Transformation-Ready: The strategic application of information and communication technologies in Africa

Education Sector Study

FINAL REPORT

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Abbreviations

AAU	Association of African Universities
ACE	Advanced Certificate in Education
ADEA	Association for Education Development in Africa
AED	Academy for Educational Development
ALICE	America Latina Interconectada Con Europa
ASGISA	Accelerated Shared Growth Initiative for South Africa
AUBC	African Universities Bandwidth Consortium
AUP	Acceptable Use Policy
AVU	African Virtual University
BECTA	British Educational Communications and Technology Agency
CAI	Community Anchor Institutions
CAT	Computer Applications Technology
CD	Compact Disc
CEO	Chief Executive Officer
CET	Centre for Educational Technology
CLARA	Cooperación Latino Americana de Redes Avanzadas
CPD	Continuing Professional Development
CPTD	Continuous Professional Training Development
CSI	Corporate Social Investment Continuous Professional Training Development
CSI	Corporate Social Investment
CSIR	Council for Scientific and Industrial Research
DANTE	Delivering Advanced Networking to Europe
DEO	District Education Offices
DFID	Department for International Development
DLR	Digital Learning Resource
DRM	Digital Rights Management
DStv	Digital Satellite Television
EFA	Education for All
ELRC	Education Labour Relations Council
EMIS	Education Management Information Systems
EthERNet	Ethiopia Education and Research Network
EUC	European Union Commission
FETMIS	Further Education and Training MIS
FOSS	Free and Open Source Software
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
GPS	Global Position System
GSM	Global System for Mobile Communications
GSMA	GSM Association
HEIs	Higher Education Institutions
HEMIS	Higher Education Management Information System
HIV	Human Immunodeficiency Virus

IBM	International Business Machines
ICT	Information and Communication Technologies
IDRC	International Development Research Centre
IEEAF	Internet Educational Equal Access Foundation
IP	Internet Protocol
IPR	Intellectual Property Rights
IRUs	Indefeasible Rights of Use
IT	Information technology
IVR	Interactive Voice Response
JANET	Joint Academic Network
KENET	Kenya Education Network Trust
LAN	Local Area Network
LCCD	Low-Cost Computing Devices
LMSs	Learning Management Systems
LPC	One Laptop per Child
LTSM	Learner Teacher Support Material
M4Lit	mobiles for literacy
Mbps	Megabits per Second
MCIT	Ministry of Communications and Information Technology
MDGs	Millennium Development Goals
MIS	Management Information Systems
MoE	Ministry of Education
MoES	Ministry of Education and Sports
MoEVT	Ministry of Education and Vocational Training of Tanzania
MTN	Mobile Telephone Network
NCERD	National Centre for Educational Resource Development
NECTEC	National Electronics and Computer Technology Centre
NEPAD	New Partnerships for Africa's Development
NESIS	National Education Statistical Information Systems
NFPTED	National Framework for Professional Teacher Education and Development
NGO	Non-Governmental Organization
NKC	National Knowledge Commission
NLR	National Lambda Rail
NRENs	National Research and Education Networks
NTN	National Knowledge Network
OECD	Organization for Economic Co-operation and Development
OER	Open Educational Resource
OLPC	One Laptop per Child
OSS	Open Source Software
PC	Personal Computer
PDA	Personal Digital Assistant
PiL	Microsoft Partners in Learning
PNC on ISAD	Presidential National Commission on Information Society and Development
POP	Point of Presence
PPPs	Private and Public Sector Partnerships
R&D	Research and Development

REN	Research and Education Network
RENU	Research and Education Network of Uganda
RIA	Research ICT Africa
RRENs	Regional Research and Education Network
SA	South Africa
SADC	Southern African Development Community
Saide	South African Institute for Distance Education
SANREN	South Africa Research and Education Network
SA-SAMS	South African Schools Administration and Management System
SCORM	Sharable Content Object Reference Model
SIDA	The Swedish Agency for International Development
SITA	The State Information Technology Agency
SITFE	Sugar Industry Trust for Education
SME	Small an Medium Enterprises
SMMEs	Small, Micro and Medium Enterprises
SMS	Short Message Service
SNSA	SchoolNet South Africa
SRS	Student Record System
SUIN	Sudan Universities Information Network
TCO	Total Cost of Ownership
TENET	Tertiary Education Network
TESSA	Teacher Education in Sub-Saharan Africa
TLI	Teacher Laptop Initiative
TORs	Terms of Reference
TPD	Teacher Professional Development
TTC	Text to Change
TV	Television
UCT	University of Cape Town
UJ	University of Johannesburg
UN	United Nations
UNDP	United Nations Development Programme
UNEB	Uganda National Examination Board
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	The United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNISA	University of South Africa
UP	University of Pretoria
USA	United States of America
USAASA	Universal Service Access Agency of South Africa
USAID	United States Agency for International Development
WGES	Working Group on Education Statistics
WGES	Working Group on Education Statistics
YAL	Young Africa Live

Chapter 1: Introduction

1 Background to the study

This study is part of a cross-sector programme of studies commissioned by the African Development Bank and the World Bank Group, with the support of the African Union. These studies have been undertaken during 2011, and will be synthesised in a report to be published in 2012 on the potential of information and communication technologies (ICT) to transform a variety of development sectors in Africa.

This study of the education sector recognises that the future development of Africa will be heavily influenced by how Africa manages to deliver quality education to its citizens. The African Union specifically acknowledged this in its *Second Decade of Education for Africa (2006-2015) Plan of Action*:

> *Education forms the basis for developing innovation, science and technology, in order to harness our resources, industrialise, and participate in the global knowledge economy and for Africa to take its rightful place in the global community. It is also the means by which Africa will entrench a culture of peace, gender equality and positive African values.*[1]

This study has examined the potential for using ICT to support the improvement and transformation of the education sector in Africa, with the aim – requested in its terms of reference – of raising awareness and stimulating action, especially among African governments and development partners. It identifies specific opportunities and challenges, and recommends areas of intervention for governments, educational institutions, the private sector and NGOs, and development partners.

