

Savoirs communs n°17

Digital Services for Education in Africa

A photograph of two young African children, a girl on the left and a boy on the right, sitting at a wooden desk. They are both looking intently at a tablet computer. The girl is wearing a red t-shirt with Arabic calligraphy, and the boy is wearing a purple and black checkered shirt. The background is slightly blurred, showing other people in a classroom setting.

Agence Française
de Développement,
Agence universitaire
de la Francophonie,
Orange & UNESCO

Savoirs communs

The *Savoirs communs* series aims to stimulate exchanges and capitalize on the respective practices of AFD and other development assistance actors and foster joint learning and knowledge building.

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Digital Services for Education in Africa

This publication is based on the conclusions of a study group made up of representatives from development agencies, international bodies, NGOs, companies in the ICT or publishing sector, training institutions, which has met in various forms in recent years to consider the potential of information and communication technologies (ICT) for improving the quality of basic education in Africa.

The work of this group has in particular culminated in the holding in Paris in October 2012 of a seminar on “Public-private partnership pathways for accessing education and professional training through information and communication technologies (ICT) for education in sub-Saharan Africa”, which brought together some 60 decision-makers, representatives from African ministries and training institutes, donors, academics and private sector representatives from both the North and South.

It became clear at the end of the seminar that there was a need to take stock of the body of knowledge and experience available in sub-Saharan Africa on the educational ICT sector so as to build on and disseminate it.

Those who wish to participate in the continuation of these discussions can do so *via* the site <http://vstice.auf.org/>

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Foreword

*Agence Française de Développement (AFD), Agence universitaire de la Francophonie (AUF), Orange and United Nations Educational, Scientific and Cultural Organization (UNESCO) have produced this 17th edition in the *Savoirs communs* series.*

Sub-Saharan Africa, basic education, technologies and IT in schools are the core concerns of this work. For three years now, we have come together as an informal working group, along with other operators and businesses, to consider the potential of technology for improving the quality of basic education in Africa. This *Savoirs communs* gives a digest of our exchanges. It also reflects the initiatives and projects we have undertaken together or whose goals we share: experiments on the use of tablets in colleges in Niger, the use of mobile phones in the continuing training of primary teachers in Madagascar, assessing the standard competences teachers need in the field of technology, and participation in the annual UNESCO Mobile Learning Week.

From the early 2000s, the mobilization of the international community, and above all the efforts of African countries themselves, has brought about a spectacular improvement in access to basic education, even though serious inequalities remain – between States, between girls and boys, and between urban and rural areas. International thinking today is mainly focused on the transition between the phases of education, and on teacher training; priorities have shifted towards improving the quality of the education system and ensuring it functions as a continuum up to secondary level. This background is the subject of the first chapter.

Chapter 2 shows that there is a real digital revolution taking place. At the end of 2014, there are more mobile devices in circulation than there are people on the planet, and Africa accounts for almost 700 million mobile phone owners,

which is more than the United States and Europe. With a level of penetration already at some 70%, the most isolated regions will be opened up in the short term and services are becoming widely available that will change the lives of the inhabitants. For the moment, only 16% of Africans have an Internet connection – the lowest level in the world – but here, too, technological solutions are set to improve the situation in the medium term.

In developing countries, mobile learning is not necessarily dependent on an Internet connection. SMS text services and voice services now mean that bandwidth problems can be sidestepped. The third chapter describes the extraordinary proliferation of experiments involving information and communication technologies (ICT) in education. It is the uses that can be made of these technologies, and not the mere spread or mastery of the tools, that interest us here.

While aware of the problems, we are convinced that the potential for ICT in education is immense. The time for innovation and experiment will never be over, but the time is now for putting systems and strategies in place to take this to the next level, including by setting up player coalitions. That is the subject of the last chapter of this 17th edition of *Savoirs communs*. We hope you will enjoy reading it.

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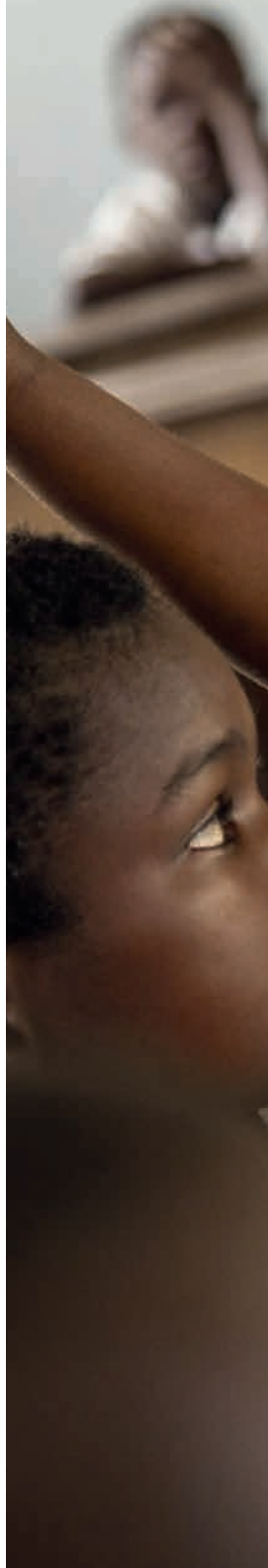
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1

The state of education in sub-Saharan Africa

Education, recognized as a universal right of each individual and an essential element in the economic and social development of nations, is evidently a key factor in the future of Africa. The UNESCO Constitution (1945) stresses the commitment of all States to *“full and equal opportunities for education for all”*. Today, after over a decade focused on access to universal primary education, there has been a gradual shift to take better account of the issues of the quality and equity of education, in view of the post agenda for the Millennium Development Goals.







1.1 | Major progress in access to education

INTERNATIONAL MOBILIZATION

The international community has mobilized substantial resources for education for all (EFA). At the World Conference held in Jomtien (Thailand) in 1990, delegates from 155 countries and representatives of some 150 organizations committed to promoting universal primary education and radically reducing illiteracy before the end of the decade. The World Education Forum, held ten years later in Dakar (Senegal), provided the opportunity to reiterate and reinforce this commitment for universal primary education. That initiative contributed to having education placed at the heart of the Millennium Development Goals in 2000 with their aim of achieving universal schooling (MDG2) and eliminating gender disparities, especially in

primary and secondary education (MDG3). In view of the encouraging results in terms of access to primary education, a fresh discussion was opened on the post-2015 follow-up to the Millennium Development Goals. Long centred round universal access to education, since 2010 the focus of the discussions has shifted, placing more emphasis on the quality and continuity of education, concentrating on social cohesion, the transition between stages, the post-primary debate and teacher training.

The mobilization of the various players – States, civil society, the international community, non-governmental organizations (NGOs) and the private sector – must not end in 2015. Quite the contrary, given the challenges that remain to be faced, efforts must be redoubled, especially in sub-Saharan Africa.



School in Koudougou
in Burkina Faso.

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BETTER USE OF FUNDS

With two thirds of its population aged under 25, universal access to education is still a major challenge for sub-Saharan Africa. It is not just a matter of making up for the delay in very many countries in providing access to education, but also of adapting to the huge rise in the numbers of pupils to be schooled, a result of strong demographic growth. Sub-Saharan Africa, which currently numbers 936 million inhabitants, has in fact seen its population grow by an average of 2.4% per year, making it the region with the highest population growth in the world: its population is set to exceed 1.3 billion people sometime around 2030.

Since the World Education Forum in Dakar (2000), considerable efforts have been made to respond to these new demographic challenges in terms of education. The amount of funds raised has been decisive. Between 1999 and 2010, public spending on education as a percentage of gross national product (GNP) increased by 5% per year in sub-Saharan Africa, with major variations between countries, with percentages varying from 1.8% in Cameroon to over 6% in Burundi (UNESCO, 2012). Today, governments in sub-Saharan Africa spend on average 18% of their total budget on education, against 15% in the rest of the world. Despite the scale of this mobilisation, disparities between States persist, often revealing shortcomings in the allocation of resources – operating costs account for too great a share.



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Last geography lesson of the school year given by the school principal in Kassombo (Democratic Republic of Congo).

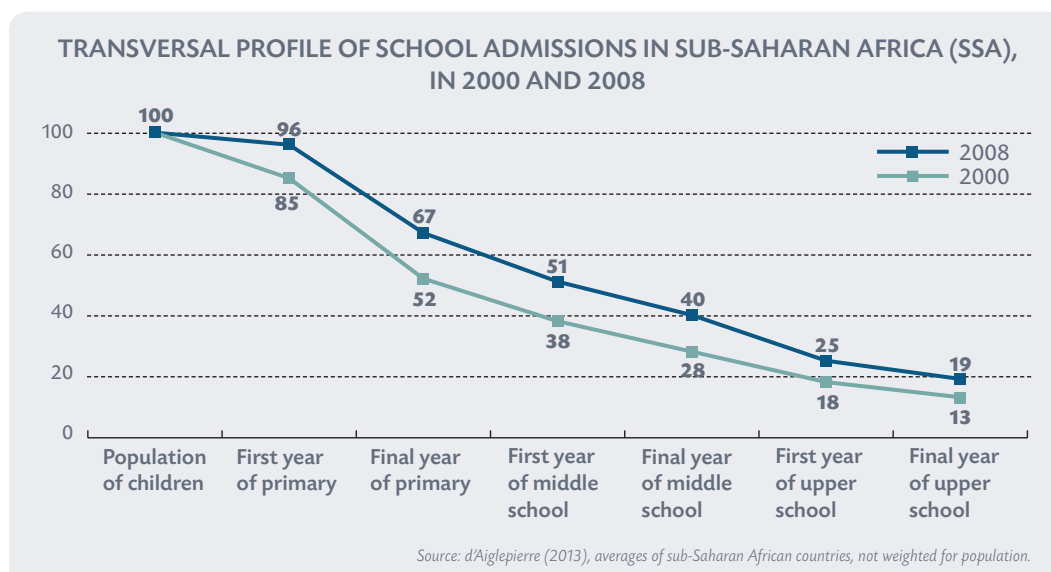
This increase in funding allocations has enabled some structural reforms to be made, such as the abolition of school fees in countries like Benin, Burundi, Mozambique, Uganda and the United Republic of Tanzania. This reduction in the costs of education for parents has often played an important part in facilitating access to primary school. At the same time, a number of policy reforms concerning teachers (status, remuneration and level of recruitment) have been implemented, resulting in a significant increase in the number of teachers, a precondition for universal access to education. In spite of this, village communities in many countries are still being called upon to recruit and pay teachers in the absence of any provided by the State.

ADVANCES IN UNIVERSAL SCHOOLING

In the years immediately after the Dakar Forum, the efforts made by States towards achieving EFA produced spectacular results

in sub-Saharan Africa. The greatest advance was in access to primary education, which governments had made their absolute priority. The number of children in primary school in sub-Saharan Africa thus rose from 82 million in 1999 to 136.4 million in 2011. In Niger for example, the number of children entering school increased more than three and a half times between 1999 and 2011 (UNESCO, 2012). In Ethiopia, over the same period, over 8.5 million more children were admitted to primary school. The net rate of first year access in sub-Saharan Africa has thus risen by 19 points in 12 years, from 58% in 1999 to 77% in 2011. Despite the considerable efforts, the latest available data from the UNESCO Institute for Statistics estimates that, for 2012, there were still 57.8 million children who were not in school. Of these, 29.6 million were in sub-Saharan Africa alone, a figure which has not changed for several years.

So, a number of challenges remain to be addressed if children are to stay in school. Primary education for all does not just mean universal access to school. It also presupposes that everyone completes his or her primary education. In 2012 the primary completion rate (PCR) – which measures the proportion of children reaching the final year of primary school – was 70%, meaning that more than three out of ten children entering primary school do not reach the final primary year.



Even though these are very substantial advances, access to and completion of secondary-level studies still pose problems.

The mobilization of funding and the structural reforms undertaken have enabled this huge increase to be addressed, in part, with a gross intake rate during the first year of secondary school at 49% in 2011, against 29% in 1999. Many sub-Saharan countries have notably included the first year of secondary school in basic education. In Rwanda, for example, the first year of secondary school was attached to primary education in 2009, which significantly increased the number of pupils enrolled at

this level of education (UNESCO, 2012). One of the countries to have benefited the most from this growth is Mozambique, where there has been a fivefold increase in its gross intake rate in secondary school according to the EFA 2011 monitoring report. Since most of the effort has for years now been focused on the primary stage, the loss of ground at secondary level is particularly severe. Thus, in 2008, out of a population of 100 children in sub-Saharan Africa, four never entered primary school, 29 abandoned their schooling at middle school (*collège*) level, 15 never went on to upper school (*lycée*), and six dropped out of upper school. All told, only 19 children continued

through to the final year of upper school. In addition, these averages mask huge disparities (urban-rural, gender). Indeed, according to the EFA 2013 report, 70% of the richest boys in urban areas completed the first year of secondary school in sub-Saharan Africa in 2010, against only 9% of girls from rural areas. A joint study by the World Bank and AFD (Mingat, 2010) carried out by Alain Mingat, Blandine Ledoux and Ramahatra Rakotomalala sought to anticipate the pressures that would be brought to bear on post-primary teaching. The study puts it this way: *“In the reference year (2005), our sample of 33 countries in sub-Saharan Africa had 14.9 million pupils enrolled in the first year of secondary school. If the rate of completion of the primary stage reaches 95% by 2020 with levels of transition from primary to the first year of secondary maintained at their current level in each country, the first year of secondary school would have 37.2 million pupils in 2020, or 2.5 times the current number. If all the pupils finishing primary school could continue with their education, the number of pupils in the first year of secondary school would reach 62.9 million by 2020, a multiplication by 4.2 over the period.”*

We see that the goals of universal access to education remain difficult to achieve. On the one hand, school structures are not yet capable of accommodating all the pupils, as the existing models do not allow for huge increases in numbers. Moreover, some families cannot afford to send their children to

middle school because of the high cost. Also, if those pupils are not going to school, they can work and help their families financially. Lastly, even though sub-Saharan Africa has been experiencing very strong economic growth for some years now, the number of jobs being created is not enough to absorb the students coming out of secondary school. Consequently, there are still a number of challenges to address.

ENORMOUS DISPARITIES BETWEEN THE COUNTRIES

Behind the regional averages, there are still enormous disparities between the countries, and even between the different zones and regions within countries, which means that it is not possible to *“[...] identify conditions that apply uniformly to education across the different countries of sub-Saharan Africa”* (Mingat, 2010).

The constraints the countries face are far from uniform. While some countries have lower demographic growth, others enjoy a more satisfactory level of school enrolment. Only a few countries are falling seriously behind in education at the same time as having to address a steady growth in their school-age population: Niger, Eritrea, Burundi, Guinea-Bissau, Uganda and to a lesser extent Burkina Faso, Chad, Mali, Mozambique, Rwanda, Senegal and Malawi are particularly affected by this dual constraint.

COMBATING ILLITERACY

Despite the progress achieved in sub-Saharan Africa, illiteracy is still a major issue. The rate of literacy has not improved enough to compensate for the effects of demographic growth. As a result, the number of illiterate adults has risen by 27% over the last 20 years, reaching 169 million in 2010 (UNESCO, 2012). Thus, out of the 775 million illiterate adults in the world in 2010, more than one fifth were in sub-Saharan Africa – in other words, 20% of the adult population. The countries with the lowest levels of literacy in the world are also concentrated in this region. These include Niger (28.7%), Burkina Faso (28.7%), Mali (33.4%), Chad (35.4%) and Ethiopia (39%), where adult literacy rates are well below 50%. There are, however, certain exceptions, like Equatorial Guinea, with a literacy rate of 94%. In order for children to learn, they need to grow up in literate surroundings. That is why adult literacy is a precondition for ensuring quality education for children, as the objectives of the Dakar Forum pointed out.



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Pupils from a school in Mauritania.

The EFA 2012 report highlights great disparities between the sub-Saharan African countries: the percentage of children excluded from primary school is only 7% in Gabon and 14% in Congo compared to over 55% in Burkina Faso and Niger (UNICEF, 2014). The gap in terms of the proportion of those excluded from the first year of middle school is even wider, with 6% in Gabon compared to 68% in Burkina Faso and 73% in Niger. It is, therefore, often inappropriate to speak of sub-Saharan Africa as if it were a homogeneous whole: there are differentiating factors that explain the major regional disparities, such as political instability, a preponderance of rural areas, the importance of social origins, the social structure, and so on.



1.2 | Additional difficulties: political instability, territorial disparities and gender

POLITICAL INSTABILITY HOLDING BACK EDUCATION

The majority of out-of-school populations are to be found in countries where there is conflict or very weak governance. At the Dakar Forum, the 181 signatory countries of the Dakar Framework for Action identified armed conflict as well as internal instability within a country as “a major barrier towards attaining Education for All” (EFA) – education being one of the sectors to suffer most from the effects of armed conflict and political instability. In the 2011 EFA Global Monitoring Report, UNESCO pointed out that the countries touched by conflict showed a gross rate of secondary school admissions

almost 30% lower than countries of equivalent revenue that were at peace. Conflicts also have an impact on the rate of literacy of the population. At the global level, the rate of literacy among adults in countries touched by conflict was 69% in 2010 compared to 85% in peaceful countries. Twenty States in sub-Saharan Africa have been touched by conflict since 1999 (UNESCO, 2011). Those countries affected by armed conflict, such as Somalia and the Democratic Republic of the Congo, are furthest from meeting the EFA goals and contain the majority of the unschooled inhabitants of sub-Saharan Africa. In the Democratic Republic of the Congo, in North Kivu, a region particularly affected by conflicts,



Lessons under a tree for Samburu children in Kenya in a community education centre from the “Loipi” project for early childhood care.

© UNESCO / Sam Dhillon

for example, the likelihood of young people aged between 17 and 22 having had only two years of schooling was twice the national average.

