to the Arab Spring and could well enhance democracy and allow people to project their liberties more. Democracy and good governance in Africa need more e-skilled persons. Building e-skills in Africa will also allow governments to tackle the governance challenge.

Box 11.3 Statement by the CEO of ST Microelectronics, Tunisia

We are unable to develop more complex services and products nowadays in Tunisia due to the lack of a high-level e-skilled workforce. We employ Tunisian engineers for three or four years in our companies, but at the end when they have the necessary skills, they quit Tunisia for Europe. Most European ICT firms offer higher salaries and better conditions. We faced this several times and we cannot develop more complex

R&D services due to this situation and to the lack of e-skills. Nowadays, several ICT companies have pooled their resources and created training courses with a private institute outside the higher education system in order to have a high-level, e-skilled workforce in Tunisia. Tunisia's situation is not a special case.

Source: Author interview.

5. Strategies for building e-skills in Africa

A fundamental point of departure in discussing the building of e-skills through education is the recognition of the schism in classifying contemporary society into the digital generation and an older, non-digital generation. The Joint Information Systems Committee (2011) of the United Kingdom, in setting its agenda for e-skills development there, categorized its target population similarly but sometimes with a different nomenclature: the "Google generation" and the "non-Google generation." The digital or Google generation refers to the younger generation who have acquired basic e-skills along with basic literacy skills from inception of their educational career. The non-digital or non-Google generation refers to those who found the ICT world thrust forcefully on them with greater degrees of intrusion on their daily activities.

The fundamental business skills and advanced e-skills now belong to the realms of formal education and literacy development. A wide range of curricula, pedagogical materials and delivery media have evolved with the advancement of ICT for upgrading these skills at various levels of the formal, three-stage cycle (primary, secondary and higher education). The younger Google generation find themselves with mobile phones early in life, use computers for leisure, send text messages, post pictures on Facebook, search for videos on YouTube and chat in multiple social media platforms — all modern societal norms. Thus, where e-skills are not formally inculcated in their school curriculum, they tend to acquire the requisite skills through peers and by regular and constant practice. The basic e-skills required by the non-Google generation are, however, more difficult to establish.

5.1. Building e-skills through nonformal education

The fundamental challenge in establishing the curriculum for basic education lies in identifying what those skills are. Intel, however, as part of its corporate social responsibility, has achieved significant progress in this respect with its "Easy Steps" program.[3] The program defines basic e-skills by ability in understanding the fundamentals of computing; having basic word processing, spreadsheet, and presentation skills, and navigating the Internet.

It proceeds from that definition to develop an intuitive website to guide users in acquiring the skills through formal community centers or, for the more discerning ones, through systematic interactive online sessions with elaborate online support. The Intel basic e-skills program has been adopted in several Asian countries including Sri Lanka and India. In India the program has been integrated into a national digital literacy scheme that parallels their equivalents in Europe. The Intel scheme, beyond the basic literacy level, includes an online curriculum for developing websites, designing business cards, and engaging in online collaboration, as part of its next level of promoting business e-skills.

5.2. Building e-skills through formal education

A wide range of tools, applications and digital content are available for students and teachers, and requires the skills mentioned above. Beyond that, states should consider the following:

5.2.1. Ensuring total connectivity at school

The first step is to ensure that connectivity and equipment in schools and universities are progressing, enabling more frequent classroom interactions, and generating e-skills among learners (box 11.4). Public policies, the market and technological changes are resolving the access problem. African countries are showing great interest in ICT for education and are bridging the equipment gap with huge public investment and initiatives. The market, through competition between firms and technology providers, has ensured a steep fall in ICT prices, enabling schools and learners to be better equipped. Finally, technology is evolving, permitting applications and less costly equipment (such as cloud computing).