The following five thematic areas were specified in the terms of reference to form the core focus of this examination:

1) ***Teacher professional development****: with an emphasis on the contextualisation and implementation of a teacher competency framework that also addresses ICT in education.*
2) ***Digital learning resources****: with an emphasis on the experience and challenges for development of open educational resources that are responsive to development needs.*
3) ***Affordable technologies****: with an emphasis on the opportunities and challenges for use of mobile devices and smart phones for access to learning materials and collaboration platforms.*
4) ***Education Management Information Systems (EMIS)****: with an emphasis on the opportunities and challenges for mobile data collection and dissemination.*

[1] Second Decade of Education for Africa (2006 – 2015), Plan of Action (Revised August 2006): http://www.nepad.org/system/files/Second%20Decade%20of%20Education%202006-2015.pdf

5) ***National Research and Education Networks (NRENs):*** *with an emphasis on the global and African experience in development of NRENS. Particular attention will be paid to costs and shared applications.*

2 Methodology

The methodology for this study has included desk research, questionnaires and interviews with selected experts and stakeholders, country case studies, and online engagement using the Educational Technology Debate[2] and eTransform Africa[3] websites.

During the desk research phase, the consultants sampled the African and global environments for examples that relate to its subject, and identified and examined experiences, potential good practices and lessons learned as well as opportunities and challenges within each of the five thematic areas. Desk research was complemented by a questionnaire to experts and stakeholders within Africa and around the world, and interviews with a selection of individuals from this group. The respondents provided insights, examples and specific experiences that supplemented information and insights gathered through desk research.

Three country case studies were undertaken. A case study on South Africa was conducted using desk research, because of the rich selection of available information on that country and the limited budget available for fieldwork. The Uganda and Senegal country case studies were 'deep dive' assessments, involving field and desk research as well as a country workshop which brought together stakeholders in the education sector. These workshops were, in both cases, sponsored by the ministries responsible for education.

Finally, a total of 24 experts wrote blog essays, covering each of the five thematic areas identified in the terms of reference. These were posted on the Educational Technology Debate website, providing opportunity for wider input permitting comment and input from various stakeholders, and ensuring that the final report and recommendations take into account the views of the diverse community that is concerned with ICT in education. Progressive preliminary outputs were also posted on the eTranform Africa website.[4] The methodology is more fully described in Annex 1.

3 A brief overview of education in Africa

This section of the introductory chapter provides a brief contextual overview of education in Africa. In doing so it draws heavily on two reports, published respectively by the UNESCO Institute of Statistics (UIS)[5] and by *info*Dev,[6] which provide authoritative recent accounts of continent-wide developments.

[2] www.edutechdebate.org
[3] www.etransformafrica.org
[4] www.etransformafrica.org
[5] Financing Education in Sub-Saharan Africa: Meeting the Challenges of Expansion, Equity and Quality, UNESCO, 2011 (http://unesdoc.unesco.org/images/0019/001921/192186e.pdf)

The African continent is, of course, highly diverse in terms of governance, development, and culture. Generalisations at a continental level do not necessarily apply to any individual country. However, in general, it should be noted that Africa has a young population by global standards. In 2010, 43% of Africa's population of about 815 million people was aged 15 or under, resulting in a very large school-going population.

3.1 Structure of the educational systems

Education in sub-Saharan Africa (SSA) is generally divided into three distinctive phases, with the number of years in each phase varying from country to country. The primary school level, normally starting at age five or six, lasts six to seven years in most countries. Secondary education takes five to seven years, and is, in many cases, further divided into lower and upper levels. The final phase is tertiary education, which leads – for those who participate in it – to a formal qualification at diploma or degree level.

3.2 Enrolment

In the 1980s and 1990s, there was a slowdown in investment in education in most sub-Saharan countries, a result of very high levels of indebtedness and, it has been argued, of the implementation of structural adjustment programmes. This situation changed between 2000 and 2008, as countries took steps to achieve the Education for All (EFA) objectives.[7]

Actual enrolment in primary schools has increased from 23 million in 1970 to 87 million in 2000 to 129 million in 2008, secondary school enrolment from 4 million to 22 million and 36 million in the same years, and tertiary enrolment from 200,000 to 2.5 million and 4.5 million.[8] This rapid increase in enrolment has led to a new definition of massification in Africa.[9] While massification in the global context refers to total enrolment above 50%, it is used in Africa to refer more to sustained high growth rates of enrolment, even if actual enrolment might be below 50%.

3.3 Teachers

African governments have invested in teacher education in an effort to deal with rapidly increasing student numbers. Between 1970 and 2008, the number of primary school teachers increased from 620,000 to 2.8 million, and the number of secondary school teachers from 180,000 to 1.8 million. Despite these increases, the average pupil-to-teacher ratio increased from 37:1 to 45:1 during the same period, indicating growing demand for teachers. The UNESCO Institute for Statistics (UIS) estimates the teacher deficit by 2008 at one million.[10]

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[6] Mike Trucano: "Survey of ICT and Education in Africa: A Summary Report Based on 53 Country Surveys", 2007. http://www.infodev.org/en/Publication.353.html

[7] http://portal.unesco.org/education/en/ev.php-URL_ID=42579&URL_DO=DO_TOPIC&URL_SECTION=201.html.

[8] UNESCO Institute for Statistics, *Financing Education in Sub-Saharan Africa,* 2011.

[9] Goolam Mohamedbhai, "The Effects of Massification on Higher Education in Africa". 2008. http://www2.aau.org/wghe/scm/meetings/mai08/adea/study_massification.pdf

[10] *op. cit.*

Within these overall figures, UIS argues that there is a need to deploy teachers in areas where shortfalls are most acute (especially in rural areas), to provide more and better pre-service and in-service training, and to offer effective career management to motivate and improve performance. UIS' report also recognises the critical challenges of absenteeism, retention, and lack of accurate data.

Teacher salaries, which are the main recurrent expenditure in education in SSA, are an important consideration. Available data show that salaries for teachers have declined significantly in real terms during the past thirty years. As UIS reports:

> *According to data covering 39 African countries (including North Africa), the average salary of a primary school teacher dropped from 8.4 times GDP per capita in 1975 to 4.0 times GDP per capita during the period 2003-2009. During this period, real GDP per capita almost doubled, however. These two sets of data imply that the growth of the real value of average teacher salaries in Africa has been stagnant for over 30 years.*[11]

3.4 Access to computers and connectivity

According to an *info*Dev report:

> *The dominant ICT access model in schools is the computer lab, involving between one and 40 computers, most of which are networked either by thin client or fat client, although some are standalone PCs as in Mali and Cameroon. These computers are used both for administration as well as support tools to aid teaching.*[12]

Computer laboratory figures used in this report show that the number of schools with computers based on this model ranged, in 2006, from 100% (Egypt) to 22.6% (South Africa) to 1.1% (Mozambique).