THE MARGINALIZATION OF POORER POPULATIONS

In sub-Saharan Africa, living in a rural area remains an additional barrier to access to education: it is more difficult to recruit and retain teachers there, logistical issues make it difficult to build and maintain schools, living conditions are more precarious and the pressure for children to do domestic or agricultural work is very strong.

In Ethiopia, over 30% of rural children had never been to school in 2011, while the figure in urban areas was only 10%. In rural communities the children most affected by this phenomenon are poor young girls, almost 45% of whom have never attended school compared to just 8% of the wealthiest boys. In addition, children living in rural areas who succeed in following a school course achieve, on average, results that are below those in urban areas, mainly in languages and mathematics. This gap can be explained, among other things, by their parents’ illiteracy and the tendency for children in rural areas to be involved in domestic and farm work during times that were normally for education.

PERSISTENT INEQUALITIES BETWEEN BOYS AND GIRLS

Gender parity in education is a long way from being attained in sub-Saharan Africa where 54% of children not in school are girls and over 60% of the illiterate population are women. This observation applies to both female pupils and female teachers, who are underrepresented in the educational institutions. Of the 17 countries with the lowest Gender Parity Index (GPI) in 2010 in primary teaching (GPI of less than 0.90), 12 were in sub-Saharan Africa. Furthermore, while the region has seen steady improvement in gender parity since 1999 in primary education, in secondary education it has stalled. The disparities between countries are equally great. Burundi, Gambia, Ghana and Uganda reached gender parity between 1990 and 2010, and Ethiopia and Senegal have made considerable progress in the last ten years. By contrast, gender inequality in education has worsened in Angola and Eritrea (UNESCO, 2012).

Girls also spend a shorter time in school than boys (educational life expectancy of 8.7 years in 2011, against 9.9 years for boys). This disparity can be explained by the fact that girls often have to leave school to look after their families or because of early marriage. In addition, the absence or dilapidated state of toilet facilities available to girls is another reason why some of

them stop going to school, with one girl out of every ten in Africa not attending school during her menstrual period.

Quite apart from the problems of literacy and access to education, girls are rarely treated on an equal footing with boys in the school system. The 2008 EFA Global Monitoring Report (UNESCO, 2008) reveals that a study conducted in rural schools in Kenya, Malawi and Rwanda showed that teachers tend to be less demanding of their girl pupils. The social representations conveyed within school *via* teaching material also play a role: in addition, to sexist prejudices, a second study conducted in Cameroon, Côte d'Ivoire and Togo, and described in the UNESCO report, highlighted the fact that mathematics books depicted 30% fewer female than male characters.



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Pupil doing his homework in a classroom in the Democratic Republic of Congo.



1.3 | The challenges of education and its organization

Aside from the state of health and the living conditions of the children, which are essential prerequisites for learning, the quality and performance of teachers needs to be improved. Less than half the children in sub-Saharan Africa can neither read nor write: a quarter of primary school age children reach the fourth year without having acquired the basics and over a third do not reach the fourth year. It is therefore indispensable to ensure that, when pupils embark on the different stages of their schooling, they really can acquire the knowledge desired.

THE QUALITY OF EDUCATION

The democratization of education has to be accompanied by radical reform of the educational systems. The increase in pupil numbers

could otherwise produce negative effects on the quality of the teaching on offer. In fact, according to the 2010 EFA Global Monitoring Report (UNESCO, 2010), *“millions of children are leaving school without having acquired basic skills. In some countries in sub-Saharan Africa, young adults with five years of education had a 40% probability of being illiterate”*. The teacher training systems are generally not able to meet the quantitative and qualitative needs of training. In Chad, for example, only 35.5% of teachers are certified to teach. In order to pursue the policy of universal access to education and improve the acquisition of skills that will enable children to continue to develop on their own, countries must strengthen the competences both of novice and existing teachers.



Teacher training
in Madagascar.

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■ Tools dedicated to monitoring the quality of teaching

For about ten years now, several national survey systems have been implemented to measure the quality of learning achievement. For example, the SACEMEQ (Southern and Eastern Africa Consortium for Monitoring Educational Quality) and PASEC (CONFEMEN's Program for the Analysis of Education Systems) programs assess and analyze the qualitative performance of education systems in English-speaking and French-speaking Africa, respectively.

On the basis of these data, several studies conducted by CONFEMEN (Conference of Ministers of Education of French-speaking countries) highlight a decline in the quality

of academic achievement. Pupils' scores in reading and mathematics tests indeed fell between the 1990s and 2000s. This fall in the level of pupils could partly be explained by the reforms conducted in favor of universal primary education and the massive increase in pupils in schools, in particular from disadvantaged families.

■ The "teacher challenge"

The democratization of education and population growth automatically create a need for more teachers.

According to one of the main analyses conducted on the subject in recent years, in 2009, UNESCO considered that the goal of universal primary education for all would require over

2 million additional teachers to be trained at international level by 2015. At the time, sub-Saharan Africa alone accounted for over 55% of this demand, *i.e.* 1,115,000 teachers. Needs in respect of the recruitment of teachers stood at around 350,000 a year (UNESCO Institute for Statistics, 2011).

In addition to these recruitment issues, there is also the question of training these teachers, which is essential for quality education to ensure a strong acquisition of knowledge by pupils.

Given the budgetary pressure on public finances that this demand for teachers implies, governments have been forced to rethink their policies on the recruitment, training and remuneration of their teachers. The choices to be made are even harder because many African States – particularly the French-speaking ones – have been influenced by the teaching system in place during the colonial period, in which teachers' status and remuneration were aligned with the policies of the former colonial power.

Following the first "macroeconomic" structural adjustment policies, which led to a decrease in salaries without new recruitment waves being conducted, the further declines in labor costs from the 2000s onwards were combined with a proactive recruitment policy. Differentiated strategies were adopted by countries in the

region, based more on political will than simply on the economic situation of States.

The structural adjustment policies of the 1980s and 1990s – and the consequent reduction in public funding – initially led to a deterioration in learning conditions, in particular due to the increase in pupil/teacher ratios in the classroom. Various solutions were subsequently experimented in an effort to reconcile the democratization of access to education, the quality of teaching, and the management of budget constraints. Consequently, shorter teacher training periods were established, particularly in French-speaking Africa, which reduced salary costs and increased the rate of training. States have also often decided to recruit teachers with a lower level of initial training. However, it is today essential to support them with in-service training.

In a context whereby many States were not in a position to train and/or recruit a sufficient number of teachers with civil servant status in order to meet needs, new recruitment methods, based on the status of alternative, non civil-service teachers – contract or community teachers –, have emerged in sub-Saharan Africa. Indeed, contract teachers have a lower level of remuneration and social coverage than teachers with civil servant status (UNESCO, 2010), while community teachers are generally paid by communities. The in-service training of these teachers is also a crucial issue.

As the Dakar Pole points out, *“while satisfying the requirements in terms of new teachers needed to attain universal primary schooling means, for many countries, keeping up the pace observed over this very recent period, an obvious question arises: how long can these new pay policies be maintained and what are the long-term economic, social and educational consequences?”* Despite these efforts and the steady growth in the numbers of teachers recruited, the average number of pupils per teacher has risen in recent years from 42 to 43 (UNESCO, 2012).

■ **Lack of access to quality educational materials, for teachers and pupils alike**

The lack, or poor quality, of teaching materials (especially textbooks), which often goes hand in hand with an unfavourable school environment (weak or inadequate infrastructure, over-full classrooms, etc.), is also to blame for the problems many African countries are experiencing in meeting the EFA goal. As pointed out by CONFEMEN *“it is recognized that when pupils have textbooks, there is a significant impact on school achievements in the majority of the countries studied. Indeed, several studies, including those of PASEC, show that having books available at home increases a pupil’s score by about 6% above the average, while the availability of mathematics and French books used in class increases them by 18% above the average.”* Consequently, the impact of educational inputs is decisive in improving

learning. However, the limited number of textbooks available to teachers makes them careful to prevent loss or damage, so very few pupils have individual access to textbooks in class or at home.

School books are still very little used in sub-Saharan Africa. According to one SACMEQ study, nearly 50% of pupils in their 6th year of school in Kenya, Malawi, Mozambique, Uganda, the United Republic of Tanzania and Zambia who were questioned said the classrooms where they studied did not possess a single book. Likewise, at the regional level, 25 to 40% of teachers said that they did not have any teaching materials relating to their subject (UNESCO, 2008). This can be explained, among other things, by the weakness of the textbook industry in sub-Saharan Africa, the poor storage conditions and the high proportion of books that are lost or damaged. In some countries, the percentage of school books that are imported is almost 80%, though these are usually more expensive than the ones produced locally.

Some countries have devised interesting solutions, such as found in South Africa, Botswana, Ghana and Uganda, which have set up a common core of programmes for all pupils in their first year of secondary school. The textbooks are therefore common to a number of classes, which makes it easier for more pupils to have access to them (Hoppers, 2008).



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Teacher training
in Madagascar.

DIRECTION AND GOVERNANCE OF EDUCATION SYSTEMS

■ The need for a good information system

The lack of data on education management limits the scope for clear diagnostics and political decision-making. The data on rates of school enrolment by educational level, literacy, teaching staff and even public spending on education are often sparse and incomplete, which makes it difficult to assess the progress that has been made in education and the prospects for achieving EFA.

■ Teacher monitoring

The functioning and quality of school systems could be improved by reducing the level of teacher absenteeism and increasing the amount of time actually spent in learning at school. The average total number of hours actually spent teaching pupils in sub-Saharan Africa is indeed significantly lower than the world average. The average total number of hours actually spent teaching pupils in sub-Saharan Africa is indeed significantly lower than the world average (700 hours per year in the first and second school years, 750 hours in the third year and 810 hours in year six), representing some 200-300 lesson hours lost compared to the official timetable (UNESCO, 2008).

According to the SACMEQ and PASEC studies, many schools in Africa fail to adhere to the official number of hours prescribed for the school year due to delays in assigning teachers, absenteeism, the high level of teacher rotation, and the time devoted to administrative tasks. This finding is more pronounced in rural areas and in those countries with the highest need for teachers.

Teacher absenteeism and lack of motivation can be real obstacles to quality teaching. In one World Bank study conducted in 2002-2003, unannounced inspections were carried out during opening hours in schools in several Southern countries, which revealed high rates of absenteeism. In Uganda, 27% of the teachers were absent at the time of the surprise visits (Chaudhury, 2006).

Furthermore, **not all the time teachers spend in school is actually devoted to teaching.** In most developed countries, 80% of school time is in fact devoted to instruction (Abadzi, 2006). However, that level of performance is rarely attained in sub-Saharan Africa. In Ethiopia, for instance, the time children spend in class in practice is one third of official school opening hours (Destefano, 2009). The time spent on administering the class (taking the roll-call, handing out books and settling the pupils down) can occupy up to 30% of classroom time.

Consequently, one of the challenges lies in maximizing the time actually dedicated to teaching compared to the time spent at school.

Education for all remains a major challenge in sub-Saharan Africa, both per se and in terms of the effects education has on other areas of life. Thus, the development of primary schooling (which results in better-educated mothers) is key to improving the health of mothers and their infant children in sub-Saharan Africa.

That said, the very fast emergence and penetration of information and communication technologies (ICT) over the past few years give a glimpse of great promise and potential in the field of education.



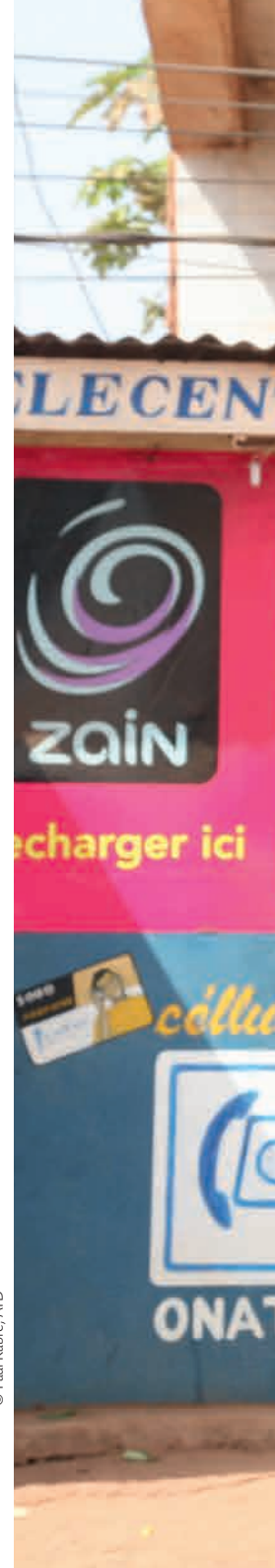
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Management tools used by a primary school headmaster in Madagascar.

2

ICT, a potent factor for development in sub-Saharan Africa

While before the 2000s, a minority of people had access to means of communication, such as a landline or mobile phone, the mobile phone is today an integral part of daily life for the great majority of them. While not ignoring the inequalities between countries, and even between urban and rural areas within any country, it must be acknowledged that the rapid spread of mobile technology has contributed to economic and social development. The availability of services on mobile devices has, for instance, had a beneficial impact in terms of farm productivity, health and safety, access to education for those who were hitherto excluded, continuing training for teachers in rural areas, access to financial services and improving the road infrastructure.



© Paul Kabré, AFD

In Burkina Faso, a telecentre,
a retail outlet for phone top-ups.

TRE DE L'ESPOIR



le cartes

laires



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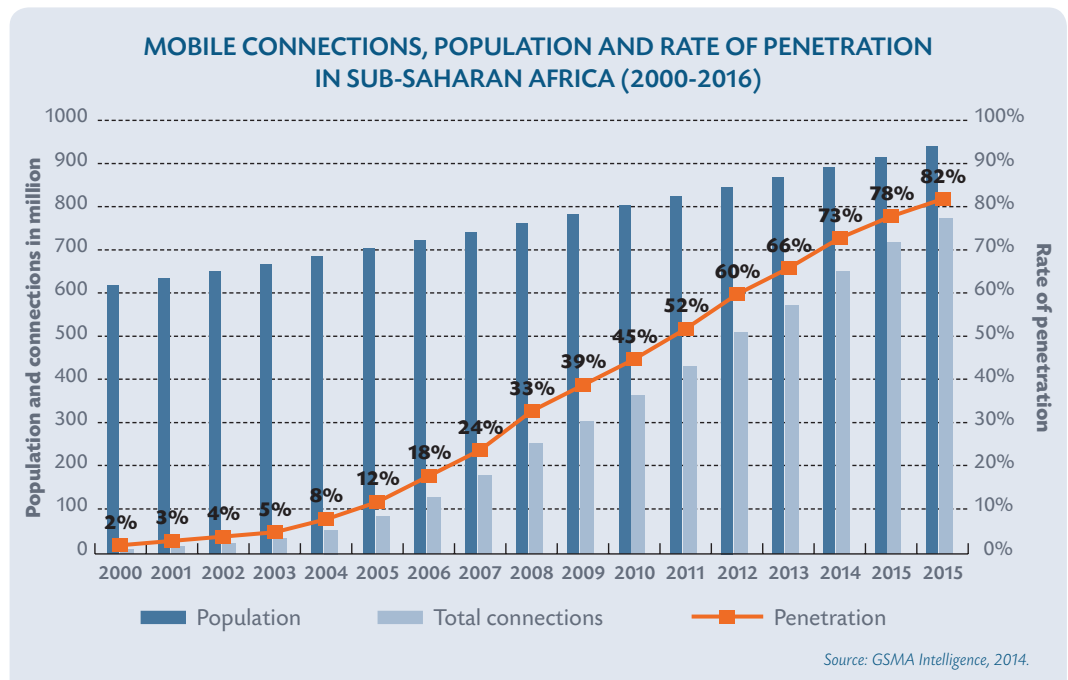




2.1 | The rapid spread of mobile devices in Africa

For more than a decade, the mobile telephony market has seen huge expansion worldwide. The spread of this technology has been particularly swift in sub-Saharan Africa. It has taken less than ten years for the vast majority of Africans to adopt the mobile phone. If the rate of penetration of the mobile is still

20 points behind that observed in developing countries as a whole (70% compared to over 90% by 2014), the African continent today numbers 650 million mobile phone holders, which is more than the United States and Europe (ITU, 2013).





In Kenya, a young Maasai girl reading on an Android phone.

© Jon MacCormack for Worldreader

FALLING PRICES AND A FAVOURABLE ECOSYSTEM

The expansion of the mobile telephony market in sub-Saharan Africa can be explained on the one hand by the fall in the cost of communications (due to competition between the telecoms operators driven by a favourable regulatory climate) and, on the other, by the fall in prices of mobile terminals (due to economies of scale and technological advances).

According to several studies, the complete liberalization of the mobile telephony market would result in a 90% fall in the average price of communications, while

partial liberalization would produce a fall of 30%. By way of illustration, the International Telecommunication Union (ITU), in its report *Measuring the Information Society*, noted a drop of around 23% between 2008 and 2009 for a basket of standard mobile services (voice and SMS) in Togo, 18% in Rwanda and 16% in Madagascar. In 2014, the operator Vodacom, a subsidiary of Vodafone, stated that it had reduced the average actual price per minute of voice communication in South Africa for prepaid options – generally speaking the option most widely used by low income groups – by 25% in 2013 and 50% over the last three years, after prices had already fallen markedly throughout the previous decade.

On the second point, according to Moore's law, either the price of mobile telephones will be halved or their power will be doubled every 18 months. For instance, in Ghana, Nigeria and South Africa, mobile phone prices fell by an average of 20% between 2009 and 2011 (these three countries accounting for 40% of telephone connections in sub-Saharan Africa). A basic telephone today costs no more than US\$10. The same trend can be seen with smartphones.