5.2.2. Shifting toward a learner-centered model and not a teacher-centered approach

ICT use at universities enables a switch from a teacher-centric pedagogy to a learner-centric one (Ben Youssef and Dahmani, 2008; Lundberg, Castillo Merino and Dahmani, 2008; Ben Youssef, Dahmani and Omrani, 2012; Ben Youssef, Ben Youssef and Dahmani, 2013; Keengwe et al., 2009; Saulnier et al., 2008). Moving from the Socratic, face-to-face, 2,500-year-old model of education to a more interactive and active learning is the first step in building e-skills. This requires a change of student and teacher behavior and organization. In fact, teachers need to acquire new skills and learn their new roles. They require enhanced confidence, as their beliefs

[3] www.intel.com/content/www/us/en/education/intel-easy-steps.html.

about technology are a major obstacle for ICT classroom use. *"If teachers are not confident in their ability or competence to handle computers, this may hamper their willingness to introduce technology in their classrooms"* (Mooij and Smets, 2001). Students are autonomously exploring new technologies and are accessing digital education contents outside the classroom. Teachers need to take advantage of these new forms of learning by strengthening e-skills of students so that they absorb learning informally. These new roles for teachers must be included in their curricula, and they must have special training.

Box 11.4 NEPAD e-Africa Commission

NEPAD is a vision and strategic framework for Africa's renewal. The NEPAD e-Africa Commission was created to promote ICT development in Africa. The Commission (with African governments) has identified ICT skills development as a key priority and has established the NEPAD e-Schools Initiative. This aims to impart ICT skills to teachers and students in primary and secondary schools in Africa, harnessing technology to improve, enrich and expand their education and to make every learner ICT literate. Over a 10year period the initiative seeks to develop all African schools (estimated to be in excess of 600,000) into NEPAD e-Schools. These schools will be provided with necessary infrastructure and ICT equipment and will have teachers that are trained and with access to applications and digital content, to ensure that ICT plays a meaningful role in enhancing education and health.

It is a multicounty, multistakeholder initiative to:

- Equip more than 550,000 African schools with state-of-the-art computers and curriculum-relevant learning materials.
- Connect the schools to the Internet by 2020.
- Teach ICT skills to young Africans in primary and secondary schools.
- Provide teachers with ICT skills to enable them to use ICT as a tool to enhance teaching and learning.

At the same time there is a need to ensure active learning where the behavior of students changes toward autonomy, problem solving and involvement. The engagement of students in active learning and problem solving through ICT is a key to pedagogically successful use of ICT and building e-skills (Barak, Lipson and Lerman, 2006). Involving more students by using these tools and improving ICT uses is a first step toward better performance in terms of e-skills. Different learning strategies ought to be implemented to increase student autonomy and involvement in classroom interactions. A large part of the learning process becomes centered on interactions outside the classroom where the student involvement is central. These changes can be observed through the change of the student behavior relating to the time spent on the Internet for pedagogical purposes and of the enrollment in more courses related to ICT (Ben Youssef, Dahmani and Omrani (2013).

Several African countries have already made this shift or are attempting to set strategies for changing the pedagogical approach. But more action is needed to have an observable impact on building e-skills and improving learning outcomes.

5.2.3. Changing the organization within education systems

Organizational change within schools and universities fosters e-skills acquisition and prepares prospective workers for new practices in firms. These changes tend to improve the employability of students and increase their future wages. ICT facilitates educational

collaboration between individuals and groups of people, which may take place locally or in separate geographic locations. Students may collaborate with peers in other schools, teachers may collaborate with their peers, and members of the local business community may serve as mentors to students, and so forth. According to Thijs and others (2001), there is a move from a traditional pedagogic organization to an emerging pedagogic organization (in the information society) based on an active, collaborative, creative, integrative and evaluative learning. This requires educational organization based on active learning with different activities, which are determined by learners in small groups and where pace is determined by learners individually. By contrast, in the classical way of teaching, there is little variation in activities: they are prescribed by the teacher in a whole class instruction, and pace is determined by the program.

Africa needs strong change in the organization of its education system and activities—a necessary condition for improving outcomes.

5.2.4. Promoting ethics in ICT use

One key result in integrating ICT in education is the fact that students acquire new e-skills and further develop their initial competencies. Understanding successful use of ICT in higher education and its implications has great practical relevance for long-term strategic pedagogical planning of technology implementation in education (Jonassen et al., 2005; Nicol and MacLeod, 2005).