The general findings in this *info*Dev report, which is the most comprehensive continental overview on the subject, are based on 2006 data. It is important to point out that there has been significant progress in terms of access to computers and connectivity in schools in some African countries (for example Rwanda, Kenya, South Africa, and Senegal) since that time, as detailed in some of the examples cited in this report. Without a further comprehensive review of current computer availability in schools, which is beyond the scope and resources available for this study, it is not possible to make a generalised updated assessment of the current level of availability in sub-Saharan Africa as a whole.

3.5 Quality of education

While EFA has been effective in terms of increasing the number of children attending school, completion rates have remained low. A few countries show figures of above 90% of students successfully completing primary school, but most have completion rates that are

[11] *op. cit.*, p. 52.
[12] Mike Trucano: "Survey of ICT and Education in Africa: A Summary Report Based on 53 Country Surveys", 2007. http://www.infodev.org/en/Publication.353.html p. 17.

lower than this. In Ethiopia and Mozambique, for example, fewer than 40% of those enrolled complete primary school.[13]

Several countries in Africa have been participating in frameworks to assess the quality of education. The Southern and Eastern African Consortium for Measuring Educational Quality (SACMEQ), which includes countries in Eastern and Francophone Africa, has used the Programme on the Analysis of Education Systems (PASEC). A much smaller number of countries has participated in international testing programmes, for example the Progress in Reading Literacy Survey (PIRLS) and the Trends in Mathematics and Science Survey (TIMSS) of the International Association for Educational Assessment (IEA). According to the UIS report:

> *In both of these programmes, the participating African countries scored at or near the lowest scores of the participating countries, from 1.5 to 2 standard deviations below the average. This poor performance is not surprising, given the context in many SSA countries of poverty, illiteracy, management and governance weaknesses, and inadequate levels of enabling inputs.14*

3.6 Expenditure on education

Over the last ten years, African countries have invested heavily in education. According to UIS, real expenditure on education has risen by 6% annually across sub-Saharan Africa over the ten years leading to 2008. Additional resources have been used mainly to widen enrolment. Nothing has exemplified the increased expenditure on education more than the abolition of school fees by several countries, first at the primary level, and increasingly at the secondary level. However, some countries have also invested in improving educational services. It should be noted, in addition, that there has been significant donor support for the education sector. In 2008, this amounted to US$2.6 billion, representing 5.6% of the SSA regional total expenditure on education for the year.[15]

A World Bank study published in 2009 (with data mostly derived from years before 2007) has said that countries in sub-Saharan Africa were spending, on average 18.2%, of government budgets on education, 'a share that approaches the upper limits of what is generally considered to be feasible.' In addition to official expenditure, assessments of educational investment should include direct expenditure by households, through fee payments, to both government and private sector institutions. Households contribute, on average, 25% of the cost of education.[16] The World Bank study qualifies the implications of increased expenditure on education at tertiary level:

> *Despite this effort, enrolment growth has outpaced financing capabilities, and in many cases resulted in deteriorating educational quality. Public expenditure per tertiary student (fell) from US$6,800 in 1980, to US$1,200 in 2002, and recently averaged just US$981 in 33 low-income SSA countries. The ratio of academic staff to students has fallen significantly, producing overcrowded classrooms and unrelenting workloads for teaching staff. This has contributed to a severe crisis in staffing,*

[13] UIS, *op. cit.*, p. 24
[14] UIS, *op. cit.*, p. 74
[15] *ibid.*, p. 44
[16] "Accelerating Catch-up: Tertiary Education for Growth in Sub-Saharan Africa", ISBN-13: 978-0-8213-7738-3, 2009, http://siteresources.worldbank.org/INTAFRICA/Resources/e-book_ACU.pdf, p. 72.

compounded by retirements (with many more to come), brain drain, attrition due to AIDS, poor working conditions, and insufficient output from postgraduate programs.[17]

3.7 Governance

It is generally recognised that good governance is a necessary part of the environment for investment in any sector to have a high likelihood of achieving investment objectives. The world governance indicator developed by the World Bank aggregates factors in six areas:[18]

1) Government effectiveness;
2) Voice and accountability;
3) Political stability and absence of violence;
4) Regulatory quality;
5) Rule of law;
6) Control of corruption.

The indicator ranges from 0 (for weak governance) to 100 (for good governance). In its 2008 evaluation, while some African countries such as Botswana and Mauritius scored above 70, the average rank for SSA was 30.1, the lowest figure among world regions.[19]

3.8 The role of the private sector

Private educational institutions, from pre-primary to university level, are playing an increasingly significant role in education in Africa. While percentage enrolment in private institutions varies between 10% and 30% in most sub-Saharan countries, it rises as high as 50% in a few of these. In Mauritius and Liberia, for example, private schools enrol over 50% of secondary school students. Private institutions in sub-Saharan Africa now account for about 18% of university enrolment.[20]

3.9 Stakeholders

The education sector involves, on a full time basis, directly or indirectly, a very large proportion of any national population. This is especially so in sub-Saharan Africa where average life expectancy is relatively low, fertility rates are high, and the population, as a result, is relatively young.[21] The population that is actively involved in the education sector includes students at all levels of education, teachers, other school staff, and (in an official capacity) regulators, managers and policy makers. A significant proportion of the private sector provides services, support facilities or learning materials to schools. Parents have become influential stakeholders because of the amount of money they contribute directly

[17] Ibid. p. xxvii.
[18] http://info.worldbank.org/governance/wgi/index.asp
[19] See page 21: Financing Education in Sub-Saharan Africa: Meeting the Challenges of Expansion, Equity and Quality, UNESCO, 2011.
[20] See Chapter 4: Financing Education in Sub-Saharan Africa: Meeting the Challenges of Expansion, Equity and Quality, UNESCO, 2011.
[21] See e.g. statistics published annually in the United Nations Human Development Reports, http://hdr.undp.org/en/. Latest is online is 2010.

to school costs. In many sub-Saharan countries, parents also play an important role in directing school policies and strategies through involvement in Parent-Teacher Associations.