In addition, the range of models sold in sub-Saharan Africa is subject to variations depending

on the socio-economic environment of each country. While almost 10% of the telephones sold in Africa can take two SIM (Subscriber Identity Module) cards, enabling choice between the tariffs of the various operators, who charge more for a connection outside their own network, the rate is close to 25% in Ghana and 30% in Nigeria – this has an effect on the rate of single subscription users, which was a mere 50% for Africa in 2013. Certain brands also offer the option of creating a number of repertoires to make sharing of telephones, a very common practice in Africa, easier (Chéneau-Loquay, 2012).

EXPANSION OF THE INFORMAL SECTOR IN MOBILE TELEPHONY

The very swift expansion in mobile telephony has proved a major factor for job creation in Africa. By 2012, over 5 million Africans were employed directly or indirectly in the mobile telephony sector. Most of those jobs nonetheless fall within the informal sector.

A cluster of minor trades has emerged in recent years to fulfil the need of retail customers for local services. From importing the products to renting mobile phones by the minute, street trading and decoding mobile phones, a whole slew of services has come into being to compensate for the technical or financial shortcomings of the users. According to Annie Chéneau-Loquay (Chéneau-Loquay, 2012), the

main reason for the expansion of the informal sector in mobile telephony is a combination of institutional and social factors: *“Responding to the social demands of a poor population seeking to keep its spending to a minimum is the essential factor that generates a need for these services, which open up employment possibilities for a population that is young and relatively educated. [...] The inadequacy of the States, which are powerless to track these activities and put a halt to fraud, makes it possible for informal or even unlawful businesses to survive. But the complicity or even involvement of the formal sector in the informal economy provides fertile ground for the creation of such businesses and even encourages it.”*

A shopfront in Ouidah, Benin.
A fishmonger's can sell mobile
phone top-ups and rent out chairs...



© Marianne Donnat, IRD

In the same time frame, obstacles in the form of lack of electricity grids and hardware maintenance have been sidestepped. Over 350 million people in sub-Saharan Africa without electricity live in areas covered by the mobile network. Solar solutions also

offer alternatives unheard of before, both for recharging terminals and providing a power supply for radio stations and the operator's relay masts. Meanwhile, the local population now maintains the mobile terminals.

MAJOR DISPARITIES BETWEEN COUNTRIES AND REGIONS

While the estimated rate of penetration of SIM cards at the end of 2014 is 162% in South Africa and 182% in Gabon, because of the widespread practice of using more than one SIM card (the average is two per person), ten countries still show a rate of less than 50% and even 30% in the case of Djibouti, Madagascar, Niger, Ethiopia and Burundi.

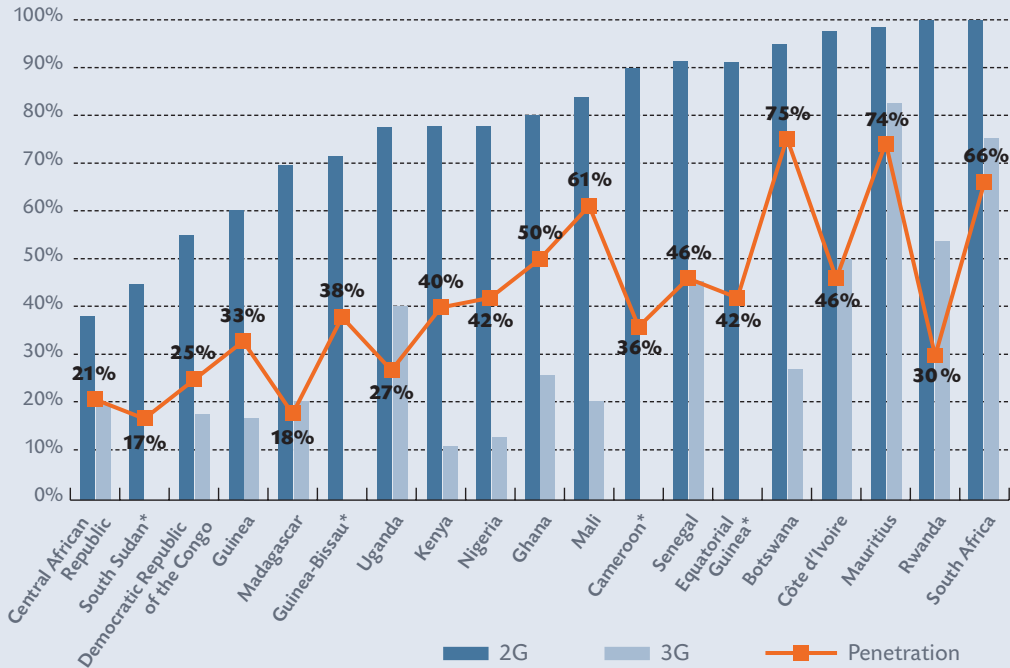
The factors influencing development, described above, have played out in different ways from one country to the next. The Global System for Mobile Association (GSMA) highlights, for instance, the lack of clarity in tax and regulatory provisions, the high cost of licences and the high rates of duty on imported mobile phones. Besides these, in some countries, the low rate of mobile penetration can also be put down to the high percentages of people living in rural areas, where there is a lack of network coverage and where many people also have low purchasing power. The ITU thus notes that while almost 90% of the urban population had mobile network coverage by 2006, the level was only 41% in rural areas (PROPARCO, 2009). That said, universal network coverage does not necessarily translate into mobile phone ownership for the majority of the population, as can be seen from Rwanda, all of which has 2G coverage, but only 30% of whose population are subscribers. Despite the significant fall in

prices, the mobile phone remains out of reach of the poorest populations. In Nigeria, the price of the cheapest mobile phone would feed a family of five for five days (AFD, 2010), and spending on communications per subscriber still accounts for 16% of gross domestic product (GDP) per capita, a much higher proportion than for other developing regions (3-5%) or Europe and the United States (1%).

Much remains to be done in extending the 2G network into certain enclaved rural areas or landlocked countries, and to make the services accessible to the population segments at the base of the social pyramid, while at the same time a strong demand is already emerging for access to the broadband mobile network (3G and above) and the services associated with it. The challenges this presents are similar to those of the previous generation of technology. Thus there are still too many countries offering weak or non-existent coverage enabling Internet access or high-speed data transfer.

In the next few years, the expected massive growth in the telecommunications sector could prove to be a positive driver of economic growth and employment.

**2G AND 3G MOBILE NETWORK COVERAGE (AS % OF THE POPULATION)
AND RATE OF PENETRATION OF SUBSCRIPTIONS IN SUB-SAHARAN AFRICA
(FOURTH QUARTER, 2013)**



In the Central African Republic, the 2G network covers 38% of the population and the 3G network 19%. 21% of the population has at least one SIM card (we call them "mobile subscribers").

*Data for 3G coverage not available.
Source: GSMS Intelligence, 2014.

THE CHALLENGE OF COVERAGE IN RURAL AREAS

Though there has been a huge increase in urbanization, only 40% of Africans currently live in a city. The people not served by the GSM network and not equipped with mobile phones are concentrated in the rural areas, and this has an impact on economic growth. These “dead” zones can mainly be explained by the fact that the telecoms operators are faced with low population density, low purchasing power, lack of electricity and high logistics and maintenance costs. To give one example, the energy bill represents only 15% of the costs of running a radio station in the most developed countries, but fuel for a diesel generator sometimes means that in Africa it can be almost 50%. The use of pylons is more frequent there, involving very heavy civil engineering costs, which can account for more than half the cost of equipping a site. The base of potential customers that would enable the investment and operating costs to be amortized proves in many cases to be too small to allow any return on investment.

There is, of course, a variety of technical solutions that one can try to adapt more or less well to rural areas. But, in the absence of data at the village or commune level on the topography, infrastructures, number of inhabitants, their purchasing power and geographical spread, it remains difficult to identify the optimum

technical solution to provide the least costly network coverage. This goes part of the way to explaining why the operators are hesitant about investing.

Nonetheless, it is sometimes difficult to make these solutions economically viable. Whereas, in the past, infrastructure development was essentially supported by private investment, bringing the rural enclaves in sub-Saharan Africa within digital coverage will require original methods of financing to be brought to bear *via* public-private partnerships (PPP) and/or infrastructure sharing, as was done with the Madagascar telecommunications infrastructure project (PICOM). Hence, at a meeting of the GSMA held in 2013, eight of the main operators present in Africa (Airtel, MTN, Etisalat, Ooredoo, Orange, STC, Vodafone and Zain) announced their intention to share their network infrastructures in Africa and the Middle East and extend their services into remote areas. Unless there are new advances that revolutionize the current cost structure, public-private cooperation or cooperation between operators will be a necessity in order to extend coverage.

THE PROMISE OF MOBILE INTERNET

The number of Internet users in sub-Saharan Africa is well below the world average, and still a long way behind Asia and the Pacific and the Arab world. In 2014, according to the ITU,

TOWARDS NEW WAYS OF BRINGING INTERNET ACCESS TO ENCLAVES?

Google balloons

In June 2013 Google announced the launch of a new programme designed to facilitate Internet access in those areas of Africa that are enclaves. Known as LOON, this project consists of sending huge inflatable balloons into the stratosphere, thus guaranteeing Internet connection over the entire continent. According to Google, these balloons, inflated with helium, equipped with electronics and fuelled by energy from photovoltaic panels, can be sent as high as 20 km in altitude. With antennae linked to receivers on the ground, they bring Internet connections to far-flung regions of Africa.

Facebook drones

In March 2014, the social network announced the setting up of its "Connectivity Lab" after it acquired the Titan Aerospace company, a manufacturer of solar energy drones. The "atmosats" drones function like satellites, suspended close to the Earth. They will act as relays to allow isolated populations to access the Internet. In fact, Facebook is one of the first investors in the "Internet.org" project, which aims to connect to the Internet the two thirds of the world's population who for want of financial and material resources do not have it.

The ABSOLUTE European project

As part of a European project, which received the "best paper" prize for potential in this field of research at the 5th International Conference on Personal Satellite Services, in October 2012 a consortium led by the Thales group developed a rapid-deployment wireless communication network, intended for use in unexpected events, emergencies and disasters. "ABSOLUTE" (Aerial Base Stations with Opportunistic Links for Unexpected & Temporary Events) aims to design and validate a network capable of supplying secure and resistant flexible broadband services. The system works by integrating various radio technologies allowing a mix of communications in a specific area. "ABSOLUTE" will build an LTE-A (mobile communication standard) base station integrated into a low-altitude platform, enabling broadband services to cover an extended area. Although it was originally intended for use in emergency situations, the project could open up the possibility of additional coverage in Africa.

only 19% of Africans had Internet access, half as many as in Asia. This low level goes hand in hand with Internet penetration in households of only 11%, against almost 36% in the Arab countries, for instance. At the same

time, while on average 28% of households in developing countries are equipped with a fixed, portable or tablet computer, the figure for sub-Saharan Africa is only 8%.

This delay is not without implications for the weakness of the ICT Development Index (IDI) and the development potential of the economy as a whole, as we will see below. Thus, on a scale of 1 to 10, sub-Saharan Africa achieved an average overall score of only 2 in 2012, against 3.94 in the Arab countries and 6.73 in Europe (ITU, 2012). The high cost of connections and terminals giving access to data compared to the purchasing power of the people, the weakness of electricity and wire or mobile telecoms infrastructures also account for this delay. Nonetheless, there have been some notable changes.

On the one hand, while the level of access to cable Internet in sub-Saharan Africa is still low in absolute terms, it is growing at a considerably faster rate than in other regions in the world. Between 2009 and 2013, the level of high-speed fixed Internet penetration in households showed annual growth of 27%, against an average of 15% in Asia and the Pacific and the Arab world. In absolute terms, sub-Saharan Africa numbers almost 3 million fixed broadband Internet subscribers in 2014.

On the other hand, the level of penetration of high-bandwidth mobile has also grown significantly, from nearly 2% in 2010 to 19% in 2014, with 172 million subscriptions. According to several analysts, Internet accessibility *via* the mobile network now offers an alternative

to the low growth in cable Internet, and the region is thus in catch-up mode *vis-à-vis* Asia and the Arab countries, which this year showed growth of 22% and 19% respectively (ITU, 2014). Demand for Internet access on the terminal side is fuelled by extremely high growth in the use of 3G keys or smartphones. Smartphone penetration levels are set to reach 20% in sub-Saharan Africa by 2017.

THE AFRICAN CONTINENT IS CONNECTED

Since 2009, the connection of the African continent using fibre optics has been moving forward apace, though the pattern is still very disparate. The West Africa Cable System (WACS) was one of the first projects for connecting the continent *via* the development of a submarine cable. Built by the Alcatel-Lucent Group, the cable starts from France and extends around the West African coast for more than 14,000 km. Since becoming operational on 11 May 2012, the cable has linked 10 African countries by fibre optics, thus giving a fresh boost to the roll-out of high-speed Internet on the continent, while strengthening its international connectivity. In addition, the prospects for development of the WACS are substantial. As an example, the speed of the connection is set to reach 5.12 Tbit/s in the next few years, compared to 500 Gb/s today.



© AUF

Mobile phone used for the integrated mobile learning programme in Madagascar, initiated by IFADEM, in partnership with Orange and AFD.

At the same time, the African Coast to Europe (ACE) undersea cable, also put into service in 2012, links France to the West African coast, thus strengthening the connection put in place by the WACS. At 17,000 km long, ACE is set, over time, to connect 18 African States (most of them coastal, but also some landlocked States like Mali and Niger) by fibre optics. Of these countries, seven will be getting an international high-speed cable connection for the first time. One of the major cables in terms of speed, ACE has a maximum peak capacity of 5.12 Tbit/s, equivalent to a load of 370 million simultaneous telephone communications.

Finally, the South Atlantic Express (SAEx) submarine cable, expected to come into service in 2014, is made up of four fibre optic cables, each with a capacity of 3.2 Tbit/s, that will link South Africa and Angola to Brazil (Fripp, 2012).

These undersea cables will at the same time strengthen the connectivity of sub-Saharan Africa and also, in the short or medium term, trigger a drastic fall in the cost of high-speed connections, by bringing down the cost of international broadband.



2.2 | ICT for economic and social development

Various studies have measured the link between the spread of the mobile phone and economic growth. While the level of mobile penetration has gone from 1% to almost 75% in barely 15 years and the wire network remains inaccessible to the vast majority of the population, mobile-based communication services have had a significant impact on development in sub-Saharan Africa. The latest results (Deloitte, 2012) for this region indicate that for each increase of 10 percentage points in mobile penetration there is a corresponding average 1.4 point increase in economic growth, with a huge impact in countries like Rwanda (+ 5.1%), the Democratic Republic of the Congo (+ 4.6%), Madagascar (+ 3.5%), Mali (+ 3.2%) and Togo (+ 2.3%). Since most

Internet access in Africa will be provided *via* the mobile network, equally noteworthy effects can be seen in terms of the rise in broadband mobile use. These impacts are due to investment and dynamism in the information and telecoms technologies sector on the one hand, and increased productivity and the spread of services across all sectors of society on the other.

DYNAMIC ICT BENEFITS ALL SECTORS

The telecoms operators have invested massively in order to set up the network and the services that go with it. Infrastructures have had to be built, and human resources trained to install, exploit and maintain them. Very



Farmers near Koutiala (Mali), with a hoe, listening to a “Jamana” radio programme about fertilizers.

often, this has called for civil engineering work, including the construction of roads, and has brought rural areas access to electricity. These expenditures have been funded by foreign direct investment, and have resulted in the transfer of know-how.

Among the many players in the ecosystem gravitating to the mobile, the operators therefore have a very substantial role, both in terms of creating direct and indirect employment and of the fresh tax revenues they bring the states. In practice they bring jobs into such varied sectors as engineering, accounting, advertising, and retail as well as after-sales services and the creation of content and services, both in the formal and informal sectors.

A study by Boston Consulting Group (BCG, 2013) estimated the revenue generated for sub-Saharan Africa by the mobile industry and services ecosystem in 2012 at close to US\$ 36 billion, or almost 3% of GDP, of which almost US\$ 28 billion came from the mobile operators alone. This ecosystem is said to generate the equivalent of nearly 3.3 million full-time jobs (World Bank, 2010) and over US\$ 12 billion in tax receipts from VAT, import duties and corporation tax. In addition, mobile use in the workplace has also generated productivity gains in a number of sectors (reductions in transport costs, modernization of the public sector, information flows, ease of job seeking, and so on). The same study put these at US\$ 24 billion, or 2.5% of GDP.

Teacher whose training was paid for by Orange banking.



In all, the mobile industry has had an impact on the economy worth US\$ 60 billion, or more than 6% of GDP. The future is just as promising, as the spread of 2G services and broadband mobile adoption could drive up the region's GDP and account for almost 8% of it by 2020.

More specifically, the mobile has a positive impact in multiple areas of society, first and foremost being the Millennium Development Goals: to eradicate extreme poverty and hunger,

achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability and build global partnerships for development. Many alliances are now emerging in these areas, like the m-Health Alliance, the m-Education Alliance and ICT 4 Farming, which can draw on the rapid technological advances in their sectors. Financial services, health and agriculture are therefore witnessing a veritable revolution.

M-PAYMENT

What has come to be known as financial inclusion, in other words access for everyone to financial services, is a major developmental challenge in sub-Saharan Africa, where only 20% of households have a bank account. Immense disparities can be seen between the different countries in the region: the rate of penetration in Guinea-Bissau is just 0.6%, while in South Africa it is above 54% (ADB, 2010).

Against this background, mobile banking has rapidly become a solution of choice. Mobile banking systems make financial services accessible, even to those who do not have a traditional bank account. A mobile phone can serve as a virtual bank card to pay for goods and services, as a terminal for money transfers, online payment and even withdrawals from cash dispensers. These new opportunities have been tested by students in Senegal to pay their university enrolment fees, as well as by the public sector in the Democratic Republic of the Congo to pay its teachers.