5.3. Building e-skills through lifelong learning and professional training

While most African businesses lack professional training, the professional training that is offered ignores e-skills and their importance. Many scholars have found that African enterprises are bridging the divide in ICT equipment, but that effective use is still very weak — often because they lack skilled workers. Emphasizing these skills in professional training seems one of the main components of an e-skills strategy.

5.3.1. Meeting the e-skills demand in the marketplace

Another way is to substantially increase the number of degrees and training dedicated to ICT. There is no systematic evaluation of the required ICT skills in the African private sector but a comparison with Europe is highly informative. The European Commission has predicted that there will be 900,000 unfilled ICT vacancies in Europe by 2015, as employers struggle to find staff with the required skills. The European Union, with a strong education system and massive professional training, is lacking skills in this particular domain.

The picture is at least of the same magnitude in Africa. There is a need to train millions of skilled people in the next few years to fully exploit and contextualize these technologies. For example, billions of applications are now made by users of mobile devices worldwide. Each application has, in general, its own "context" and particular aims. Few applications are made by Africans for Africans. South Africa is leading the continent by setting a specific strategy

aiming at promoting the development of these m-applications. Nigeria, Morocco and Tunisia are close behind—but most African countries still need to pick up.

Universities are the main supplier of e-skills demand in the marketplace. Universities have the responsibility not only for the qualitative aspects of e-skills needed but also to adapt and provide solutions for the increasing scarcity of ICT professionals within the market. The foreseeable lack of e-skills in a few years shows that universities and policymakers are far from agreeing on what actions are urgent. In some countries the supply and demand disequilibrium of ICT students is expected to deepen even more dramatically as the number of ICT students continues to climb only marginally, or in some cases even drop. This contradicts the general trend for higher salaries and elite status of ICT graduates.

The different approaches of universities and industry to the graduate skills required widen the gap between what universities offer and what industry needs. Industry has pragmatic goals and expectations, looking for young employees immediately employable and functional without much additional investment in training. So, they would like to influence curricula and make them more practical and relevant. Industry would like to identify the most promising students and potential employees in advance. An appropriate preliminary selection of graduates would greatly lower industry's risk in investing in new employees—in many companies the main objective in their relationship with universities.

5.3.2. Attracting high e-skills profiles to African ICT technoparks and areas of innovation

As an industry with short technological cycles, the ICT industry is particularly appropriate for lifelong learning. This is essential for e-skills competence building and certification, as businesses face the need to respond to the shortening of the technology life cycles in ICT and the accompanying obsolescence of related knowledge, skills and competencies of their employees. This opens new horizons to work based on nonformal learning. Updating professional training through a continuous educational process is not always undertaken by universities of most African countries, with some noted exceptions.

Most African countries are also building technoparks and areas of innovation dedicated to ICT applications. While the agglomeration effect is very important for networks of innovators, most of these technoparks remain in an early stage. In fact, there is a need to have the best facilities in the country in these areas. These areas need to attract the best entrepreneurs in these sectors and to offer them the required incentives. Many multinationals' firms like Microsoft, Apple, Blackberry, Orange and so on are developing specific programs within these areas of innovation.

Yet developing e-skills through the education system alone will not capture the full ICT dividend. The three main messages from the literature of the last two decades that investigated firms' productivity gains after investing in and using ICT are: first, investment in ICT is not enough to make productivity gains (the "Solow Paradox", see Solow, 1987); second, organizational change is complementary to ICT investment, and can improve firm efficiency

and productivity; and third, investment in ICT needs to be accompanied by human capital investment (e-skills) to foster productivity (Ben Youssef et al., 2011).

5.3.3. Generalizing e-skills training for Africa's workforce

Most African firms lack the resources to invest in general training in e-skills, even though workers need to know how the technology works and to explore its possibilities. This process must be generalized to all employees, not just top management (as was the approach several years ago). Most workers explore the technology by themselves outside working hours, and often by trial and error—the process is not well structured.