4 ICT in education in Africa: setting the scene

4.1 A conceptual framework

Governments and other stakeholders around the world have increasingly been embracing a vision for development which includes movement towards what have become called 'Knowledge Societies', and have been adopting policies and strategies to foster this development. Governments of developing countries see it as necessary to build more knowledge-based societies not only to improve the efficiency of domestic economies but also to take advantage of economic opportunities outside their own borders. Education is critical to the development of knowledge societies as it is the source of basic skills, a foundation for knowledge acquisition and innovation and an engine for socio-economic development. However, education systems have been relatively slow to respond to this new demand, typically tending to focus firstly on technical ICT skills and only latterly beginning to consider the range of 21st century skills which students need to think creatively, solve problems, communicate effectively, identify and analyse existing information, and create knowledge.

The NEPAD e-Schools Initiative provides a useful starting point for developing a conceptual framework for ICT in Education in Africa.[22] The vision of the NEPAD e-Schools Initiative is to ensure that young Africans can participate actively in the global Information Society and knowledge economy. Significantly, the initiative itself makes no explicit reference to ICT. It proposes that the focus of business planning in African schooling should be set squarely on ensuring that schools are better equipped to prepare learners socially and economically to become proactive, engaged citizens. Technologies are tools that should contribute towards achieving this, rather than becoming another logistical 'problem' that needs to be 'solved'.

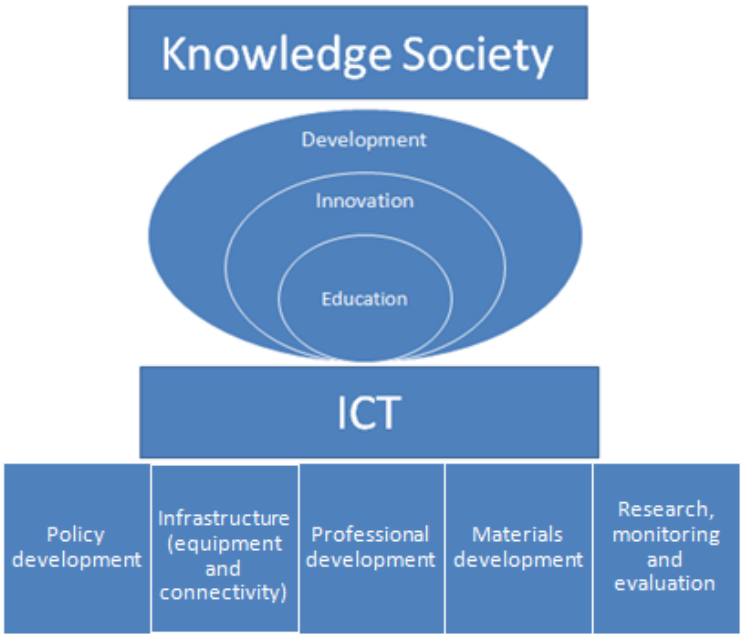
In order to clarify how ICT can contribute to achieving its vision, NEPAD has divided ICT integration into a number of different areas, for each of which it has defined an overall statement of achievement. The statements in this framework are discussed in more detail in Chapter 5. They identify the following components:

- Legal, regulatory and policy framework;
- Bandwidth and connectivity;
- Infrastructure and technology;
- ICT applications;
- Educational content;
- Professional development;
- Governance and operations;
- Change management and advocacy;
- Monitoring, evaluation and research.

[22] Nepad e-Schools Initiative. Chapter 4 - Defining a framework for NEPAD e-Schools Business Planning

As the NEPAD framework indicates, ICT interventions are not uni-dimensional. Rather, ICT itself as a concept is treated as comprising several interrelated ideas, each of which requires consideration. For a knowledge society to be realised, supported and developed, education and innovation should be viewed as interrelated drivers for socio-economic development, in a context where ICT is the enabler for both innovation and education. Figure 1.1, which is adapted from a 2010 report by the education in development agency GeSCI,[23] highlights relevant dimensions to consider in ICT interventions, which are then discussed briefly in the following paragraphs.

Figure 1.1 - Framework for reflecting on ICT, Education, Innovation and Development to support a Knowledge Society



GeSCI's report considers ICT in education to be critical both for development at a societal level, and for enabling individuals to secure employment in a knowledge society. However, the potential of ICT in education can only be realised when it is embedded in a social context that is open to innovation and supported by a favourable policy environment. Government policy has a real impact on strategic initiatives and often determines their parameters through laws, regulations and the allocation of funds. The potential educational power of Web 2.0 platforms is particularly significant in contributing to education and the knowledge society. Content is important in these, primarily as a tool to be used by learners to construct their own knowledge, building on what it is that they already know.[24]

The NEPAD e-Schools Initiative has identified the following principles as fundamental to supporting the uptake of ICT in schools: [25]

[23] Neil Butcher and Associates (2010). ICT, Education, Development, and the Knowledge Society - Thematic paper prepared for African Leaders in ICT: Building Leadership Capacities for ICT and Knowledge Societies in Africa
[24] Neil Butcher and Associates (2010). ICT, Education, Development, and the Knowledge Society - Thematic paper prepared for African Leaders in ICT: Building Leadership Capacities for ICT and Knowledge Societies in Africa
[25] See: Ernst & Young. (2006). NEPAD e-Schools Initiative Business Plan. Unpublished report.

- Across the continent, every young African and each school context is unique.

- There is no single technical or educational model/approach to integrating ICT in schools which can be adopted across the continent, or even uniformly across a single country.

- The primary objective of continental and national e-schooling policies and plans should therefore be to create an enabling environment which stimulates and supports schools to invest in, acquire, and effectively use ICT to the educational benefit of young Africans.

- To be successful, any investment in ICT infrastructure should be accompanied by investments in:
  - supportive legal, regulatory, and policy frameworks;
  - affordable connectivity;
  - relevant educational ICT applications and electronic content (teaching and learning materials for both school and health contexts);
  - professional development of all important players, including government officials, schools principals, administrators, teachers, and learners;
  - maintenance and support strategies; and
  - effective governance and operational systems and processes.

- Experience suggests that several infrastructural preconditions are required before a school is able to integrate ICT effectively into its day-to-day operations. These include access to reliable power, secure and appropriate school buildings, and good road access to the school. Provision of this infrastructure, while critical to effective integration of ICT into schools, is not specifically part of initiatives concerned with ICT in education. An important objective of e-schooling initiatives should be their alignment with national infrastructure delivery initiatives.