Undoubtedly the best-known mobile banking model is M-PESA, developed by Safaricom (Vodafone) in Kenya. This service had more than 15 million subscribers in 2014, or 30% of the Kenyan population, and almost 35,000 partner stores. Similarly, Orange Money, the Orange Group's mobile banking service, launched

in 2008 in Côte d'Ivoire and now present in 13 countries, reached 10 million customers in April 2014. Nonetheless, issues such as consumer protection and the management of network-related risks remain to be resolved.

M-HEALTH

ICT can also play a part in the development of new applications in the field of health-care. For some years now, mobile health (or m-health) initiatives have been springing up across sub-Saharan Africa. Based on the same principle as mobile banking, the success of these initiatives depends on the involvement of the various interested parties within the local ecosystems.

The experience of using ICT in the healthcare sector has so far been confined to limited areas with modest budgets, but the fields of application of these technologies are nonetheless varied.

As an example, the Mobile Technology for Community health (MoteCh) initiative, launched by the Grameen Foundation and funded by the Bill & Melinda Gates Foundation in Ghana, is behind two m-health services: MoteCh Midwife, which enables pregnant women to receive messages about their pregnancy in the language of their choice, and ChildCount, a Short Message Service (SMS) application that enables healthcare personnel

to download information concerning their patients from an external database in order to ensure better monitoring and control. Similarly, MPedigree, a social enterprise launched in 2007 and operating in several countries in sub-Saharan Africa, is a health platform that uses mobile technology to enable anyone to verify the effectiveness and safety of medication. Lastly, in Mali and Burkina Faso the Pesinet association has devised a system for monitoring the weight of newborn babies *via* a mobile phone, allowing problems with some of them to be swiftly identified and corrected.

However, projects designed to spread and share information still make up the majority, along the lines of *Info Ado – Apprendre à vivre au Sénégal*, a programme of awareness-raising and prevention of the risks associated with sex aimed at adolescents, set up in 2011 by the NGOs OneWorld UK and Butterfly Works in partnership with several other NGOs. The application is built around an online teaching platform, radio broadcasts and a system of anonymous questions-and-answers *via* SMS. With over 250,000 questions received, the project is a success.

The beneficial uses of ICT in the healthcare field are therefore numerous. They can at the same time reduce the time it takes for patients to access healthcare, and strengthen the diagnostic and therapeutic capacities of health professionals by allowing them to

follow their patients remotely, increasing the awareness of the public about health issues, and improving the gathering and management of data.

M-FARMING

Mobile telephony can also have a strong impact in the farming sector, from production right through to distribution. Technological innovations provide not only technical support, but also access to meteorological and financial information, which can help drive down costs, reduce waste and increase yields. For instance, the introduction of the mobile phone service developed by Safaricom, giving farmers regular updates on the prices and availability of goods, enabled the variations in cereal prices in Niger to be reduced by 10 to 16% between 2001 and 2006.

OPEN AND BIG DATA

The spread of the mobile phone and the Internet, taken together with the diversification in their uses (connected devices, social networks, etc.), has led to unending growth in the volume of digital data. To take one example, every day, 118 billion emails are sent throughout the world. According to Stephen Gold of IBM, 90% of all the world's data has been created in the last two years (Brasseur, 2013).

This mass of data (“Big Data”) is a potential source of value. This is made possible by advanced analytic techniques (“Big Analytics”), which enable knowledge to be extracted from the entire body of information available (administrative and business data of all kinds: numerical data, text or audio data or images, structured or not). Making this data available to the public at large (Open Data) can help increase its value, as the variety of experience attests, leading to the creation of new services or applications to facilitate or automate decision-making (McKinsey Global Institute, 2011), to increase administrative transparency, better understand the needs of users, or evaluate services.

As an example, the Digital Matatus Network project, a collaboration bringing together students and researchers from the University of Nairobi, the Center for Sustainable Urban Development of Columbia University and the Civic Data Design Lab of the Massachusetts Institute of Technology (MIT), aimed to reconstitute the informal network of minibuses, the “matatus”, circulating in Nairobi. While for many years the use of this network had functioned intuitively, depending on experience and habit, the researchers were able to chart the network of matatus relying on the ubiquitous use of mobile phones. This dynamic geolocalization data thus helps improve traffic flow and optimize use of the network. The project has also enabled the

matatus to achieve official status by making the distribution of permits easier.

The opening up and exploitation of large-scale data offers potential for application in all fields, as witness the “Data for Development” competition organized by the Orange Group in partnership with the Catholic University of Louvain and MIT. Anonymized data on five months of mobile use by the operator’s customers in Côte d’Ivoire were made available to the scientific community. Its analysis enabled lessons to be learned about the daily lives of Ivoirians and services to be offered to them designed to improve their living conditions. The data on use of mobiles, taken together with that of the relay antennae, can for instance make it possible to draw inferences about the mobility of the populations. The analysis of communications between individuals can also shed light on the social structure of the populations. Two studies in particular have won awards: the first, carried out by an Irish team from IBM Research, is studying urban mobility in Abidjan with a view to optimizing the deployment of public transport; in the second, researchers from Birmingham University won an award for their application in the healthcare field.

Proceeding from the finding that certain health problems are caused by social behaviour, the Birmingham University researchers built a tool to assist in understanding the patterns

and spatial aspects of the propagation of an epidemic, thus enabling optimization of the actions taken to contain it. They were able to compare the effectiveness of two possible actions: placing a territory in quarantine or spreading information about prophylactic measures (hygiene, vaccination, etc.). The study suggests that, while the first approach allows the portion of territory behind the *cordon sanitaire* to be relatively well protected, the rate of propagation in the rest of the country does not fall at all. By contrast, the second strategy, based on a campaign initially alerting only 1% of individuals, turned out to be more effective: the information received from the authorities is quickly transmitted to networks of friends and acquaintances, who in a sense become “agents of immunity”.

RESPECT FOR PRIVACY AND DATA TRANSPARENCY

While Big Data can offer advantages that are both societal and economic, it raises major questions in terms of protection of the personal data and privacy of citizens. The potential for combining this information is such that it seems almost impossible for data relating to individual people to be made truly anonymous.

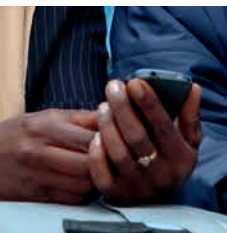
The respect for privacy and the security of exchanges is in practice a barrier to the effective use of these data cross-matching tools. Many players are opposed to broader exchanges of data on those receiving social benefits, referring for instance to the risk that they will be subject to excessive surveillance.

That said, most of the time these are one-off cross-matches and not information storage. Given the interest both users and the public authorities could have in such cross-matching of data, securing these exchanges is now a necessary step, both to guarantee respect for user privacy and to enable them to be offered an improved range of services.



Nurse examining a child in the Ouolofobougou neighbourhood in Bamako (Mali).

© Djantoli (NGO)



2.3 | M-education, the main lever for growth in educational ICT

A great deal is riding on the use of ICT in education, with so many new prospects being opened in the teaching and learning processes. The dematerialization of paper media has brought about considerable changes in the way content is created, stored, accessed and transmitted. The sharing of information has been made much easier, which promotes transparency. The workload of planning, management and control is lightened. Potentially, it affects all the players and interested parties in the educational sector: decision-makers and managers, administrative staff, heads, teachers, inspectors, pupils and their parents, recruiters, suppliers and so on.

Among the technologies available, “nomadic” tools like basic and mid-range telephones, smartphones and tablets and the services associated with them will without doubt be the principal vectors of transformation in the education world. The mobile phone will be

the most important in Africa, for a number of reasons:

- The mobile phone is extremely widespread and the network is available over a large proportion of the territory, making it possible to reach a huge public, everywhere and at any time, including isolated populations and those hitherto excluded from the formal educational system (street children, children with disabilities etc.).
- The mobile phone, and even more so the smartphone, offer a number of functions for communicating (vocal conversations, SMS, instant messaging [IM]), for listening to or recording resources *via* radio or MP3, watching or making videos, photos, reading the news or other content (SMS, pdf, e-pub), it gives access to all sorts of applications and makes peer-to-peer exchanges possible within communities.



© AUF

Teachers in Madagascar familiarizing themselves with the use of mobile phones for training purposes.

■ As a familiar object and one that is therefore easy to use, both for teachers, heads and administrative staff as well as for pupils and students, there is no obstacle to its use in the educational context.

M-education today has the support of many organizations promoting the integration of mobile technology into education throughout the world. Numerous projects have been launched at all levels of learning. In 2011, UNESCO launched Mobile Learning Week, a one-week symposium, while the United States Agency for International Development (USAID) was the driving force behind an alliance, the Mobiles for Education Alliance, bringing together various international

organizations, foundations, NGOs and development agencies. The aim of these initiatives is to create a space for discussion and dialogue about the role of quality, low-cost mobile technologies in literacy and gender equality in order to improve the quality of the educational system at all levels, especially in developing countries. In Tunis, in December 2013, the first African Ministerial Forum on ICT Integration in Education and Training was held, jointly organized by the Association for the Development of Education in Africa (ADEA), the African Development Bank (ADB), the *Organisation Internationale de la Francophonie* (OIF), UNESCO and Intel, which shows the importance of this topic at the political level.

THE ECONOMIC WEIGHT OF E-EDUCATION

In 2013, e-education accounted for only 1% of total education spending worldwide, or around US\$ 34 billion (GSMA, 2012). The principal potential area of growth is likely to be fuelled by mobile technology. A report by GSMA and McKinsey & Company estimates sales of up to US\$ 70 billion for the mobile operators, US\$ 38 billion for products and services in mobile education and US\$ 32 billion for smartphones and tablets in the 2020s. Furthermore, this growth is set to be more substantial in developing countries, as the market in m-education is expected to increase by 50-55% over that period in Latin America, Asia and the Pacific, Africa and the Middle East.

E-books and e-courses accessible via mobile devices

The research conducted by Aptara in 2011 revealed that out of 1,350 publishers questioned worldwide, 84% were already producing e-books or planning to do so in the near future.

The Learning Management System (LMS) and design tools

Educators use the LMS to manage lesson content and plans and to personalize the content. The demand also exists for design tools that are independent of any of the LMS providers.

Learning tools based on play or simulations (serious games)

These applications integrate programmes into environments based on enhanced or virtual reality, helping students to understand and learn in ways that are more fun.

Tools for collaboration

Networking platforms allow users to generate content, share it and discuss it within communities. Mobile phones make it possible to do this in real time, allowing the users to obtain immediate feedback.

Personalized evaluation services

Educators can now assess pupils' comprehension by using mobile devices. These provide real time updates on the progress of each pupil, enabling the teacher to follow the progress of the class and adapt and personalize the teaching, for instance, of pupils requiring support.

Preparation for tests

Students the world over take standard tests such as the Scholastic Aptitude Test (SAT), Graduate Record Examination (GRE) and Graduate Management Admission Test (GMAT). These tests can now be administered using mobile applications. In addition, the candidates can compare their performance with that of thousands of others.

Distance tutoring and help with homework

The applications in this field have a promising future, especially in the many developed countries in Asia like Japan and South Korea where out-of-school support is a requirement and already accounts for almost 10% of total education expenditure.

GETTING QUALITY CONTENT TO THE TARGETED PUBLIC

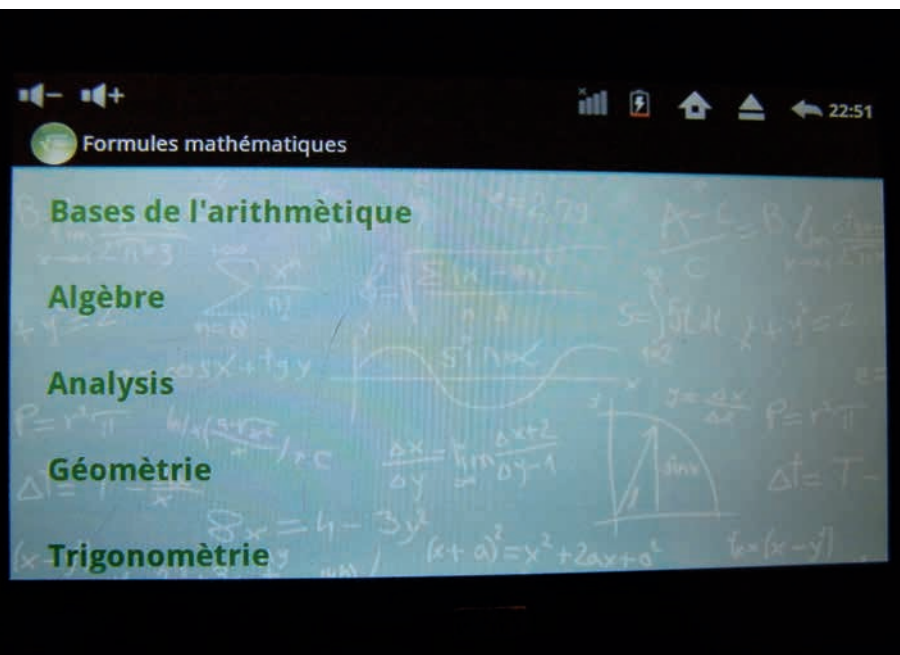
ICT can, first and foremost, allow large-scale access to a great variety of content, individually or collectively, both for the preparation of lessons and for working in or out of the classroom. In this way, in the face of the extreme shortage of teaching materials, ICT can help to make accessible a large number of resources at very low cost, with the option of updating the content.

This approach does not necessarily require very advanced technologies. Started in Pakistan, the Rehan School is one of the first initiatives to have offered remote courses that could be accessed from a basic mobile phone. The application offers short educational sequences, showing how to write common names and words and conveying mathematical and scientific concepts. Sometimes featuring television personalities, the teaching sketches are intended for viewing on small telephone screens. The films are sold for a few cents in the telecoms boutiques and can then be exchanged by Bluetooth. The Rehan School estimates that over 40,000 individuals follow its lessons, but the real number is certainly higher. On the same lines, the SMS Story project, which started in Papua-New Guinea, has successfully improved teachers' classroom practices in teaching children to read by using short messages and sent by SMS.

IMPROVING TEACHER TRAINING

The shortage of qualified teachers at all levels of the system (particularly teachers already in post at primary level) can be partly compensated by "nomadic" technologies, which offer great flexibility in the way training is organized, especially in terms of the division of time between activities that require the teacher to be physically present and those that consist of remote self-training. This flexibility is all the more necessary as teachers must avoid being too long away from their classes. But these technologies can also help support pupils by tutoring, so as to combat the demotivation that can cause the learner to drop out.

Faced with these findings, a number of initiatives have been set up. For instance, the Primary Teaching Learning Program (PTLP), the joint UNESCO-Nokia initiative for continuing distance training of teachers, or the French-speaking distance teacher training initiative (IFADEM) introduce new technologies into hybrid systems by tutoring, and thus respond to the especially difficult challenge of training staff in posts in rural areas, where the efforts need to be concentrated, according to the Dakar sectoral analysis centre (BREDA).



Example of educational content on tablets for maths in Niger.

PROMOTING LEARNER-CENTRED TEACHING

ICT can facilitate teaching that draws on what are called “active” methods, geared to the development of skills over and above the transmission of content. These methods are based on cooperative learning, case studies, problem scenarios and teaching projects led by the learners. ICT enables the transmission of knowledge as well as complex situation-problem solving, case studies, simulations, and so forth.

The PTLP has shown that teachers who had adapted their teaching practices communicated more in English during the courses and

with greater interactivity, and offered their pupils more frequent opportunities to talk in small groups and listen to audio resources with loudspeakers and mobile phones. In this way, they obtained results from the children that were highly encouraging. Their skills in spoken English increased overall, with a higher percentage achieving grade 1 in the Trinity test (50% against 35% originally).

ACTING ON EVALUATIONS AND FEEDBACK

Of the classroom practices clearly associated with improvements in pupil performance, continuous assessment and exams can also be supported by mobile technologies, which facilitate the administration, correction and consultation of results, both internally and externally.

As an example, the Tangerine system, deployed in Kenya, aims to help teachers in their assessment activities. With Tangerine, the reading level of a pupil can be evaluated, by recording the candidate’s answers on a mobile phone, on the smartphone or a tablet. A certificate of aptitude can be issued without the need for the candidate to travel. The data gathered by the application also allows comparisons of the learning levels of pupils according to their age, geographical area and gender. On the same lines, the MoMaths project, started in 2009, allows pupils to review

and assess their knowledge of mathematics, while comparing their results with their peers at school, region or country level, using their mobile phone and the instant messaging service Mxit. By 2011, the programme already included 200 secondary schools across the country, or nearly 50,000 pupils. Lastly, in the Real-Time Access and Utilization of Children's Learning Data project, in place in Ghana, pupils enter their results by mobile phone to compile local, regional or national statistics so that a database can be built up to encourage knowledge-sharing and the circulation of experiences among the schools.

The visibility of test results, made possible by the use of ICT, helps increase the accountability of educational staff (teachers, heads and educational advisers) and ensure greater involvement by parents and communities, thus preparing the ground for participatory management.

OVERCOMING THE LACK OF DATA FOR MANAGING THE EDUCATION SYSTEM

Having access to reliable and recent data about teaching materials, school equipment, the number and qualifications of teachers, the organization of pupil flows and study times is an essential requirement in devising and carrying out any educational activity. Many governments and decision-makers suffering from the lack of adequate recent data have

come to see how useful smartphones and tablets can be in remedying these problems. The enthusiastic welcome given to the EDUCI experimental solution, presented at the first African Ministerial Forum on ICT Integration in Education and Training bears witness to this. This solution, built in partnership between Microsoft, Orange, Nokia and the UNESCO International Institute for Educational Planning (IIEP), and tested in December 2012 by the Ministry of National Education of Côte d'Ivoire, was designed to collect information about educational input, thus replacing the traditional paper surveys.