ICT and new organizational practices like teamwork and project management, adopted together, offer complementary impacts on firm performance (Askenazy and Caroli, 2010; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2003; Garicano, 2010; Garicano and Hubbard, 2009; Ichniowski et al., 1997; Melville et al., 2004). To foster corporate ICT use, Africa needs to adopt such practices and foster employees' e-skills inside the firm. These organizational practices also need skills like problem solving, critical thinking and multitasking. Since much ICT is collaborative, it readily allows for such organizational change, helping make economies more efficient. E-skills have a strong effect on worker behavior. A new strand of research shows that e-skills improve performance, while ICT investments and new organizational practices may motivate workers, partly through self-improving behaviors outside the firm's time. Firms need more autonomous workers with the ability to take the initiative and to be fully involved in their job.

5.4. Fostering social uses of ICT for an inclusive society

Acquiring e-skills is fundamental to all citizens in life. Mobile applications are now widely developed in Africa. They are affecting financial transactions (such as M-Pesa in Kenya), public health, education, labor and leisure. Ensuring equal access to these applications by all citizens needs specific programs and training for disadvantaged populations. While young people can build e-skills in their schools and workers in their workplaces, disadvantaged people may have less chance to be trained in these technologies and thus be excluded from the digital world. Social inclusion programs therefore need to address this challenge and to set specific programs for disadvantaged populations.

5.4.1. Promoting e-administration and e-governance applications

The more people use these technologies the more they can explore their potential and master their use. Since these e-skills are transferable, acquiring them in social life leads to greater use in professional life. Promoting e-administration and e-governance applications implies that all the population will need to use these technologies. Cooperative learning and transfer of skills may occur between the components of society. Service delivery must use ICT as much as possible. Generalizing ICT use in public affairs, especially in social service delivery, will help.

In turn, greater use of e-governance systems helps people acquire e-skills. The good news is that African countries are developing their e-applications in these areas.

5.4.2. Making mobile broadband more affordable

Despite these good intentions and the need to move beyond access to skills, without such access skills are irrelevant. A regional comparison highlights that mobile-broadband services remain largely unaffordable in Africa, where the price of a computer-based plan with 1 GB of data volume averages more than 50% of monthly gross national income (GNI) per capita (table 11.3). In the Arab States and Asia and the Pacific by contrast, postpaid handset-based services are relatively affordable, accounting for 2.2% and 3.5% of monthly GNI per capita, respectively; prices in the Americas and Commonwealth of Independent States remain relatively high (5% or above of monthly GNI per capita) for all mobile-broadband services. And even mobile phone ownership is lower in Africa than other regions (table 11.4).

Table 11.3 Price of mobile-broadband services by region, early 2013 (% of GNI per capita)

Service	Europe	Arab States	Commonwealth of Independent States	Americas	Asia and Pacific	Africa
Prepaid handset-based (500 MB)	1.1	5.7	5.7	5.9	5.9	38.8
Postpaid handset-based (500 MB)	1.1	2.2	5.6	5.0	3.5	36.2
Prepaid computer-based (1 GB)	1.9	7.4	7.6	11.1	12.6	58.3
Postpaid computer-based (1 GB)	1.2	2.5	7.4	8.0	10.6	54.6

Source: ITU World Telecommunication/ICT Indicators database.

5.4.3. Promoting digital literacy for rural Africans Urban

Africans are more likely than rural Africans to use ICT and have e-skills. To reverse this digital divide and ensure social inclusion, specific training sessions and access to ICT are required in rural Africa. Governments are the catalysts that can influence the universities – ICT industry relationship, as a high number of African universities are public universities. More, governments can go far beyond being only catalysts in the education system with industry: their regulatory role should maintain and support an educational infrastructure that provides enough educated peoples for all social and economic needs. Governments can indeed dramatically change university–industry relations with focused incentives.