- Dysfunctional schools cannot be made functional through the deployment of ICT.

- Successful integration of ICT into education depends on schools developing the capacity to produce their own technology plans rather than responding to directives from above. When technology decisions are forced onto schools it is usually not possible for school communities to develop a sense of ownership of the technology they receive, which results in high levels of wastage. Schools need to be empowered to develop technology plans which support their unique requirements and contexts, and to make their resulting choices and investments accordingly.

- Integration of ICT in education should be driven by national governments through the appropriate policy and planning processes. These processes should draw on support and contributions from donors, the private sector and civil society. These contributions should be aligned with a clear national strategy rather than dictating what that strategy should be.

- There is a multitude of ways in which one can imagine a future where ICTs are integrated into schools and have changed the way in which education systems function. To name a few:

    - Government support staff communicate by e-mail with each other and school management teams and no longer rely on hard-copy letters, gazettes and official circulars which are posted or delivered to them.
    - Government positions and vacancies are published electronically and distributed by e-mail to improve transparency in job application and appointment processes. Applications can be submitted electronically.
    - School management teams make extensive use of EMIS data to report on their school status and to manage school record-keeping, staff appointments and other management functions.
    - Teachers can access curriculum documents and supportive educational content linked to these documents freely and easily from the Internet, in order to reduce their preparation time and improve the quality of their teaching.
    - Individual teachers are in electronic contact with a whole community of peers and have access to a range of professional development opportunities which encourage and sustain collegial support and innovation.
    - Parents can access information about individual school performance and make applications for enrolment electronically.
    - Parents are notified by e-mail or SMS if their child is absent from school, ill or involved in disciplinary action.
    - School progress reports are distributed electronically to parents and there is a repository for each learner, accessible through the World Wide Web, through which they can view all reports throughout their child's school career.
    - Learners can access assessment material from the Internet and can submit applications for further educational opportunities and bursaries and scholarships online.
    - Learners use and publish information to the World Wide Web and are able to collaborate with other learners in other schools, other regions and internationally.
    - Learners can access school timetables, homework assignments, assessment dates and extramural schedules electronically, and are notified electronically of new events and programme changes.[26]

4.1.1 Policy development

Internationally, the need to provide quality education for all learners has motivated countries to develop plans focused on the use of ICT for teaching and learning. The drive to promote ICT in education has typically been aligned with broader social and economic goals. In particular, visions of how ICT in education can lead to participation in a global knowledge economy, and of how ICT will improve national economies, are set out in ICT policies.

While national policies provide a framework for implementation, there is a trend towards a more decentralised approach in implementation, examples of which include Australia, Thailand and Indonesia. ICT integration in schools needs to consider individual social,

[26] Nepad e-Schools Initiative. Chapter 4 - Defining a framework for NEPAD e-Schools Business Planning

economic and political environments, recognising that change will not occur in the same manner in each country or across different locations in any one country, and that integration of ICT in education needs to be sensitive to cultural differences.

4.1.2 ICT Infrastructure and networks

The role of technology infrastructure in enabling ICT in education has been recognised internationally. ICT infrastructure, in this context, includes access to equipment as well as connectivity. An important aspect of the use of ICT in education concerns the devices through which educators and learners access learning materials and collaborative platforms. It is very expensive to equip schools and universities and to keep them up to date with ICT equipment. This is not just a matter of hardware and software purchases, but also the recurrent costs associated with maintenance and support. Rapid advances in technology have continued to add potential to the use of ICT as an integral part of teaching and learning. However, changes and innovations in technology tend to be much faster than changes in the education system. This is an area of concern as reform may be dependent on technologies that are no longer available or supported.

Connectivity is an important aspect of accessing learning resources. At a policy level, connectivity requires continued focus on the supply of competitive access to wireline and wireless broadband networks, and on the allocation of spectrum targeting wireless broadband services. Many countries have addressed this issue. For example, in Turkey, Egypt and Jordan, the Ministries of Education have taken responsibility for funding broadband Internet connectivity for schools. [27]

4.1.3 Professional development

Appropriate teacher training is essential if educators are to use ICT effectively for teaching and learning. Fully integrating technology into teaching and learning requires well-qualified educators. There are as many schools of thought on how best to equip educators with skills and knowledge to use ICT for teaching as there are tried-and-tested models for professional development. The dominant schools of thought regarding ICT integration are divided between those which focus on whether teachers need ICT literacy skills, without looking at how those skills will be applied pedagogically, or whether ICT should be deployed in a manner that equips teachers with ICT literacy skills and, at the same time, shows teachers how to use these skills to plan lessons and use technology for teaching and learning.

There is great interest in participatory approaches to professional development which involve educators in initiating and designing their own professional development, sharing materials and ideas, and discussing challenges and solutions. This approach can also help teachers to become model lifelong learners. Case studies have indicated that a model of 'learning by doing' may be a good starting point for initiating forms of future staff development linked to school-based curriculum.[28]

[27] HEDCOM Sub-committee on ICT. 2008. Report on the Study Tour of the Hedcom Sub-committee on ICT.
[28] Detailed case studies are presented in Annex 4.

4.1.4 Materials Development

The provision of materials for learning is considered critical for the successful integration of ICT in education. One of the most important developments globally n this area has been the emergence of Open Education Resources and Web 2.0 platforms, which allow the user to become a source as well as a consumer of information (the architecture of participation). New ICT services such as blogs and wikis encourage users to add to and shape content within their communities, rather than 'owning' their own content and reading that of others.

4.1.5 Research, monitoring, and evaluation

Evaluation is recognised as especially important in the field of ICT, where technology itself is evolving very rapidly and where there are many unknown factorss about how to apply it most effectively. However, monitoring and evaluation are not receiving the attention they require. Many of the issues and challenges associated with educational ICT initiatives are well-known to experts and practitioners in the field. However, data on the nature and extent of these challenges are limited in most countries because of a lack of monitoring and evaluation tools, and of methodologies that address the use of ICT in schools and its impact on teaching and learning.