While today ICT, especially the services offered by mobile technologies, represent a real lever for economic and social development in sub-Saharan Africa, the ways in which they are being deployed in the education sector deserve special attention.

3

Integrating ICT into teaching in sub-Saharan Africa

Since the 1960s, various information and communication technologies have aroused strong interest in sub-Saharan Africa as a way of increasing access to education, and enhancing its quality and fairness.

The study of the development of ICT in education in sub-Saharan Africa shows up more and more clearly the interface between the institutional offering, individual use and the dynamism of the private sector. New educational services are becoming possible. These technologies, previously the preserve of school computer labs or confined to the classroom, have since the 2000s also been used outside the school environment.



BRAVO

20

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(1)

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Two highlighters, one pink and one white, are visible in the foreground.



3.1 | Radio and television, vectors of education since the 1970s

“ICTE offer access to low-cost teaching resources, added value compared to traditional teaching, and a complementary solution for teacher training.”

Starting in the 1960s and continuing in the 1970s, the international educational community showed an interest in radio and television as a lever for making teaching generally available. The tool of television was in fact to become a means of training teachers and compensating for their absence, thus contributing to achieving the goal of universal schooling. On 30 September 1968, Robert McNamara, then the President of the World Bank, told its Board of Governors: *“With the terrible and growing shortage of qualified teachers all over the developing world we must find ways to make good teachers more productive. This will involve investment in textbooks, in audio-*

visual materials, and above all in the use of modern communications techniques (radio, film and television) for teaching purposes.” (Pauvert, 2001).

EDUCATIONAL RADIO, THE PRECURSOR OF ICTE

The first initiatives to introduce technologies into education were carried out by States directly, as they were at the time embarking on wide-ranging education reforms. During that period – from decolonization through to the 1980s – the dominant paradigm in education, common to African States and international



Young woman from Koutiala, listening to an education programme in Mali.

© UNESCO / Serge Daniel

organizations, was that of the interventionist State. Against that background, major large-scale programmes were developed, which were to some extent successful. In this way, the Bouaké schools radio in Côte d'Ivoire allowed more than 2,000 teachers per year to be trained in the 1970s.

Radio was in fact one of the first technologies to be put to work in the service of education in sub-Saharan Africa. In 1986, in Guinea, an experimental schools radio project was started at the national educational research and documentation institute (*l'Institut national de documentation, de recherche et d'action pédagogique,*

the present-day Indrap), with the assistance of the cultural and technical cooperation agency that is now the *Organisation internationale de la Francophonie* (OIF). The radio broadcasts were therefore mainly focused on primary teachers' needs so as to improve their teaching techniques, and on subjects that were considered as priorities for the pupils: French, arithmetic and science. In the early 1990s, radio was given a broader role in the promotion of basic education, with the support of UNICEF, especially with respect to girls' access to education. While the results in terms of scholastic performance are still not properly understood, these programmes helped to train a large number of teachers.

THE LARGE-SCALE IMPACT OF EDUCATIONAL TELEVISION

Throughout the 1960s, the concept of educational television took hold in Africa. One of the most iconic examples of the development of these programmes can be found in Côte d'Ivoire. After initial trials in Senegal and Niger (where educational television existed before national television) in 1965 and 1966, Côte d'Ivoire was chosen in 1971 as the testing ground, then for the large-scale roll-out, of a massive project for schooling *via* television. The Programme for Education by Television (PETV) was made the responsibility of UNESCO, assisted by cooperation from Belgium, France and the Ford Foundation. The PETV gave an illustration of how, from the 1970s, innovative programmes could be launched with the aid of the "new" ICT (Awokou, 2007).

In the first five years, the rate of school enrolment in that country went from 20% to over 60%. While 300,000 pupils were receiving the programmes in 1975-1976, this had increased to 700,000 by 1980 (out of a total of one million pupils). Some evaluation reports indicate that the proportion of pupils who had had the benefit of television courses entering the sixth year of study was significantly higher than for the others, that the percentage having to retake a year had fallen from 30% to 10% during the lifetime of the project,

and that pupils had acquired a better mastery of spoken French. The programme ran for 14 years and finally ended in 1982. For some observers, the programme had simply fulfilled its objectives, but according to a World Bank report (Murphy, 2002), the significant place given to technical assistance for expatriates proved an obstacle to the development of national capacities and local ownership of the system.

Long-term commitment, cooperation between the interested parties and the strengthening of local capacities emerge as the prior and necessary conditions for a large-scale institutionalized project.



In Dakar (Senegal), satellite dishes to receive television.

© Danielle Sequi, AFD



3.2 | Uses mainly centred round school

The development of individual computer technology has proved a major turning point in the implementation of projects dependent on technology use, and calls for the acquisition of computer skills first by teachers and then by pupils. At the same time, NGOs, training institutions and international organizations are setting up a number of experiments without the State always having defined its goals or provided a framework for these actions and initiatives.

THE MASS DISTRIBUTION OF COMPUTER HARDWARE

Between 1990 and 2000, multiple actions were started in order to turn technologies into a lever for improving education in sub-Saharan Africa. Many initiatives focused on equipping schools with computer hardware. A number of NGOs contributed, on varying scales, to bringing computer hardware into Africa, such

as groups like Computer Aid International, Digital Links, SchoolNet Africa and World Computer Exchange. Sometimes with backing from cooperation agencies or development agencies like USAID, the African Bank or the French Ministry of Foreign Affairs, these individual initiatives grew without adequate

THE DIFFERENT AIMS OF ICT IN EDUCATION

- **Learning technology:** training of teachers and pupils in the use of digital and computer tools;
- **Learning with technology:** use of ICT to complement traditional ways of learning;
- **Learning through technology:** the possibility for learners to have direct teaching input *via* interactive digital applications or access to platforms for remote collaboration and exchanges.



Computer lesson
in Burkina Faso.

© AFD

coordination. States found it difficult to define their national strategies with regard to ICT in Education.

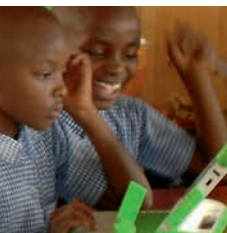
FAMILIARIZATION WITH COMPUTERS IN A COLLECTIVE SETTING

Though the initiatives were broadly destined for use in a school environment, the sending of hardware on a regular basis nonetheless helped with the spread of computer laboratories in African teaching establishments. Depending on the type of resources available, premises that were equipped with computers offered good places for computer training – for learning the technology. This stage opened the door to the more profound integration of ICTE into the school environment. As well as computer training, the teacher could also use

the computer itself as an educational medium, depending on the accessories available: CD-ROMs, projectors, and so on.

Often driven by philanthropic considerations, not all of these many projects had the benefit of an environment in which they could thrive, but they still contributed to fairer access to computer equipment for pupils and teachers. This type of action still remains the predominant model for access to technology in schools.

Only with the advent of the first personal computers, smaller and easier to handle, would teaching practices become individualized. While the classroom remains the principal framework for the use of ICT, from now on the pupils can be the main beneficiaries.



3.3 | School IT is gradually becoming more personalized

In the 2000s, various projects were begun, mainly aimed at giving each schoolchild access to IT tools, individually or shared among a small group. Personalizing the practice of computer technology multiplies the potential uses of ICT in education, not just by familiarization with the technology tools themselves (learning technology), but also by the acquisition of cognitive skills (learning through technology).

IT AS A TOOL, FROM SCHOOL TO PUPIL

The American One Laptop per Child (OLPC) project, launched in several African countries in 2005, aimed to equip schools with laptop computers at low cost. While the average price of an inexpensive personal computer

was between US\$ 200 and US\$ 500, OLPC offered its ultraportable XO-1 computer at the price of US\$ 100. This technological breakthrough marked an important step in potential access to ICT. OLPC became an institutional system: the programme was “bought” by governments, which then took responsibility for distribution to the schools. The underlying logic of the initiative was one of centralization, thus enabling the large-scale distribution of the equipment. Almost 2 million teachers and pupils are now involved in the programme worldwide (<http://one.laptop.org/>) and more than 2.4 million computers have been delivered. Sugar is the free teaching platform installed on the XO computers from the OLPC Foundation. Sugar is both a graphic interface at the same time



© One Laptop Per Child (OLPC)

2.4 million computers have been delivered thanks to the OLPC project.

as containing applications, and was designed specifically for children, to support them in their learning with a variety of available content: reading courses, drawing tools, e-books, interactive applications and so on.

Following on from OLPC, the Intel group launched Classmate PC, a similar programme also intended for pupils in developing countries. Though it has a smaller presence in sub-Saharan Africa than the OLPC project, Classmate PC has enabled laptop computers to be delivered to primary schools in the Seychelles and Kenya, particularly in rural areas. Also in Kenya, the CFSK (Computer for School in Kenya) project was started in 2002 with the aim of distributing computers to almost 9,000 schools. More recently, certain

initiatives have been undertaken in order to equip primary schools with tablets. The Thai government took up the OLPC concept in 2012 and converted it into One Tablet per Child (OTPC). To date, 800,000 tablets are thought to have been distributed to pupils in the country's primary schools.

THE INFLUENCE OF ICT ON PUPIL PERFORMANCE

There are very few impact assessment studies with regard to these programmes in sub-Saharan Africa. One that could be mentioned is the study entitled "Technology and Child Development: Evidence from the One Laptop per Child Program", conducted in February 2012 by the Inter-American Development

Bank to evaluate the impact of the One Laptop per Child project in Peru. The assessment shows that the use of fixed or portable computers in fact has little effect on the pupils' basic skills. While it concludes that there is no effect on learning in the basic subjects, it nonetheless points out that over 15 months, the children working with these machines on educational content were between 4 and 6 months ahead in skills that are not normally measured (cognitive skills and tests of logic like those used in IQ tests).

A study conducted in 2005 by Michael Trucano, a specialist in e-education at the World Bank (Trucano, 2005), is also cautious in describing the benefits associated with the use of computers in the classroom. The causal connection between improved academic performance in pupils and using a computer in class is not clear (AFD, 2010). It is rare in Africa to have the chance to use a computer at home as well, as only 8% of households had one in 2013. One of the main limitations on these projects is, therefore, the fact that computer use is dependent on being in a classroom. The OLPC project marked a turning point in equipping pupils individually. While pupils have the option of taking their computer home in the evening, collective use of the computer is still preferred in the classroom context.

There has been a shift in the past few years from a tool-based approach to an approach centred on content and use, or even on the activities of pupils based on the system and content. The breakthrough produced by the large-scale distribution of portable tools has helped transform teaching practices by spreading them into the out-of-school environment.

DISTANCE LEARNING IN HIGHER EDUCATION

The main initiatives based on the use of ICT and the Internet in education originally focused on distance learning at university level. Thus, the African Virtual University (AVU), set up by the World Bank in 1997, was originally conceived as an alternative to traditional teaching. When it became an intergovernmental agency in 2003, it was training 40,000 people, mostly on short programmes. It shifted its focus to teacher training and to integrating technology into higher education. The AVU has ten e-learning centres.

The *Agence universitaire de la Francophonie* (AUF) has also, since 1999, set up around forty French-speaking digital campuses, more than half of them in Africa. In these infrastructures, dedicated to technology and set up within the universities, the AUF offers access to over 80 first and masters

degrees entirely by distance learning, about 30 of which are awarded by African institutions and created with its support.

More recently, the MOOCs (Massive Open Online Courses) phenomenon has grown up, first in the United States and then in Europe. The AUF is funding the development of the first MOOCs in higher education in Africa, in partnership with the French Ministry for Higher Education and with the support of UNESCO, and in 2015 it will use this form of remote learning to offer training and certification in ICTE skills for teachers. The African universities are taking a growing interest in this new method of learning, especially in view of the ever-increasing demand for higher education at a time when the continent is experiencing a deficit in qualified teachers.



3.4 | ICTE emerges from the school context

Access to mobile technologies on the African continent opens up opportunities to make changes to traditional teaching tools, as they provide a continuum between learning that happens in and out of the classroom. The mobile revolution thus marks the point at which institutional supply turns into demand, and new systems start to be built around private uses.

CAPITALIZING ON EXISTING USES

M-learning (or m-education), or the use of mobile technology in the service of education, is a recent practice, opening up fresh possibilities in the educational field. Given the shortage of books in many African schools,

the digital tablet was soon seen as a solution to make up for the missing textbooks, and taken up both by governments and international organizations. In practice, this shortage is one that affects almost every African country. In Cameroon there is on average one textbook on reading per 11 pupils and one mathematics book per 13 children (UNESCO, Newsletter, 2012). The price of digital content on tablets is falling sharply compared to the traditional media (books, CD and DVD, etc.). One digital textbook, for instance, costs one-third to half the price of a paper textbook (AFD, 2012), with zero marginal cost. The tablet, used originally for its reading function, has the further advantage of introducing gradual changes into current teaching practices.



© Jon MacCormack for Worldreader

Access to new technologies provides a continuum between learning inside and outside the classroom.

The digital tablet today has potential uses that extend beyond the classroom. The American NGO WorldReader has set itself the goal of extending access to reading to the most underprivileged children by distributing readers designed by Amazon. With the financial support of USAID, Kindles have been made available to 600,000 children in nine States in sub-Saharan Africa. The NGO has stated that children using this system spend 50% more time on reading, and read up to 90 books per year. Moreover, the report published by USAID following the iRead impact study in Ghana of 337 pupils in six different schools in 2010-2011 shows a number of positive aspects of the use of readers. The pupils using Kindles proved to be more enthusiastic about reading, which

allowed them to improve their technical skills and achieve better scores in the standardized tests.

Old and outdated traditional computer hardware and the costs of maintenance have prompted those devising projects to turn to technologies that are cheaper to buy and easier to handle. Internet access is made easier by tablets and by the possibility of connecting *via* the mobile networks. Relatively cheap compared to the laptop computer and more flexible in its uses, tablets have the potential to provide an efficient response to part of the educational needs of sub-Saharan Africa. The pupil needs only a few days of practice to master the device and understand how it

AN AFD-ORANGE INITIATIVE LAUNCHED IN NIGER

In March 2013, AFD, in partnership with the NGO Aide et action, Orange, the Ministry of Education of Niger and the University of Niamey, launched an experimental project using tablets, aimed at teachers and pupils in the 4th year at the two middle schools of Niamey and the suburb of Soudouré. The tablets provided digital textbooks, dictionaries, after-school books and books for young Africans. Financed by the Orange Foundation Orangelabs and AFD, the project involves some 150 pupils, 20 teachers and management staff. This initiative aims to use the budget allocated for paper books and other teaching materials for tablets instead (AFD, 2012).

Background to the experiment

With almost 16 million inhabitants and steady demographic growth of 3.1% per year, Niger must face two major challenges: to pursue its policy of universal access to education and improve its quality across the whole country. One study of post-primary teaching, carried out in 2005, showed serious disparities in secondary school numbers between urban and rural areas, boys and girls, and between children from well-off and underprivileged homes. The lack of teaching resources, especially books and textbooks, aggravated the situation.

Methodology

DTablets loaded with digital resources (digital textbooks, educational podcasts, multiple-choice questionnaires (MCQ), after-school books and so forth) were delivered in 2013 and 2014 to pupils and teachers at two middle schools in Niger, after they had been given suitable training. In order to improve the spread of textbooks and promote digital publishing, the employees of Indrap were also trained in the use of e-publishing tools. As well as the distribution of tablets, the initiative involves multiple other actions: the

provision of digital infrastructures (access to the mobile network and energy), the supply of digital resources, free or under licence, for in-school and after-school use, the training of those involved in digital publishing, evaluation of use, etc. The initiative has thus helped mobilize all the interested parties, so as to speed up the move of the players in education towards the digital.

Evaluation

- The various waves of interviews carried out with pupils and the use analysis confirm that pupils benefit from being equipped with tablets. Most of the tablets are personalized, and the middle school pupils were enthusiastic about them. Over 70% of them said they were completely satisfied and almost 21% fairly satisfied.
- The tablet as a medium for reading school material (course and year books) is especially relevant for the less gifted. Pupils in Soudouré who had very few books available in year 4 were the ones who made most use of the Aldiko application. In addition, it functions as a factor for social justice in favour of the poorest and of young girls.
- It can be estimated that 1/4 of teachers use the tablet both for private purposes and for lessons.
- Teaching resources remain a key element. Without them, the teachers show no interest in the system.
- Parents show a certain interest in this system, though some of them are wary of “temptations”.
- For pupils who have no electricity, an individual charger is the solution.
- There is a great need for in-service maintenance of the devices, with more than 2/3 of screens cracked but functioning, defective chargers, blocked codes, and so on.

works, by contrast with a computer, which requires a longer period of training. As with smartphones, the manufacturing costs of tablets have been falling rapidly.¹ In addition, by contrast with traditional computers (PCs or laptops), these mobile tools consume so little energy that the lack of electricity is no longer an obstacle to their deployment now that efficient solar charging solutions exist.

Tablets support uses that are geared to developing computer skills (learning technology) on the one hand, and also developing cognitive skills on the other, *via* the general ICT functionalities (learning with/through technology).

The multiple potential uses of digital tablets have convinced the planners that they can rely on this tool in the educational context. Nonetheless, this institution-driven distribution of tablets remains limited compared to the level of penetration of mobile telephony in sub-Saharan Africa.

While experience of its use in teaching is limited compared to computers or tablets, the main advantage of the mobile phone is that it is accessible and almost ubiquitous. While scarcely 13% of the population of Africa has access to a reliable Internet connection, 63% of them have a mobile phone (ITU, 2013), a very high proportion of those being young people. At a time when the number of mobile phones has outstripped the number

of people, the demand for the creation of out-of-classroom teaching services continues to grow, using a tool that does not require any specific training. The diversifying supply, from MCQ to entire courses that can be accessed remotely, is adapting to this demand.