Table 11.4 Mobile phone ownership (per 100 people)

Region	2005	2006	2007	2008	2009	2010	2011	2012	2013
Africa	12.4	17.8	23.5	32.4	38.4	45.7	53.6	59.8	63.5
Arab States	26.8	38.8	52.6	63.0	76.2	87.7	96.4	101.6	105.1
Asia and Pacific	22.6	28.8	37.1	46.6	56.3	67.7	77.3	83.1	88.7
Commonwealth of Independent States	59.7	81.8	96.1	112.2	127.5	135.1	147.0	158.9	169.8

Europe	91.7	101.2	111.7	117.2	117.0	117.6	120.1	123.3	126.5
Americas	52.1	62.0	72.1	81.5	88.0	95.0	101.4	105.3	109.4

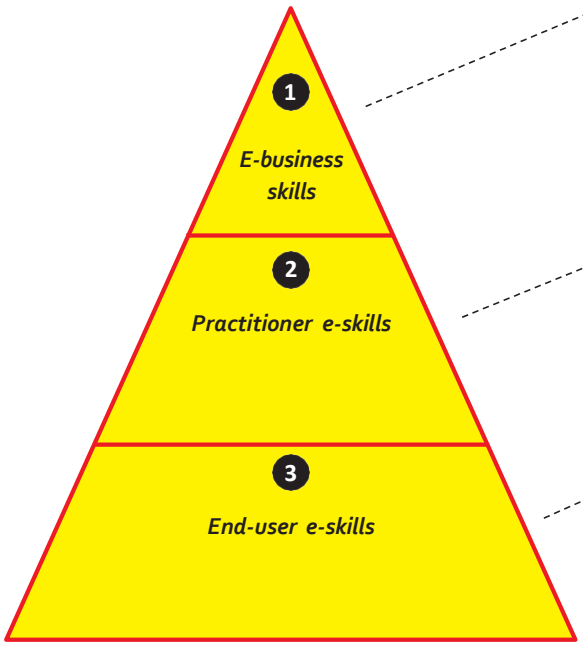
Source: ITU Statistics (www.itu.int/ict/statistics).

6. Conclusion

Africa must build its e-skills — and soon — to foster its economic growth and social inclusion. African leaders in Cape Town committed themselves to a connected future with fast-tracked broadband penetration of 80% of African citizens by 2020. Incidentally, Africa is now ringed by huge terabytes of optical fiber broadband capacity. The next challenge is to extend these capacities inland as arteries of "last mile" broadband access — necessary to ensure sustainable growth and prosperity, especially among the poorest of the poor and often through small and medium enterprises. However, such investment also needs to build the required e-skills, which are not only technological but also the more general skills of critical thinking and teamwork.

E-skills can be built in Africa through three main strategies: changing the education model (targeting teachers and boosting their ICT confidence); giving general training at African firms (which requires strong finances and investment in organizational change); and improving the capacity of citizens to acquire e-skills and develop more social applications. In this way, the potential that ICT offers Africa can be captured, helping the continent move from just consuming ICT to developing it.

Annex 11.1. The three groups of ICT skills (European Union)



1 E-business skills (e-leadership skills): These are capabilities needed to exploit opportunities provided by ICT, notably the Internet, to ensure more efficient and effective performance of different types of organizations; to explore possibilities for new ways of conducting business, administrative and organizational processes; and to establish new businesses.

2 Practitioner e-skills: These are capabilities required for researching, developing, designing, planning strategically, managing, producing, consulting, marketing, selling, integrating, installing, administering, maintaining, supporting, and servicing ICT systems.

3 End-user e-skills: These are capabilities required for the effective application of ICT systems and devices by the individual. At the general level they cover "digital literacy," which relates to the confident and critical use of ICT for work, leisure, learning and communication. In the workforce ICT users apply systems as tools in support of their own work. ICT user skills cover the use of common software tools and of specialized tools supporting business functions within industry.

References

AfDB (African Development Bank). (2013). Connecting Africa: An Assessment of Progress Towards the Connect Africa Summit Goals. Tunis.

Aker, J. C., and Mbiti, I. M. (2010). Mobile Phones and Economic Development in Africa. Journal of Economic Perspectives, 24(3), 207-232.

Aker, J. C., Collier, P., and Vicente, P. C. (2011). Is information power? Using mobile phones and free newspapers during an election in Mozambique. Review of Economics and Statistics, 99(2), 185-200.

Antonelli, C. (2003). The Economics of Innovation, New Technologies and Structural Change. Routledge, 208 p.

Askenazy, P., and Caroli, E. (2010). Innovative Work Practices, Information Technologies, and Working Conditions: Evidence for France. Industrial Relations, 49(4), 544–565.