4.2 Trends in implementation[29]

Innovations in technology have resulted in an increased use of ICT in education worldwide. This has led governments and other stakeholders to develop policies to guide that use. In Africa, many governments have focused on developing national ICT policies and National Information and Communication Infrastructure Plans to support their socio-economic development efforts and their policies concerning ICT in education. Several African countries are prioritising the use of ICT in education to achieve critical strategic development objectives. For example:

- Kenya's *National Information and Communication Technology (ICT) Strategy for Education* recognises that 'an ICT literate workforce is the foundation on which the nation will become a knowledge-based economy…. [Education is] a platform for equipping the nation with ICT skills in order to create dynamic and sustainable economic growth.'[30]
- The *Egyptian Information Society Initiative* aims to use e-learning applications to spread knowledge and information through the Internet. The Egypt Education Initiative's objective is to improve education in Egypt through the effective use of ICT.[31]
- In South Africa, the government has expressed its commitment to the knowledge society through the establishment of a Presidential National Commission on Information Society and Development (PNC on ISAD), which focuses on policy and development of ICT in

[29] This section has been adapted from: Neil Butcher and Associates (2010). ICT, Education, Development, and the Knowledge Society - Thematic paper prepared for African Leaders in ICT: Building Leadership Capacities for ICT and Knowledge Societies in Africa

[30] Kenyan Ministry of Education (June 2006). National Information and Communication Technology (ICT) Strategy for Education and Training, p.3.

[31] Czerniewicz, L. (ed). 2007. Report on Higher Education ICTs and e-Learning in Egypt, p.4. Cape Town: CET

priority areas of e-Government including e-health; e-education; small, micro and medium Enterprises (SMMEs); and content development.[32]

Unsurprisingly, African countries are at very different stages in considering policies to harness ICT in support of education and development. As a result, in some instances, ICT and development policies may not be complemented by other relevant policies – for example a telecommunications policy that supports such development – or by associated budgetary allocations. Some countries (for example Angola, the Republic of Congo and Cameroon) have national ICT policies but not policies that make specific reference to ICT and education. Furthermore, ICT policies are not always accompanied by a detailed implementation plan or commitment from government to implement them.[33] The World Bank notes that developing countries have faced challenges in adapting policies and regulations to rapid changes in technology and market structure.[34]

Nevertheless, ICT is expanding the range of options available to education planners in the teaching and learning strategies they choose to use, providing an often bewildering array of choices in systems, design options, teaching and learning combinations, and strategies for administering and managing education. Increasingly, investment in ICT is being seen by education institutions as a necessary part of establishing their competitive advantage, because it is attractive to students (particularly in those parts of the world where young people have near-ubiquitous access to ICT) and because it is deemed essential by governments, parents, employers and funders of higher education. There is, however, no automatic correlation between increased spending on ICT and improved performance of education. Benefit and impact, to the extent that they can be reliably measured at all, are more functions of how ICT is deployed than of what technologies are used.

The development towards knowledge societies has placed greater emphasis on the need to ensure that people are information-literate. Information literacy has been defined as:

> *The capacity to identify and issue and then to identify, locate and evaluate relevant information in order to engage with it or to solve a problem arising from it.*[35]

Information literacy should not be considered a given, even amongst learners with ubiquitous access to ICT – though many institutions are mistakenly assuming greater information literacy amongst 'tech-savvy' learners. Education systems need to provide formal instruction in information, visual, and technological literacy as well as in how to create meaningful content with today's tools. However, it is important to consider expanded definitions of these literacies that are based on mastering underlying concepts rather than on specialised skill sets. Education systems need to develop and establish methods for teaching and evaluating these critical literacies at all levels of education.

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[32] The PNC on ISAD, http://www.pnc.gov.za

[33] Information drawn from various country reports in Farrell, G., Isaacs, S., and Trucano, M (2007). Survey of ICT and Education in Africa (Volume 2): 53 Country Reports. Washington, DC: infoDev / World Bank.

[34] IEG (Independent Evaluation Group). 2011. Capturing Technology for Development: An Evaluation of World Bank Group Activities in Information and Communication Technologies. Washington, DC: Independent Evaluation Group. The World Bank Group.

[35] McCausland, H.,Wache, D. & Berk, M. (1999). *Computer literacy; its implications and outcomes. A case study from the Flexible Learning Centre*. University of South Australia. p. 2.

As students learn the skills of using ICT in education, the professional role of teachers as mentors – able to impart the wisdom that only experience can provide – also grows in importance. The role of the teacher in the classroom is becoming more like that of an instructional manager who helps to guide students through individualised learning pathways, identifying relevant learning resources, creating collaborative learning opportunities, and providing insight and support both during formal classes and outside contact time. However, most professional development programmes focus on trying to teach educators to use the technology. Professional development work also needs to address ways in which mentors can guide learners in this environment, and to include:

- developing and supporting mentoring in formal education and in employment structures;
- fostering coherence and discipline in thinking;
- navigating the ethics of a world with no apparent limits;
- coping with the challenges of 'unlimited' choice; and
- encouraging learners and or employees to become creators in the educational and professional environments.

Another significant trend is the emergence of the concept of Open Education Resources (OER), which refers to educational resources that are freely available for use by educators and learners without an accompanying need to pay royalties or licence fees. The concept is gaining momentum and is seen by some as having potential transformative power for education. There has also been very considerable growth in the collective sharing of knowledge and the generation of knowledge-related content as more people become connected, and as those who are connected make use of Web 2.0 technologies and services. Collective intelligence and mass amateurisation are, as a result, pushing the boundaries of scholarship, while dynamic knowledge creation and social computing tools and processes are becoming more widespread and accepted. The digitisation of information in all media has introduced significant challenges concerning intellectual property, especially copyright. Copyright regimes and their associated business models, which worked effectively prior to the development of ICT, are increasingly under threat and in some cases rapidly becoming redundant.[36]

ICT is also reducing barriers to entry for potential competitors to traditional education institutions, by reducing the importance of geographical distance as a barrier, by reducing the overhead and logistical requirements of running education programmes and research agencies, and by expanding cheap access to information resources. Yet another trend is the growth in number and types of distance education programmes in which teachers and students are physically separated and in which teaching and learning takes place by means of single technologies or combinations of ICT. In the past, such programmes made use of print, radio, and television. Now, ICT is driving changes in these 'open' or distance education programmes, which are increasingly using the Internet and the World Wide Web for the delivery of educational materials and adopting a more extensive range of interactive forms.