While the early initiatives were often limited to setting up mobile applications, the potential has expanded, in particular towards the personalization of applications depending on the school level. New applications have been designed that do not use the Internet, such as MCQ platforms or the sending of SMS containing short lessons or audio recordings. As an example, the *M-Ubuntu* programme in South Africa offers pupils in the partner schools a tutorial service in reading and writing, conducted by specialists resident in the United States, the United Kingdom, Sweden and Italy. The BYOD (Bring Your Own Device) model, too, opens up the option for pupils to bring their own hardware (mobile phone, computer, etc.) into school to be used in class with their teacher.

Today, online and mobile information services are booming. The service offered by *Groupe Digital Afrique*, which sends exam results (including the *baccalauréat*) by SMS, for the price of EUR 0.1 to EUR 0.2, had over 100,000 users per country in 2012 (including Senegal, Malawi, Mali and Niger). The demand for this type of services strongly reflects the expectations of

¹ This is possible because of the integration of so-called SoC (System-on-Chip) components, which opens the way to the creation of high-performance tablets from just one SoC.

View of the front of the Manhica Multimedia Community Centre (Mozambique).



© UNESCO / Sergio Santimano

parents for regular, automated and immediate follow-up of their children's results.

CROSS-FERTILIZATION OF PRACTICES AND TOOLS

The cross-fertilization of teaching models and tools has now broadened the potential of ICT within the educational framework. Certain technologies, perceived as outdated compared to more innovative technology, nonetheless remain very much embedded in local practice. Today they are undergoing a partial revival, thanks to the combination of different media that can be used in any single

project. Despite its limited uses in teaching, radio is a medium that still has considerable reach in terms of its audience. Cheaper than a computer, it also has a cost-benefit ratio that makes it attractive to many project planners (Trucano, 2005). Launched in 2008, the BBC Janala programme, offering English courses in a combination of different media, including lessons of a few minutes *via* mobile phone, received more than 85,000 calls per day in the weeks following the launch of the service. In 15 months, over 10 million calls (paid, but at a reduced price compared to a normal communication) were made, by over 3 million users. A similar programme, Urban

Planet Mobile, had more than 100,000 users within three months of its launch in Indonesia, paying US\$ 4.95 per month for daily lessons via mobile phone. By multiplying the media channels, the educational scope of the programme was enhanced, with the offer of a paid, individual add-on as well as the standard, free-of-charge teaching. The programme relies on a combination of media, bringing together audio-telephonic courses on CD-Rom, an Internet platform adaptable to broad or other bandwidths, a television game in English, and short lessons published in newspapers and course books. The successful roll-out of the initiative was made possible by funding from the Department for International Development (DFID), British cooperation and support from various players from the public and private sectors.

Television, a feature of very many households, is witnessing a revival in its educational uses, by being combined with other media. As part of the Bridge IT programme in Tanzania, short educational videos, also available on mobile phones, are broadcast on the classroom television so that all the pupils can take part collectively. The e-Schools' Network in South Africa has also, since March 2013, been developing an educational project, the object of which is to exploit unused television frequencies. There are currently ten schools taking part in the project.

Another digital tool with multiple uses, the interactive whiteboard (IWB), is also being used in some schools in sub-Saharan Africa. At the end of the 2000s, the Education for All Network (REPTA), in partnership with the

THE REBIRTH OF EDUCATIONAL RADIO

Since it was started in 2006, the community radio Nakaseke Naseke Community, a joint initiative by primary teachers in private and public schools in Uganda, has been broadcasting an educational programme designed to improve pupils' school performance, Radio Quiz Competition. The programme targets the 95 primary schools in the district. Radio Quiz Competition is a competition broadcast live every Sunday on community radio. Three schools are invited to answer a series of questions, during which the

teachers present give the correct answers and explain if the pupils get them wrong, for the benefit of the listeners.

More recently, in 2011 and 2012 in the Cankuzo, Cibitoke, Kayanza, Mwaro and Rutana provinces in Burundi, the Nderagakura schools radio broadcast programmes in support of teacher training carried out by IFADEM, led by the AUF and OIF in partnership with the Burundi Ministry of Education and AFD.

Worldwide Fund for Digital Solidarity (FSN) and, in France, the interministerial delegation for digital education in Africa (DIENA) made interactive whiteboards available to schools in Burkina Faso, Niger, Benin, Senegal and Mali, along with open content. The use of the IWB has had a positive effect on motivation, for pupils and teachers alike. However, their impact in terms of learning has been muted. This system marginalizes the direct participation of the pupils in favour of multi-media demonstrations initiated by the teacher (AFD, 2010).

The diversity of multimedia tools multiplies the teaching potential with pupils and learners in general. That said, the integration of ICT depends not so much on technological advances as on the appropriation of these technologies to help users in their learning. For this to happen, a common dynamic has to be set up, including political decision-makers, the teaching community, publishers and the telecommunications sector, so as to ensure that the projects undertaken are economically viable in the longer term, and that the ICTE have a social impact.

Today, almost all African countries are showing an interest in ICTE, despite significant disparities in implementation. In practice, a whole raft of conditions must be satisfied to ensure these technologies are deployed efficiently within the educational landscape.

That transition now seems to be happening, due to the fact that policies are emerging, networks evolving and government leaders increasingly committing to ICTE. In spite of all this, there are still obstacles of an educational, economic, technical and institutional nature to be overcome if ICTE are to become a real lever for development in sub-Saharan Africa.

TECHNOLOGIES AND EDUCATIONAL USES

Date first appeared	Institutional sphere*			Private sphere**	
	Since 1970	Since 1990	Since 2000	Since 2010	
Dominant technologies	1 Television - radio	2 Computer lab equipment	3 Individual equipment (e.g. computer)	4 Mobile	5 Tablets
ICT dynamics	Spread of mass education	Cross-fertilization of tools and models (Both professional and private uses, Bring Your Own Device, etc.)			Spread of mass education
Learning	••••		••	••	•••

* Top-down changes driven by States.

** Bottom-up transposition of existing uses in the educational context.

OPEN EDUCATIONAL RESOURCES (OER), AN OPPORTUNITY TO ENHANCE THE QUALITY OF EDUCATION

In Africa, where there is very little access to school textbooks, these teaching and learning resources, either in the public domain or put in circulation under an open licence (making them free to use, adapt and distribute) represent an opportunity to improve the quality of education, facilitate political dialogue and share knowledge. This is, however, subject to the condition that the teachers have the skills not only to use them, but also to turn them into

resources and share them. That is why UNESCO encourages the development of these resources, among other things through the Paris OER Declaration, of which it is a signatory. This Declaration encourages States to contribute to raising the awareness and use of these resources, create environments that foster the development of information and communication technologies and promote open licences, especially for educational materials produced with public money.

**ACTIONS AND TOOLS FOR MANAGEMENT OF THE EDUCATION SYSTEM
IN SUB-SAHARAN AFRICA**

	IN SCHOOL		OUT OF SCHOOL
	Specific place dedicated to computers	In the classroom	
Objective	Fairness of access to digital resources	Individual use of the digital tool in a collective setting	Individual use of mobile technologies
Tools	<ul style="list-style-type: none"> • Fixed/laptop computers • Tablets 		
		<ul style="list-style-type: none"> • Mobile phone • E-reader • Television/radio 	
Educational benefits	<ul style="list-style-type: none"> • Access to quality input • Access to quality interactive multimedia content • Familiarization with computing tools 		
		<ul style="list-style-type: none"> • Working tools (school textbooks, etc.) • Digital campuses 	<ul style="list-style-type: none"> • Literacy • Remote access to knowledge • Access to personalized content • School support <i>via</i> learning supports
Options already implemented	Programmes for supplying computer hardware in the 1990s	<ul style="list-style-type: none"> • One Laptop per Child • One Tablet per Child 	<ul style="list-style-type: none"> • Radio-TV educational programmes • BBC Janala • MoMaths • Worldreader • Tangerine • Rehan School

ACTIONS AND EDUCATIONAL TOOLS FOR TEACHERS IN SUB-SAHARAN AFRICA

	IN SCHOOL		OUT OF SCHOOL
	Specific place dedicated to computers	In the classroom	
Objective	Fairness of access to digital resources	Quality and diversification of teaching methods	Improved initial and continuing professional training of teachers
Tools	<ul style="list-style-type: none"> • Fixed/laptop computers • Tablets 		
		<ul style="list-style-type: none"> • Mobile phone • E-reader • Television/radio 	
Educational benefits	<ul style="list-style-type: none"> • Access to quality input • Familiarization with computing tools 		
		<ul style="list-style-type: none"> • Enriches what teachers can offer • Aids in preparation and organization of lessons • Makes up for the shortfall in textbooks • Access to platforms for discussion 	<ul style="list-style-type: none"> • Develops skills of teachers in initial or continuing training • Remote monitoring of pupils
Options already implemented	Programmes for supply of computer hardware	<ul style="list-style-type: none"> • Sesamath • Global e-Schools and Communities Initiative • SMS Story 	<ul style="list-style-type: none"> • Teacher Education in Sub-Saharan Africa (TESSA) • IFADEM • New Partnership for Africa's Development (NEPAD) • Teacher Training Initiative for sub-Saharan Africa (TTISSA)

THE CFIT PROJECT: ICT TO IMPROVE THE QUALITY OF TEACHER TRAINING

One of the challenges is to ensure that the institutions providing initial training for teachers become pioneers in the use of ICT, in particular by improving the equipment and skills of the trainers.

The UNESCO project, "Enhancing Teacher Education for Bridging the Education Quality Gap in Africa" therefore aims to transform the learning methods in the teacher-training institutes, notably by introducing the use of ICT. Financed with help from the Chinese

Government, it was launched in November 2012 after the Global Education for All Meeting. Eight countries are taking part: Congo, Côte d'Ivoire, Ethiopia, Namibia, Liberia, Uganda, the Democratic Republic of the Congo and the United Republic of Tanzania. While the project takes different forms depending on the country, it essentially involves providing equipment and building the capacities of those training teachers, with the innovation of setting up of a regional network to encourage the exchange of experiences among the countries taking part.

Teacher with a tablet in the Democratic Republic of Congo.



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ACTIONS AND TOOLS FOR MANAGING THE EDUCATIONAL SYSTEM IN SUB-SAHARAN AFRICA

Objective	<ul style="list-style-type: none"> • Strengthen fairness in access to digital resources • Optimize the Educational Information Management System (EMIS) • Make information available at regional level for sharing between schools and parents
Tools	<ul style="list-style-type: none"> • Fixed/laptop computers • Tablets
	<ul style="list-style-type: none"> • Mobile phone
	<ul style="list-style-type: none"> • Television/radio
Educational benefits	<ul style="list-style-type: none"> • Access to quality input • Familiarization with computing tools
	<ul style="list-style-type: none"> • Improved human resources management • Effective management of education system budgets • Sharing of information in the education management system
	<ul style="list-style-type: none"> • Comparing school performances in different schools and measuring the impact of the projects initiated • Following up performance indicators (absenteeism, results, etc.) • Sending parents the school performance reports on their children • Setting up a joint user network
Options already implemented	<ul style="list-style-type: none"> • Programmes for the supply of IT hardware • NEPAD eSchool Business Plan • Real-Time Access and Utilization of Children’s Learning Data • UNESCO-IIEP

4

Conditions for the successful use of ICTE in education in sub-Saharan Africa

For ICTE to play their full part as a lever for educational improvement in sub-Saharan Africa, particular care will have to be taken to respond to the technico-economic constraints and the needs of users, to find “sustainable” funding sources and lay the groundwork for lasting and efficient multi-player cooperation.





Teacher with a tablet in the Democratic Republic of Congo.



4.1 | Responding to technico-economic constraints and user needs

RELYING ON THE TECHNOLOGY BEST SUITED TO THE CONTEXT

Local technical, logistical and infrastructural constraints are considered as one of the major obstacles to the deployment and use of digital technologies for teaching and learning purposes. In sub-Saharan Africa in particular, where close to 600 million inhabitants still had no electricity in 2014, infrastructural problems represent a considerable barrier to the integration of ICT into educational programmes, and go some way to explain the mediocre results obtained by the first generation of projects in this field.

Access to electricity and the telephone networks to be able to make phone calls or use the Internet is very uneven, as we have already pointed out. As a reminder, only 12% of the population has access to a reliable Internet connection (World Bank, 2012). The very few schools that have an Internet connection find that their use is limited by power cuts and low connection speeds.

An additional problem is that of hardware maintenance. This is particularly the case for computer equipment, which does not stand up well to the climatic conditions (the heat, and the often damp and/or dusty environment in



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Solar panels supplying the Abomey teacher's college with electricity (Benin).

the classrooms, especially in rural areas) and may be weakened by computer viruses. This point is furthermore factored into the total cost of ownership (TCO) of the systems put in place because, as emphasized in a study by the Vital Wave Consulting firm, the initial cost of a computer for use in education accounts, over a five-year period, for less than 28% of the total cost over its lifetime, and 13% in the case of low-cost computers. Failure to address this aspect explains why the installed base of computers in schools is rapidly becoming unusable for lack of the financial means and the spare parts needed to maintain and repair them (Karsenti, 2009).

An analysis of TCO also reveals that, aside from the technical aspects and maintenance problems, projects must also factor in change management and the training of the players.

Thus, the challenge lies not so much in the initial provision of hardware as in the capacity to select the technology that is best suited to the context – though mobile technologies in many ways make it easier to meet those challenges – bearing in mind that technology, maintenance and use are closely connected, as is borne out by a detailed analysis of the territories and in particular the gap in development between urban and rural areas.

ACCESS TO ELECTRICITY IN SUB-SAHARAN AFRICA: CONSTRAINTS AND OPPORTUNITIES

In sub-Saharan Africa, only 16% of households, fewer than 5% in rural areas, have access to the services of an electricity provider, which makes it harder to deploy technology. It is therefore not unusual for the owner of a mobile phone to travel fifteen kilometres to recharge his or her mobile.

This energy divide, caused by major infrastructural problems, has led a number of entrepreneurs to invest in the solar energy sector, which represents an interesting alternative to the deployment of traditional electricity services. As an example, solar chargers in public places

allow a mobile phone to be charged for an average of only 12 US cents. This use of solar energy moreover creates new businesses for small entrepreneurs, while at the same time saving time and money for the users.

According to the "Overview of the Off-Grid Lighting Market in Africa" report, drawn up by the Lighting Africa programme of the World Bank and the International Finance Corporation (IFC), sub-Saharan Africa is becoming the biggest market in the world for off-grid electricity. 250 million people stand to benefit from electricity produced in this way by 2030.

MAKING PROJECTS FIT EXISTING PRACTICES

The primary response in terms of change management is, on the one hand, to rely on technology that is relatively widely spread among the target populations, and on the other to mobilize local cultural support. In fact, projects that fit within existing practices have the strongest likelihood of being adopted by the target public.

This suggests that from now on, many initiatives will seek to better adapt the technologies and teaching content to the needs of teachers and pupils and to specific local characteristics.

One illustration of this approach can be seen in the awareness-raising and citizenship education project designed for children, named "Apisha Paro" ("Parents' promise") (E-Learning Africa, 2013) initiated by the Kenyan Government in the run-up to the presidential elections of March 2013, which aimed to encourage children to ask the adults around them to give a written undertaking to vote and to abide by the result of the elections. By harnessing the children's shared local and cultural references, as well as the various media controlled by the different parties involved (cartoon strips, FM radio broadcasts, SMS, use of social networks and so on) to illustrate the message in a plurality of ways, the project was a real success.

On the same lines, the teacher training programme of IFADEM in Madagascar also used this technique, making use of a variety of different traditional or more recent media (teaching kit plus mobile phone, mobile phone plus radio, etc.) that have complementary effects, so as to make the project stronger and more sustainable.

However, this latter initiative also revealed that, even for relatively straightforward technologies, there was a real need for ongoing support, especially for those using a mobile phone for the first time.

SUPPORT AND CAPACITY BUILDING FOR TEACHERS AND HEADS

One study carried out in a number of African establishments, to better understand the reactions of teachers faced with the arrival of computer hardware in their schools, clearly showed that a number of teachers struggled to adopt teaching methods that make optimal use of the ICTE. There was, in particular, a disconnect between the innovations made possible by advancing technology and their actual integration into teaching in the school context.

Even if those findings related to older generations of programme, it is vital to keep in mind that while, especially with mobile technologies, the cross-fertilization of practices and media by

relying on and integrating the existing ones is a factor in the success of the projects, ongoing support for the players is still essential. Do we need to be reminded that merely distributing IT media is not enough to make ICT a lever for the improvement of education in sub-Saharan Africa? Once again, the absolute necessity must be stressed of putting programmes in place that do not leave the teachers on their own with the ICTE, be it for training themselves or training their pupils.

The involvement of the players in the educational system, such as school heads, also fosters the development and the success of innovative projects, as can be seen from the study led by Geir Ottestad, "School Leadership for ICT and Teachers' Use of Digital Tools" (Ottestad, 2013). Observation shows, in practice, that the more the respondents are invested in the use of ICT in teaching, the more inclined they will be to support the teachers in integrating ICT into school and to adopt fresh teaching methods. Programmes should also be deployed that are specifically designed for them.

Lastly, while there are noteworthy initiatives like the NGO iEARN (International Education and Resource Network), which operates in many sub-Saharan African countries and is developing a programme specifically designed to train teachers in IT and the Internet, the use of ICT should be seen in the context of the more

widespread problem – the inadequate general and professional levels of many teachers who are fresh from mass recruitment. This is being tackled by initiatives like the IFADEM TESSA (Teacher Education in Sub-Saharan Africa) programme, from which 400,000 teachers in 12 African countries have benefited, or the UNESCO-China Funds-in-Trust (CFIT) project

called “Enhancing Teacher Education for Bridging the Education Quality Gap in Africa”. This project, launched in November 2012 at the end of the Global Education for All meeting, seeks to strengthen the capacities of the ministries and the main teacher training institutes in the area of initial and continuing teacher training.