Bailard, C. S. (2009). Mobile Phone Diffusion and Corruption in Africa. Political Communication, 26(3), 333–353.

Barak, M., Lipson, A., and Lerman, S. (2006). Wireless Laptops as Means for Promoting Active Learning in Large Lecture Halls. Journal of Research on Technology in Education, 38, 245–263.

Ben Youssef, A., Ben Youssef, H., and Dahmani, M. (2013). Higher Education Teachers E-Skills and the Innovation Process. International Journal of Computer and Information Technology, 2(2), 185–195.

Ben Youssef, A., Dahmani, M., and Omrani, N. (2012). Students' e-skills, organizational change and diversity of learning processs: Evidence from French universities in 2010. ZEW Discussion Papers 12-031, ZEW - Leibniz Centre for European Economic Research.

Ben Youssef, A., Dahmani, M., and Omrani, N. (2013). Information Technologies, Students' E-Skills and Diversity of Learning Process. Education and Information Technologies, 20, 141–159.

Ben Youssef, A., Hadhri, W., and M'henni, H. (2011). Intra-Firm Diffusion of Innovation: Evidence from Tunisian SMEs Regarding Information and Communication Technologies. Middle East Development Journal, 3(1), 75–97.

Ben Youssef, A., and Dahmani, M. (2008). The Impact of ICT on Student Performance in Higher Education: Direct Effects, Indirect Effects and Organisational Change. RUSC. Universities and Knowledge Society Journal, 5(1), 45–56.

Bresnahan, T. F., and Trajtenberg, M. (1995). General Purpose Technologies: Engines of Growth. Journal of Econometrics, 65(1), 83–108.

Bresnahan, T. F., Brynjolfsson, E., and Hitt, L. M. (2002). Information Technology, Workplace Organization and the Demand for Skilled Labor: Firm-Level Evidence. The Quarterly Journal of Economics, 117(1), 339–376.

Brynjolfsson, E., and Hitt, L. M. (2003). Computing Productivity: Firm-Level Evidence. The Review of Economics and Statistics, 85(4), 793–808.

Carvin, A. (2000). Mind the Gap: The Digital Divide as the Civil Rights Issue of the New Millennium. MultiMedia Schools, 7(1), 56–59.

Dalberg. (2013). Impact of the Internet in Africa: Establishing Conditions for Success and Catalyzing Inclusive Growth in Ghana, Kenya, Senegal and Nigeria.

Danielson, D. R. (2003). Transitional Volatility in Web Navigation. Information Technology and Society, 1(3), 131–158.

Dlodlo, N. (2009). Access to ICT Education for Girls and Women in Rural South Africa: A Case Study. Technology in Society, 31(2), 168-175.

EIU (Economist Intelligence Unit). (2009). E-Readiness Rankings 2009: The Usage Imperative. London.

Garicano, L., and Hubbard, T. N. (2009). Earnings Inequality and Coordination Costs: Evidence from U.S. Law firms. NBER Working Paper 14741, National Bureau of Economic Research, Cambridge, MA.

Garicano, L. (2010). Policemen, Managers, Lawyers: New Results on Complementarities between Organization and Information and Communication Technology. International Journal of Industrial Organization, 28(4), 355–358.

Gilster, P. (1998). Digital Literacy. London: Wiley. Graham, Mark. 2011. "Time Machines and Virtual Portals: The Spatialities of the Digital Divide.". Progress in Development Studies, 11(3), 211–227.

Helpman, E. (1998). General Purpose Technologies and Economic Growth. MIT Press.

Hollenstein, H. (2004). Determinants of the Adoption of Information and Communication Technologies. Structural Change and Economic Dynamics, 15(3), 315–342.

Ichniowski, C., Shaw, K., and Prennushi, G. (1997). The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines. American Economic Review, 87(3), 291–313.