[36] The Independent Evaluation Group (2011). An Evaluation of World Bank Group Activities in Information and Communication Technologies - Capturing Technology for DevelopmentWorld Bank report. The World Bank Group: Washington DC

The final trend that needs to be considered here is that mobile and personal technology is increasingly seen as a delivery platform for services of *all* kinds, reaching well beyond the education sector. In Africa, mobile cellular subscriptions in 2010 reached 45 per 100 people,[37] and this proportion continues to rise due to very high demand and falling costs. The growth in the capabilities of mobile and personal devices is enabling and feeding on increased availability of digital materials and applications. The Amazon Kindle (a wireless e-book reader) and the Apple iPad (a slate computer with touchscreen interface) are examples of devices that are meeting the needs of emerging e-reader and e-textbook markets. The use of these and other mobile devices for educational purposes is often described through the term 'm-learning', although this is also used more widely to describe any sort of learning that takes place when the learner is not at a fixed, predetermined location or takes advantage of the learning opportunities offered by mobile technologies and networks.[38]

4.3 Critical issues

There are many issues and challenges which need to be taken into account when considering the use of ICT in education. A number of these are explored in more detail throughout this report. They include:[39]

- *The absence of comprehensive policies that enable and support interventions, and which are themselves supported by clearly defined and resourced strategies for implementation at national level as well as at the level of educational institutions.* Strong government support is important for advancing ICT availability and usage in education as a broad social and economic development enterprise, a challenge faced by many education institutions in Africa. The creation of a strong enabling policy environment requires that African leaders have sufficient information and understanding about the knowledge economy and are familiar with the ways in which policy frameworks may hinder or support this objective. Some of the critical policy questions surrounding the use of ICT in education relate to access, equity, finance and the challenges of scaling interventions.

- *The lack of financing and prioritisation of ICT investments as a barrier to effective ICT use.* Little is known about the true costs of ICT in education and, given budgetary and resource constraints, widespread investment in ICT in education may not be possible in many African countries. Despite a widespread belief that investing in ICT is cost-effective, as well as ongoing reductions in the price of hardware, software and connectivity, the total cost of ownership of ICT – which includes maintenance, upgrading, skills and development as well as these three factors – remains high. It is, therefore, critically important to improve understanding of the costs and benefits

[37] http://www.itu.int/ITU-D/ict/statistics/at_glance/KeyTelecom2010.html
[38] http://en.wikipedia.org/wiki/MLearning
[39] Information in this section is based on reports from Trucano, Michael. 2005. Knowledge Maps: ICTs in Education. Washington, DC: infoDev / World Bank; Neil Butcher and Associates (2010). ICT, Education, Development, and the Knowledge Society - Thematic paper prepared for African Leaders in ICT: Building Leadership Capacities for ICT and Knowledge Societies in Africa; and World Bank. ICT and Education-Key issues. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTEDUCATION/0,,contentMDK:20533883~menuPK:617610~pagePK:148956~piPK:216618~theSitePK:282386~isCURL:Y,00.html

associated with ICT types and uses in different educational contexts, so that scarce resources can be targeted effectively. Because there are high up-front costs and large recurrent costs, governmnts have used a variety of different financing and cost-recovery mechanisms. Public-private partnerships and user fees are important components of financing ICT in education in many countries, but more research is needed to determine the impact and effectiveness of these mechanisms.

- *Limitations in the infrastructure required to support the use of ICT in education.* Particularly important factors in this context are limited access to power (about 60% of the population in Africa lacks domestic access to electricity)[40] and the lack of affordable and reliable Internet access (less than 12% of the population in Africa were believed to be Internet users in March 2011).[41] The lack of an affordable and accessible telecommunication backbone and of a stable electrical supply impacts on the roll-out of ICT in education and development initiatives. The wide gap in ICT access between urban and rural areas has resulted in a concentration of such initiatives in the former.

- *A lack of capacity at all levels to integrate and support the use of ICT effectively in education.* This challenge includes a shortage of human capacity across all important stakeholder groups (including policymakers, teachers, administrators, technical staff and education managers). Harnessing ICT for education and socio-economic development requires visionary and skilled leadership and management. African political leaders, civil servants and administrators need to be knowledgeable about the potential that ICT presents in terms of socio-economic development. It is important to build expertise among African leaders and administrators and to ensure that leveraging ICT for a knowledge society is both a top-down and bottom-up process.

- *A lack of necessary ICT skills amongst teachers and of specific training to enable them to use ICT effectively in the classroom*. The professional development of teachers is crucial to ICT for education as they are at the heart of the educational process. Experience has shown that a variety of support and enabling mechanisms is needed in order to optimise teacher use of ICT. Teachers require access to relevant, timely and ongoing professional development to enable them to explore the use of new tools and techniques that can help them to engage with and support learners in new and productive ways. They also need time and resources to explore this new knowledge base and to develop new skills, with the support of school administrations. Lastly, teachers and their managers require sufficient access to technologies and the necessary technical support.

- *Limited supply of appropriate content, including learning materials and learning support tools.* Although ICT (and the Internet in particular) provides access to a wide range of resources, there is relatively little digital education content that is relevant to local contexts or based on local curriculum frameworks. Experience shows that unless digital learning resources are directly related to the curriculum, and to the assessment methods used to evaluate educational outcomes, ICT interventions may not have positive educational impacts.

[40] http://www.lightingafrica.org/component/k2/item/22.html?layout=item
[41] "Internet usage statistics for Africa", March 2011, http://www.internetworldstats.com/stats1.htm

- *Lack of accurate, comprehensive, up-to-date data on education.* In Africa, donors, rather than governments, have been the key players in EMIS development and therefore organic growth towards data-driven planning has been largely absent.

- *The tendency of ICT to accentuate social, cultural and economic disparities*. ICT projects tend to give preference to schools and learners in urban areas and in areas where infrastructure is well established. There is, as a result, a very real risk that ICT can further marginalise groups already excluded or marginalised from educational practices and innovations – such as special needs students, learners in remote areas, students from historically marginalised linguistic, cultural or ethnic groups and from low income communities. However, ICT also holds promise and offers opportunities for facilitating greater inclusion of such groups in existing educational practices and environments. Supportive policies and careful planning and monitoring are needed to achieve this

It is generally believed that ICT can empower teachers and learners, promote change and foster the development of 21st century skills, but data to support these perceived benefits from ICT are limited and evidence of effective impact is elusive. Globally, insufficient attention is paid to monitoring and evaluation during the design of most ICT initiatives, and Africa is no exception. In addition, there appears to be a shortage of useful resources attempting to translate what is known to work and not work in this field. As technology and the specific tools available for education change quickly, and as new technologies emerge, it is critical that their cost and impact in educational settings are examined. As a result, there is a great need for research on the appropriateness of specific ICT tools to help meet educational goals.