AN ICT COMPETENCY FRAMEWORK FOR TEACHERS

While the use of ICT varies according to the discipline being taught, the learning goals and the pupils, it is however still important to establish the guiding principles for the use of ICT in teaching. This is the goal of the “ICT Competency Framework for Teachers” (ICT CFT), devised by UNESCO, which sets out the many ways in which ICT can transform education. They provide attractive, rapidly evolving learning environments; they blur the boundaries between formal and informal education and encourage teachers to devise new teaching methods. In so doing, they force a reassessment of the aptitudes and competencies pupils need in order to become active members of the knowledge society and knowledge economy.

The Framework puts the emphasis on the skills teachers need in order to make information and communication technologies an integral part of how they practice their profession, and aims to offer support in drawing up national standards and policies in this area. It is built around three stages of learning: technological literacy (in which pupils use ICT to learn more effectively), in-depth knowledge (in which pupils acquire more in-depth knowledge in the disciplines they study at school and apply this to practical problem-solving), and knowledge creation (in which pupils, as citizens and future economic players, create new knowledge in order to build more harmonious and prosperous societies).

THE FRENCH-SPEAKING DISTANCE TEACHER TRAINING INITIATIVE (IFADEM) IN MADAGASCAR

In Madagascar, IFADEM, coordinated by the *Agence universitaire de la Francophonie* (AUF), in partnership with the Madagascar National Professional Training Institute (INFP), Orange and *Agence Française de Développement* (AFD), launched the “mobile-assisted learning” programme, which enabled teachers to be remotely supported throughout a 9-month continuing training course, using mobile phones and tutoring. The experiment, which involved 436 teachers and 22 tutors, took place from August 2012 to April 2013 in the Amoron’i Mania province, in central Madagascar.

At the start of the training, all participants received a mobile phone with an MP3 player in addition to the traditional teaching kit comprising training manuals, a dictionary and grammar book.

Sound files, linked to the self-training manuals, were loaded onto the phones and the teachers could listen to them at their leisure. A private virtual network (*via* a “fleet subscription”) was made available to them, enabling the tutors and teachers to communicate throughout the entire length of the training. MCQs were sent each day, related to the content of the IFADEM manuals, which the teachers could answer directly on their phones. If the answer was wrong, a message told them which part of the manual to look in for the right answer, thus helping keep up their motivation levels and encouraging them to read the manual. Throughout the training, allowances were paid to the teachers and trainers to cover the costs of travel and accommodation. To ensure the

security of these financial transactions, the money was transferred directly to the teachers’ mobile accounts and could be withdrawn by them at an Orange boutique.

The experiment was evaluated by external experts. Their reports revealed, among other things, that:

- Participation in the MCQ campaign was a strong indicator of results in the final evaluations. A gap in the theoretical evaluations of six points was recorded between the teachers who took no part in the MCQs and those whose participation was highest.
- The telephone fostered the building of real user communities, usually based on geographical proximity, and reinforced the role of the tutor in the training.
- The absence of network coverage, not failure to master the technology, was the main reason for the low level of use of the phones by some teachers.
- The supply of solar chargers for the phones proved indispensable in rural areas.
- The phone is a better medium than simple MP3 players or radio sets for making audio resources available to teachers in continuing training.
- As well as self-training and ongoing support, several teachers interviewed as part of a qualitative survey mentioned the use of sound files in class, which had not been part of the initial recommendation (Jaillet *et al.*, 2013).



4.2 | Finding “sustainable” funding models

A reminder is probably needed at the outset that the primary source of funding does not necessarily involve extra spending! It could even be said that most of the projects that become “sustainable” will be ones that do not require additional financing, in that they take over an existing budget, by offering an improved service at an equivalent price or driving down costs in the long term (for instance the logistical cost of the distribution of teaching materials or providing in-person training) by using ICT.

SPECIFIC FEATURES OF THE DIGITAL ECONOMY AND INSTRUMENTS OF PUBLIC INTERVENTION

The digitization of society is working radical changes in modes of consumption and prod-

uction, which will also have an effect on the education sector. Many goods and services are characterized by:

- The preponderance of fixed costs in the initial phase of development or production, and low or even negligible marginal costs once the first unit has been produced.
- The difficulty of practising exclusion by price, and/or the fact that consumption by one more person does not diminish the satisfaction of the others.
- Positive externalities, in the sense that the consumer behaviour of one party has a positive impact on the wellbeing or behaviour of others, without this playing any part in his or her decisions.



© Orange

Group of college schoolgirls in Niger, using tablets recharged with solar chargers.

Illustrations of these three cases can be found in:

- The software or news industries, where dematerialization means copies can be made for virtually no cost.
- The difficulties encountered by the music and publishing industries, especially in terms of payment for copies of works.
- The finding that the usefulness and value of a trading platform increases with the number of users.

These characteristics argue in favour of new economic models for the industries concerned, and new instruments for public

intervention, close to those of the public economy. For instance, companies producing goods whose production characteristics show growing returns could be made subject to laws or regulation or, though this is less frequent nowadays, nationalized in order to restrict the profit from their monopoly. The production of a collective asset could be taken over by the public authorities, made the subject of a public-private partnership with business, or provided with a framework that stimulates the community growth of open resource creation. Producers of goods with positive externalities, often under-consumed because their prices are too high, could be given public subsidies to sell them for less, or the buyers could be subsidized so as to be able to buy them at their market price.

THE OPEN SOURCE MODEL AND FREE-OF-CHARGE COMMUNITY RESOURCES

The Open Source model refers to software whose licence complies with the criteria specifically laid down by the Open Source Initiative, in other words freedom of redistribution, of access to the source code and of modification. Interest in this freely available software (Free/Open Source Software – FLOSS) is growing fast in Africa. The Schoolnet Namibia initiative was one of the first to promote FLOSS in the country's schools, via its OpenLab model set up in February 2000. Today, more and more countries are going down this route. Thus, while the South African Government has signed a partnership agreement with Microsoft, it also champions the use of open source software, and promotes its use in all its schools.

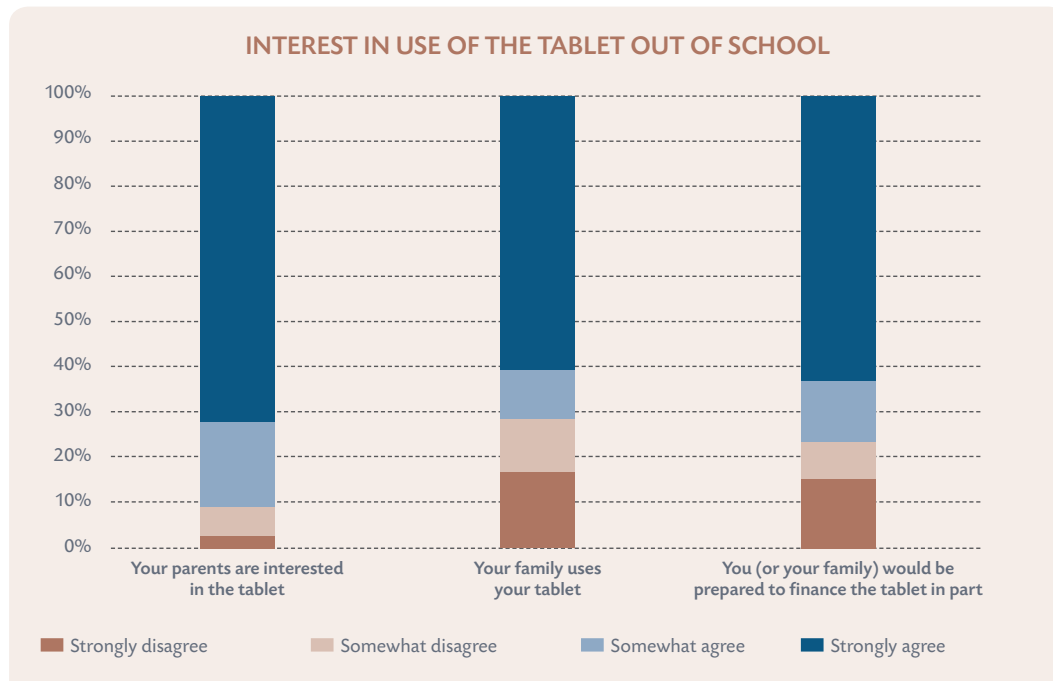
A number of organizations have been set up with a view to encouraging the use and spread of this software for training and teaching purposes. Launched in February 2003 in Bamako, the Free and Open Source Software Foundation for Africa (FOSSFA) is a network of practitioners, professionals and organizations promoting the use of open-source software. FOSSFA has an education subdivision focusing on the promotion of open-source solutions in education in Africa. The LinuxChix Africa organization, set up in 2004, is based on the same founding principles with the accent on gender equality in access to IT training. Lastly, *Bokjang Bokjef* also promotes the use and development of open-source software in Senegal.

Founded as a private initiative in France in 2001, *Sésamath* aims to foster the development of exchanges between mathematics teachers through the use of ICT. The association distributes via the Internet, free of charge, open-source teaching resources and working tools, and also works in the collaborative design of resources (school textbooks and exercise books). With over 900,000 pupils signed up in 2011 to *Labomep*, a software programme of personalized online exercises, and 14,000 teachers signed up to *SésaProf*, a platform for exchanges and discussion among teachers, the association has opened the way to the creation of personalized multimedia teaching content, while at the same time fostering collaboration among teachers. Adaptation of the teaching resources made available by *Sésamath* under open-source licence to the needs of other French-speaking countries, especially in Africa, has begun under the leadership of a private publisher, Agathe Amoikon. The project thus differs somewhat from the original philosophy of *Sésamaths* France in that the adaptation to the African context is being paid for by this publisher and will therefore be subject to its rights. The digital version will not, therefore, be free of charge and the return on investment is set to come from the paper versions of the work, although these will cost less than “traditional” school books.

PROMOTING SHARED USE

The major programmes for bringing in ICT to the educational sectors, as described in the previous chapter, have essentially been financed out of public budgets. By contrast, many of the new ICT uses and equipment that can be used for education have been developed outside the classroom and are for the most part the product of private funding.

Recent technological and societal developments have raised some questions over these frontiers. As an illustration, mobile devices (laptops, mobile phones, MP3 players and tablets) easily cross the boundaries of space and time: a device purchased with public funds and used within a school establishment can now easily enter the pupil’s family home, while a pupil’s or teacher’s own personal device can be used within the school context – a trend



covered by the term BYOD. This interchangeability of uses has led to the focus shifting from the object and its ownership to the use made of it, as is being formally recognized in the emerging field of the collaborative economy, one of the challenges of which is to consume better by making more intensive use of the resources available.

A State might directly finance the purchase of tablets for its educational system, but it could also subsidize families to do so. Those families could, in exchange for a contribution, also use the device for private purposes.

As part of a trial of digital tablets in Niger, one survey showed that 60% of middle school pupils stated that the tablet was used by their family, 70% of parents thought it was of interest to them, and 60% of them would be prepared to contribute to the purchase price.

MOBILIZING FAMILIES ACCORDING TO THEIR MEANS

For most countries, the financing of education is predominantly public. Very often, the only expenses that still fall on families are enrolment fees, transport costs, and the costs of school meals, lodging and school supplies. The public funding of education is based on the principle of compulsory schooling, which applies to all children of a given age. In primary school, for instance, given that annual spending per

pupil sometimes represents a very substantial portion of household revenue, the lack of public funding would *de facto* exclude many children.

Above the legal age for compulsory schooling, the principle of mainly public funding supposedly meets the demands of fairness or equality of opportunity. Nonetheless, where large groups of the poorest children on the margins do not have access to, or complete, their primary education, and/or access to post-primary schooling is excessively biased in favour of children from better-off backgrounds, some economists (Beillerot and Mosconi, 2006) argue that the better-off families should be made to pay and students from modest social backgrounds given grants from public funds, in order to avoid negative redistribution.

Furthermore, this latter argument seems particularly apposite in view of the private individual profitability of the educational investment (calculated at the personal level), which is greater than its social profitability as the majority of costs are borne by the public authority. There is also the fact that rates of return differ according to educational level: these differences are, for private and social returns respectively, nearly 37% and 25% for primary, 24% and 18% for secondary, 28% and 11% for higher education (Paul, 2007).

In most countries, public resources are subject to stringent budget constraints. Public authorities who wish to prioritize their ICT spending might ask families for a higher contribution to their funding. The general idea would be to resort to private funding, calling first of all on the highest level pupils (higher, then secondary) as well as the best-off families and at the same time to set up a system of subsidized or free education for the less well-off and/or primary pupils.

INVOLVING BUSINESSES

Companies working in the ICT sector (infrastructures, telecoms, content and terminals) could also have something to gain from participating in the financing of the ICT deployed in the education sector.

Their participation might be totally disinterested, as when they finance programmes *via* their foundations, this initiative helps strengthen their brand image. However, it should be noted that this source of financing can only ever be marginal in terms of the region-wide or nation-wide need for equipment.

Companies can also give heavy discounts on the products and services provided to educational establishments, both for reasons of corporate social responsibility and “citizenship” and out of a desire to invest in teachers, whom international surveys show are major

consumers of equipment and communications.

Groups like Microsoft, Orange, Intel and Cisco, to name but a few, offer software packages, Internet services, microprocessors and hardware at preferential rates. Their detractors point out that these companies also have a more direct commercial interest in doing so. Once working habits are acquired with one software package, cognitive costs arise if the individual is forced to switch, which builds a degree of loyalty. The main consideration seems to be that there is a “win-win” relationship between the companies, the public authorities and the consumers. Here, one can cite the experience of IFADEM in Madagascar, where the operator Orange drastically cut its charges for communications for professional use (calls between peers, teachers and/or tutors, were paid for by the project funders and not the users themselves), but was able to justify its “investment” by swiftly building its installed base of customers, as almost 30% of the IFADEM participants were first-time mobile phone owners, and those taking part in the experiment used the SIM card supplied for private calls for which they paid.

Lastly, one sees more and more projects based on alternative sources of funding. Micro-finance and crowdfunding are providing new tools for funding educational projects in sub-Saharan Africa. Some resources are

also being made available completely free of charge, as with the open-source resources we have just described. While the list of possible scenarios for funding a product or service harnessing ICT for educational purposes is not exhaustive, the various interested parties

can find many reasons to justify their participation. But reliance on innovative business models, each of which depends on the commitment of very diverse players, sometimes with opposing interests, calls for hitherto untried models of cooperation.

THE TEXTBOOK IN THE DIGITAL AGE

The still uncertain market for digital publishing, notably in Africa, illustrates the need to develop new business models. The characteristic of a digital book is first of all that it drives down variable costs: *“Unlike the fixed costs of creation, also called the ‘costs of expression’ (the work of the author and the cost of producing a manuscript) which do not vary according to the numbers of copies produced, it is mainly the variable costs of production and distribution that can change, or even in some cases disappear with digital publishing. These are the printing (around 17% of the sales price before tax), and the part of the costs of dissemination (around 7%) and distribution (around 13%) that relates to physical transport. If one adds storage, it is possible to save up to 50% of the value of the paper product”.*

The foundations of the printed book industry in Africa are very fragile, so the transition to digital is an opportunity, especially for school publishing, which alone accounts for 75-95% (including up to 80% of imported textbooks) of the sector compared to 10% in Europe.

Thought and experimentation will probably have to go into testing the various possible models: production of school content by public entities such as Indrap in Niger or Cripem in Djibouti, which includes royalties in the fixed costs, where they are written by employees of that body; subsidies to private publishers in order to have free-of-charge electronic versions; or encouragement to produce community resources as we have seen with *Sésamaths*. In all likelihood, in the short term, all these models will form part of the mix.



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Digital resources
accessible on tablets.



4.3 | Laying the groundwork for effective, lasting multi-player collaboration

STRUCTURING COLLABORATIVE APPROACHES

The analysis of projects aimed at introducing ICT in response to the challenges of the social economy, especially in the education sector, points up the emergence of new forms of partnerships, bringing together start-ups, small and medium-sized businesses, big multinationals, public authorities, universities, financial backers, NGOs and so on. The interest of this approach lies in the way it mobilizes different sources of funding around these projects – as we have pointed out above – and harnesses various types of skills and sensitivities, which are vital in designing and implementing projects that respond to the

needs of different populations, relying on the most relevant innovations to come from the private sector or the collective social economy.

But, whether they are initiated by private enterprise, philanthropic foundations or NGOs, even today there is an observable lack of coordination and cohesion among these initiatives. These partnerships most probably find themselves confronted with cultural differences between the structures involved.

In addition, initiatives run as projects on a micro-local level have all too often been detached from the educational priorities defined at national level and not coordinated with any other experiments.



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ICTE can only be deployed through consultation and partnerships between the different actors and by the involvement of public authorities.

In order to move past the pilot stage and put real national strategies in place for ICT, the different players (State, businesses, NGOs and financial backers) need to cooperate to produce programmes that are structured from the design phase through to evaluation, to avoid the “silo” mentality.

PROMOTING THE STRATEGIC STATE

The steering of these partnerships by the state offers a real opportunity to make ICTE a permanent part of the educational landscape in Africa. Projects might be devised with no public authority involvement, but without it, implementation will be impossible. Securing the support of African governments and

education ministries as early as possible in the process is a *sine qua non* for the effective and lasting deployment of the new technologies in education.

With this in mind, States need to define their needs clearly, decide on the precise role they want ICT to play in education, set down the guidelines and provide a macro-national framework to ensure the different ICT initiatives go forward in a consistent, coordinated manner. As an example, the South African Ministry of Education published a White Paper on e-education in 2004, ensuring that an institutional framework existed that was favourable to the integration of ICT in education (Ministry of Education, 2004).

MOMATH, BBC JANALA: GOOD EXAMPLES OF MULTIPARTY COOPERATION

“Mobile educational applications are showing very positive results.”