ITU (International Telecommunication Union). (2012). World Telecommunication/ICT Indicators Database 2012. [E-resource, on CD-ROM and online]. www.itu.int/ITU-D/ict/publications/world/world.html

Joint Information Systems Committee of UK. (2011). Developing Digital Literacies: Briefing Paper in support of JISC Grant Funding 4/11. London. www.jisc.ac.uk/media/documents/funding/2011/04/Briefingpaper.pdf

Jonassen, D., Lee, C. B., Yang, C.-C., and Laffey, J. (2005). The Collaboration Principle in Multimedia Learning. In R. Mayer (Ed.), The Cambridge Handbook of Multimedia Learning (pp. 247–270). Cambridge University Press.

Keengwe, J., Onchwari, G., and Onchwari, J. (2009). Technology and Student Learning: Toward a Learner-Centered Teaching Model. Association for the Advancement of Computing in Education Journal, 17(1), 11–22.

Kwan, M.-P. (2001). Cyberspatial Cognition and Individual Access to Information: The Behavioral Foundation of Cybergeography. Environment and Planning. B, Planning and Design, 28(1), 21–37.

Larsson, L. (2002). Digital literacy checklist. http://depts.washington.edu/hserv/teaching/diglit

Lundberg, J., Castillo Merino, D., and Dahmani, M. (2008). Do Online Students Perform Better than Face-to-face Students? Reflections and a Short Review of some Empirical Findings. RUSC. Universities and Knowledge Society Journal, 5(1), 35–44.

Melville, N., Kraemer, K. N., and Gurbaxani, V. (2004). Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value. Management Information Systems Quarterly, 28(2), 283–322.

Mooij, T., and Smeets, E. (2001). Modelling and Supporting ICT Implementation in Secondary Schools. Computers and Education, 36, 265–281.

Nicol, D. J., and MacLeod, I. A. (2005). Using a Shared Workspace and Wireless Laptops to Improve Collaborative Project Learning in an Engineering Design Class. Computers and Education, 44(4), 459–475.

Okpaku, J. O. (2006). Leapfrogging into the Information Economy: Harnessing Information and Communications Technologies in Botswana, Mauritania and Tanzania. In L. Fox and R. Liebenthal (Eds.), Attacking Africa's poverty: Experience from the ground (pp. 149–176). World Bank.

Park, J., and Kim, J. (2000). Contextual Navigation Aids for Two World Wide Web Systems. International Journal of Human-Computer Interaction, 12(2), 193–217.

Rogers, E. (1995). Diffusion of Innovations (4th ed.). Free Press.

Saulnier, B. M., Landry, J. P., Longenecker, H. E., and Wagner, T. A. (2008). From Teaching to Learning: Learner-Centered Teaching and Assessment in Information Systems Education. Journal of Information Systems, 19(2), 169–175.

Schmidt, J. P., and Stork, C. (2008). Towards Evidence Based ICT Policy and Regulation: e-Skills. Volume ONE 2008 Policy Paper 3. Research ICT Africa.

Soby, M. (2003). Digital Competences: From ICT Skills to Digital "Bildung.". University of Oslo.

Solow, R.M. (1987). We'd better watch out. New York Times Book Review, 36, 36.

Steyaert, J. (2002). Inequality and the Digital Divide: Myths and Realities. In S. Hick and J. G. McNutt (Eds.), Advocacy, Activism and the Internet (pp. 199–211). Lyceum Press.

Tcheng, H., Huet, J. M., Viennois, I. and Romdhane, M. (2007). Telecoms and Development in Africa: the Chicken or the Egg? Convergence Letter, No 8.

Thijs, A., Almekinders, R., Blijleven, P., Pelgrum, W., and Voogt, J. (2001). Learning through the Web: A Literature Study on the Potential Uses of the Web for Student Learning. University of Twente, Faculty of Educational Science and Technology, Department of Curriculum.

van Deursen, A. J., and van Dijk, J. A. (2010). Measuring Internet Skills. International Journal of Human-Computer Interaction, 26(10), 891–916.

van Dijk, J. A. (2005). The Deepening Divide. Inequality in the Information Society. Sage.

von Hippel, E. (2005). Democratizing Innovation. MIT Press.

Yonazi, E., Kelly, T., Halewood, N., and Blackman, C. (2012). The Transformational Use of Information and Communication Technologies in Africa. World Bank.