The South African Government gave the Nokia telecommunications group a mandate to set up a programme using mobile telephony as an educational medium. The South African social networking platform MXit was used to send out mathematics exercises, as part of the “Mobile mathematics” (MoMath) project the company had initiated in that country. Through that application, theory lessons, exercises and tutorials corresponding to the national programme approved by the Ministry of Education were made available free of charge to participants and teachers, who could communicate with each other *via* the platform.

The first recorded results in South Africa suggest that the programme has succeeded in benefiting from the contribution of technology, while at the same time ensuring quality of content. An evaluation of the project in 2010 (United Nations, 2011) showed that 82% of learners used the service outside school hours, during the holidays and at weekends.

This success is the fruit of a multiple partnership model between the Ministry of Education, a local NGO, three big mobile operators, Nokia, a local textbook publisher and MXit, the company that runs the online discussion platform (UNESCO, 2013), the operating costs of which are extremely low.

The cross-media English language-learning programme BBC Janala, in Bangladesh, is an iconic example of cooperation between very diverse players, for both its funding and implementation. The development costs and part of the operating costs (excluding phone communications) of this project, which was run by the BBC World Service Trust, were funded by a public body, the British Department for International Development (DFID). The programme was also supported by six telecoms operators, which reduced their prices to the cost of a local call, allowing the users of BBC Janala to call at a rate 10 times less than that of other added-value services offered by the mobile operators. Lastly, the end-users made a contribution, because they had to pay the price of that local call and were using their own device. This service would most probably not have come into being, or been so successful with such a wide audience, if it had been necessary to amortize the fixed costs of development, bill the service at its true production cost and supply the hardware.

The analysis of both these experiences argues in favour of involving all the interested parties in financing and implementing ICT in education so as to make the projects “sustainable”.

In all, the State must play a decisive role as the driver of ICT integration, ensuring swift deployment on a national scale.

The growing power and involvement of the public authorities should enable a national strategy to be drawn up that includes, in particular, a series of financial or regulatory incentives, ensures that the expertise available in the private sector is directed towards meeting the educational needs of the population as a whole, builds the capacities of those carrying out local projects and ensures they are targeted at a suitably diverse public.

DEVELOPING THE CULTURE OF EVALUATION AND EXPERIMENTATION

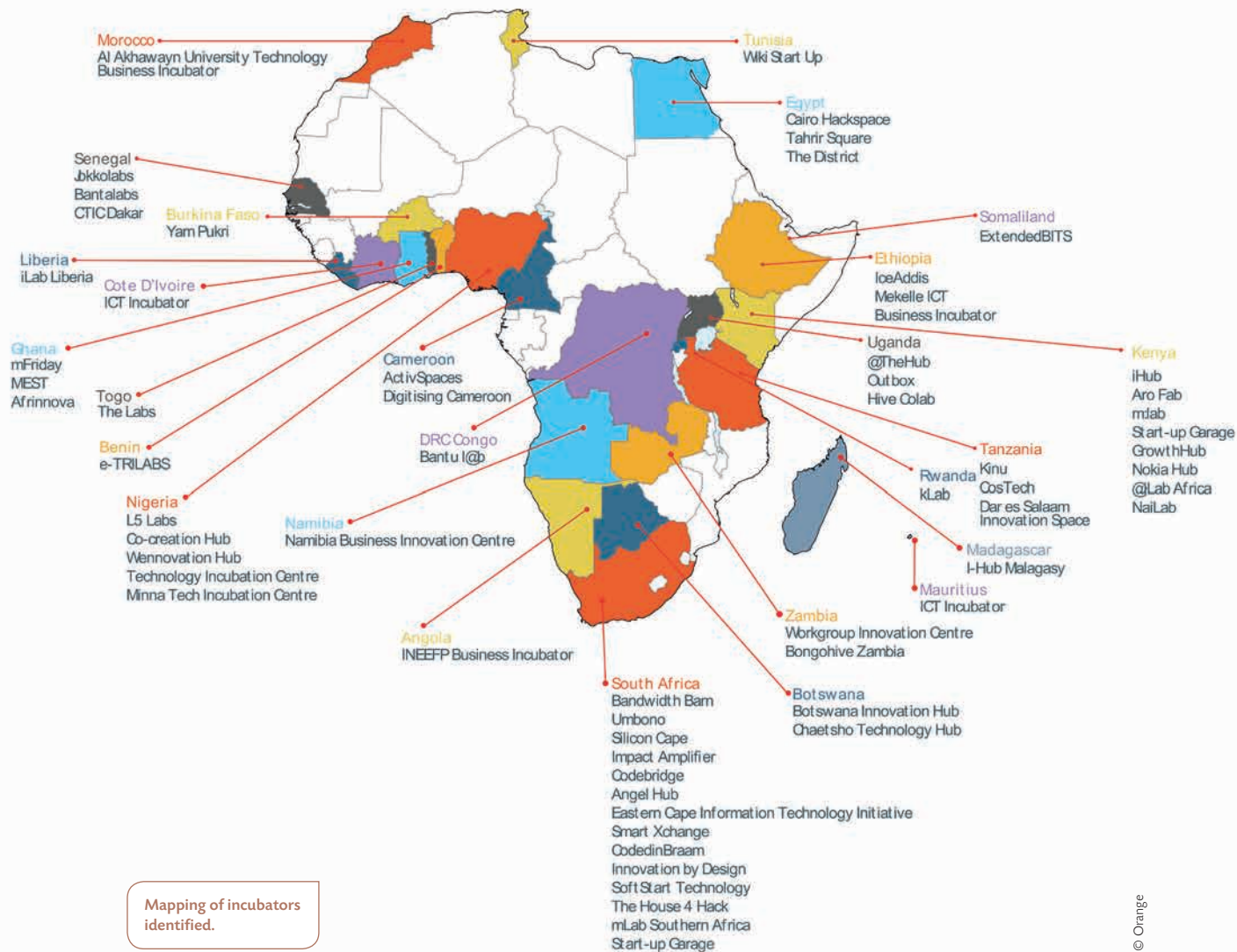
The development of rigorous evaluation guards against an excess of optimism with regard to ICT, and helps identify the real contribution of information technology to education. Evaluation can be used to influence the overall design and direction of projects, as well as to adapt and modify them at the pilot stage to achieve optimum cooperation between public authorities and private players. Public authorities want proof of effectiveness before they commit, which is an argument in favour of experimenting on an ambitious scale before rolling out a solution, as Esther Duflo points out (Duflo, 2009). In addition, in the field of education, evaluation is often necessary in order to persuade national public

authorities or international institutions of the benefits of supporting innovative approaches, especially when they mark a break from established habits, practices or financing models.

SUPPORTING THE ECOSYSTEM

For some years now, dozens of African start-ups have been appearing in the digital sector. Their growing numbers attest in particular to the setting up of ongoing support structures, headed by major IT or telecoms groups, and the availability of joint public funding, aimed at developing local capacities. The start-ups are increasingly supported by local incubators, which offer them accounting, legal and marketing assistance.

As an illustration, the incubator supported by Orange and the World Bank in Senegal, set up in the 2000s, was designed to put in place a model and ecosystem favourable to the emergence and development of businesses in the ICT sector. The “incubated” businesses pay back to the incubator 10% of the difference in their turnover before and after incubation, and at the same time, they are encouraged to orient their business activities towards social projects. One could also cite the World Wide Web Foundation incubator project launched in Kenya and Ghana in April 2010, with the aid of Vodafone. That project has annual funding of US\$ 300,000, US\$ 60,000 of which is intended for the operating costs of the



Mapping of incubators identified.

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COLLECTING AND RECYCLING MOBILES: THE CHALLENGE OF THE CYCLICAL ECONOMY

Faced with the huge growth in the number of mobile phones in Africa, Orange, Emmaüs International, the Morphosis company and various interested parties set up an initiative in 2010 aimed at developing a cyclical economy. It involves three stages:

Recover: to limit the ecological impact of used mobile phones, the collection of “old” mobiles is encouraged in France, to prolong their life cycle, recover precious raw materials and gradually bring the socially responsible business to self-funding status from France to Africa.

Repair: mobiles collected in France are sent to the Ateliers du Bocage located in Deux-Sèvres, which is a social inclusion enterprise, a member of the Emmaüs charity, which sorts and tests them. All those that are no longer usable are decontaminated and recycled, and the others are reconditioned, the personal data erased, and they are then sold second-hand, especially in Africa.

Re-use: in Africa there is a huge flood of mobile phones, and when they no longer work they become a major ecological problem. Encouraging recycling is therefore a priority. Through the workshops created by Orange France and Emmaüs International in Burkina Faso, Benin, Côte d’Ivoire, Niger and Madagascar, discarded mobiles are now collected, and then sent to France for recycling. 30 local jobs have already been created and over 1 million mobiles collected and recycled.

Recycle: the new company, Morphosis, takes direct delivery of the containers of mobile phone waste at the port of Le Havre. It sorts each type of waste and handles them according to their composition. In particular, it recovers rare metals from the electronic cards, which can be used again in the manufacture of new products.



Initiatives to collect, repair and recycle mobile phone devices are growing in France and Africa with the aim of giving them a new lease of life.

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| Annexes

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Principal abbreviations and acronyms

Annex 2 _____ 105

Glossary



The Karamajongs account for the majority of the population in Northeast Uganda. Teachers have dropped textbooks and pencils and now use blackboards and chalk. The material is less expensive and more suited to the region's dry climate.



JIRWA AELAP	LCENTRE	EKIMAR ATIDWE	ESSA
7-12-2009	LORUKUMU LC	JISATA 21	IPRESUK 24
Kumar Kigir: (Numeracy)		TOSUM Kigir: (Literacy)	
2+1+2=		Elap	
2+3=		[Diagram of a structure]	
1+0=		ayokat	
3+10=		-erikat	
4+0=		-jibaren	
5+1+		-ekuwam	
1+1+		-ayakat	
		-Jakipi	

2+2=5
2+3=35
1+0=
3+4=64

2+2=5
2+3=35
1+0=
3+4=64

2+2=5
2+3=35
1+0=
3+4=64

2+2=5
2+3=35
1+0=
3+4=64

1234
101112
KINO 19
12+4=5
25+6=7
32+66
40+5
5-88

Annex 1 Principal abbreviations and acronyms

ABSOLUTE	Aerial Base Stations with Opportunistic Links for Unexpected & Temporary Events	INFP	Madagascar National Professional Training Institute
ACE	African Coast to Europe	ITU	International Telecommunication Union
ADB	African Development Bank	IWB	Interactive Whiteboard
ADEA	Association for the Development of Education in Africa	LMS	Learning Management System
AFD	<i>Agence Française de Développement</i>	MDG	Millennium Development Goals
AUF	<i>Agence universitaire de la Francophonie</i>	MIT	Massachusetts Institute of Technology
AVU	African Virtual University	MOOC	Massive Open Online Courses
BCG	Boston Consulting Group	MCQ	Multiple-choice Questionnaire
BYOD	Bring Your Own Device	NENA	New African digital publications
CFIT	China Funds in Trust with UNESCO	NEPAD	New Partnership for Africa's Development
CFSK	Computer for School in Kenya	NGO	Non-Governmental Organization
CONFEMEN	Conference of Ministers of Education of French-speaking countries	OECD	Organization for Economic Cooperation and Development
DFID	Department For International Development (the UK development agency)	OER	Open Educational Resources
DIENA	French Interministerial Delegation for Digital Education in Africa	OIF	<i>Organisation internationale de la francophonie</i>
EFA	Education for All	OLPC	One Laptop per Child
EMIS	Educational Information Management System	OTPC	One Tablet per Child
FLOSS	Free/Open Source Software	PASEC	Program for the Analysis of Education Systems
FOSSFA	Free and Open Source Software Foundation for Africa	PCR	Primary Completion Rate
GDP	Gross Domestic Product	PETV	Programme for Education by Television
GMAT	Graduate Management Admission Test	PICOM	Madagascar Telecoms Infrastructure Project
GNP	Gross National Product	PPP	Public-Private Partnership
GPI	Gender Parity Index	PTLP	Primary Teaching Learning Program
GRE	Graduate Record Examination	REPTA	Education for All Network
GSM	Global System for Mobile communications	SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality
HTS	High Throughput Satellite	SAEx	South Atlantic Express
ICT	Information and Communication Technologies	SAT	Scholastic Aptitude Test
IDI	ICT Development Index	SIM	Subscriber Identity Module
IFADEM	French-speaking remote teacher training initiative	SMS	Short Message Service
IFE	<i>Instituts de formation des enseignants</i>	TESSA	Teacher Education in Sub-Saharan Africa
IFC	International Finance Corporation	TTI	Teacher Training Institutes
IIEP	UNESCO International Institute for Educational Planning	UNESCO	United Nations Educational, Scientific and Cultural Organization
Indrap	<i>L'Institut national de documentation, de recherche et d'animation pédagogique</i>	UNICEF	United Nations International Children's Emergency Fund
		UPE	Universal Primary Education
		USAID	United States Agency for International Development
		VSAT	Very Small Aperture Terminal
		WACS	West Africa Cable System

Annex 2 Glossary

Bandwidth: Volume of information that can be carried on a telecommunications line. The larger it is, the faster the information is transmitted.

Big Data: Collection, exploration and analysis of large masses of data for statistical purposes.

Broadband: Expression used to denote high-speed transmission networks.

E-book: Work that can be read on a computer, touch-screen tablet or dedicated device called an e-reader.

E-learning: Online learning focused on developing the learner's skills, structured around interaction with the tutor and peers.

Free software: Software that is distributed free of charge, online or *via* diskettes or CD-Rom.

ICT: Computer tools, hardware and software, used in the information society.

ICT in Education (ICTE): Field of information and communications technology devoted to education-related research and applications, specifically with reference to teaching-learning initiatives, approaches, methods, processes and techniques that involve the use of digital tools for educational purposes.

M-banking: Financial services (viewing account balances, transferring money, paying bills, etc.), available *via* a mobile device connected to a network.

M-farming: Services more or less closely related to farming, permanently available *via* a mobile device connected to a network.

M-health: Services more or less closely related to health, permanently available *via* a mobile device connected to a network.

M-learning: Learning, in person or remotely, based on mobile technologies, designed to provide solutions suitable for people on the move.

Open or Open Source software: Software subject to a licence based on the principles of allowing freedom of use, modification and distribution.

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AGENCE FRANÇAISE DE DÉVELOPPEMENT (AFD)

AFD, the *Agence Française de Développement*, is a public development-finance institution that has worked for 70 years to alleviate poverty and foster sustainable development in the developing world and in the French Overseas Provinces. AFD executes the French Government's development aid policies.

Working on four continents, AFD has seventy-one field offices and bureaus, including nine in France's overseas provinces and one in Brussels. The Agency provides financing and support for projects that improve living conditions, promote economic growth, and protect the planet.

In 2013, AFD committed €7.8 billion to projects in developing and emerging countries and in the French Overseas Provinces. These AFD-financed projects will provide schooling for children, improve maternal health, promote equality between men and women, support farmers and small businesses, and bolster access to drinking water, transportation and energy. These newly-funded projects will also help mitigate climate disruption by abating nearly 3.3 million metric tons of carbon dioxide-equivalent annually.

www.afd.fr/lang/en/home

UNESCO

Since its creation in 1945, UNESCO's mission has been to contribute to peace, poverty reduction, sustainable development and to the intercultural dialogue, and education is one of its main activities in order to achieve this objective. The Organization defends the right of each individual to high-quality education and firmly believes that education plays an essential role in human, social and economic development.

In the education sector, its action aims to achieve Education for All (EFA) and to strengthen education systems all over the world.

UNESCO is the only United Nations organization with a mission covering all the aspects of education: from preschool to higher education, including literacy, non-formal education, and technical and vocational education and training.

The Organization gives special attention to progress in equity and access, to improving quality, and ensures that education develops knowledge and skills in fields such as sustainable development, the fight against AIDS, human rights and gender equality. It works together with governments and a wide range of partners in order to enhance the effectiveness of education systems through policy changes.

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AGENCE UNIVERSITAIRE DE LA FRANCOPHONIE

The *Agence universitaire de la Francophonie* is an international association of French-speaking universities, which aims to establish links between French-language universities. The association has been working in the sector of higher education and research for over 50 years. Its objective is to support the training of professionals who are capable of contributing to the development of their countries.

It comprises 800 universities on the five continents and in a hundred countries, including 59 member countries (or observers) from the International Organization of La Francophonie. It is the operator specialised in Francophonie for higher education and research.

The association's mandate is to support the development strategies of member institutions, bring out a new generation of teachers, researchers, experts and professionals and development actors, and promote the French-speaking scientific community, so that it becomes an international reference and provides its contribution to global issues (climate change, poverty, agriculture, food security, health, law...). AUF conducts its activities by developing partnerships with various organisations (UNESCO, EU, NGOs, private sector companies...).

www.auf.org

ORANGE

Orange is one of the world's leading telecommunications operators with sales of EUR 41 billion in 2013 and 159,000 employees worldwide at 30 September 2014, including 99,800 employees in France. Present in 30 countries, the Group had a total customer base of 240 million customers worldwide at 30 September 2014, including 182 million mobile customers and 16 million fixed broadband customers. Orange is also a leading provider of global IT and telecommunication services to multinational companies, under the brand Orange Business Services.

The Orange Labs undertake the Group's research activities and coordinate its standardisation activities. They also manage its network strategy. They have overall technical responsibility for Orange products and services, from the definition and creation of innovative services to the maintenance of the solutions implemented in each country. The Orange Labs are present in 9 countries, over 3 continents. Each centre is integrated into a geographic ecosystem of its own, as close as possible to local markets, and works in a network with all local players (associations, start-ups, businesses, universities, research laboratories...) as well as international bodies and collaborative projects.

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