Chapter 2: Sketching the Landscape

1 Introduction

Chapter 1 has provided an overview of the context of education in Africa, together with a conceptual framework and review of critical issues concerning the integration of ICT in education. This second chapter provides analysis in greater depth of the landscape of ICT in education. The analysis is organised around five themes that were defined in the terms of reference for the study, with links made as appropriate between these five areas to highlight the connections between them. It draws on the detailed accounts of these five areas which are included in Annexes 2 to 6, to which readers who are particularly interested in specific areas of the report should refer. The five thematic areas are:

- Affordable technologies for educators and learners
- Digital learning resources
- Teachers' professional development
- Educational Management Information Systems (EMIS); and
- National Research and Education Networks (NRENs)

2 Affordable technologies for educators and learners: emerging trends

For technologies to be used successfully in education, they must be affordable and accessible. This is a barrier for many schools, teachers and learners in Africa. An important element in enabling the use of ICT in education concerns the devices through which educators and learners access learning materials and collaboration platforms. In recent years, there have been a number of positive innovations in both the technologies being used by educators and learners and in the cost of these technologies.

Before discussing technology further, it is important to put the term 'affordable', which is often loosely used, into context. Perhaps the most important contextual point is that, at school level, budgets are very constrained and leave limited scope for investment in technology. For instance, according to statistics from UNESCO, in 2009 Uganda spent $84.80 per primary student and $247.10 per secondary student, while Senegal spent $388.10 per primary student in 2008 and an estimated $465 per secondary student.[42] At an individual level, a survey of ICT access and use conducted by Research ICT Africa in 2008 indicated that large numbers of Africans continue to be marginalised due to the high cost of access and that households at that time were spending considerable proportions of household income on communication (though it should be noted that communications

[42] UNESCO, 'Public expenditure per student, PPP$', http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=3562

markets and access have moved on significantly since these survey data were collected).[43] Definitions of affordability are therefore relative and it is within this context of relative affordability that the use of affordable technologies in education should be considered.

Some critical technological innovations in the ICT sector, and the use of these technologies in education, are outlined in Table 2.1 below and discussed in more detail in subsequent paragraphs. Some of the potential opportunities that arise from these trends are considered in chapter 3. It is, of course, the case that technology is always changing. There will be continued innovation in the technology and there are likely to be further reductions in cost. This means that resources which are being used now or which are currently under consideration will change, while new tools will emerge whose potential is not yet clear. These technology trends should also be understood in the context of broader trends in ICT in education,[44] while technology itself should always be considered within the broader educational needs, challenges and context discussed throughout this report.

Table 2.1 - Technology trends

Generation of Technology	Trends	Type of learning	Access
PC based innovation (early)	Low-cost computing devices (including recycled computers)	One-to-one, class room, laboratory and collaborative learning	Single or shared (offline and online)
Non-PC based innovation (medium)	PDAs, mobile phones, smart phones, 3G phones	Ubiquitous learning	Single and personal (always connected to mobile provider/s except PDAs)
New-age devices (latest)	Merging PC and mobile phones: iPhone, iPads, tablet PCs, eReaders and eBooks	Intuitive, interactive, touch-screen, peer-to-peer, collaborative work	Single but can be shared in certain contexts – still early and evolving (designed to be social and internet-friendly but can function offline)

The following paragraphs focus substantially on the use of mobile devices. However, this should not be taken to imply that other technologies are not being used in education or that these should be ignored when considering ICT investments. Older technologies such as television and radio continue to be used to support both formal and informal education, and remain important especially in terms of reach. Digital migration may also open opportunities for more channels and diversity of content (including educational content).

[43] Allison Gillwald and Christopher Stork, Research ICT Africa, 'ICT access and usage in Africa', 2008. http://www.researchictafrica.net/publications/Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_1/RIA%20Policy%20Paper%20Vol%201%20Paper%202%20-%20ICT%20Access%20and%20Usage%20in%20Africa%202008.pdf

[44] Robert Hawkins wrote a useful summary of these in 2010: Hawkins, R (2010), '10 global trends in ICT in education', http://blogs.worldbank.org/edutech/node/544

Newer technologies such as interactive whiteboards are used widely in schools in developed countries[45] but remain expensive for schools in Africa, while questions have been raised about their impact and value.[46] The reality is that education institutions and strategies will need to consider and deal with a mix of different and hybrid technologies and infrastructures (*e.g*. legacy technology and infrastructure, the devices which teachers and learners already own, and emerging technologies).

When considering 'affordability' it is also important to note that the procurement cost of devices is only a fraction of the total cost incurred, and so total cost of ownership is the critical factor which must be considered in decision-making. In addition, the dynamic nature of technology means that most of the technologies covered in this section are new and that their effect in education is not yet fully understood. The report outlines emerging trends, but effective technology selection for educational purposes requires a wider understanding of the parameters for making good choices (which have been well documented in the literature, as illustrated in Chapter 1) rather than specific focus on any particular technology type.

2.1 Low-cost computing devices (LCCD)

The last decade has seen a number of ambitious low-cost computing projects and technologies, such as the One Laptop per Child (OLPC) initiative which initially met with a great deal of media enthusiasm. Although some two million educators and learners are currently involved in one way or another with OLPC, it is still seen as an interesting model which has yet to prove commercial viability or to deliver on its promise to bring the unit price below US$100. One positive outcome of OLPC is that its announcement forced other companies to revisit designs and reset price expectations for their equipment.

Currently, low cost computers typically range in price between US$200 to US$500. Lower-cost netbooks[47] and smaller laptops are becoming increasingly popular. Extended power, Linux operating systems, and localised keyboards are attractive features of these kinds of devices. Although commercial low-cost computer models mostly target urban professionals, they are increasing being used in education. Manufacturers such as Dell[48]

[45] The Becta Harnessing Technology Schools Survey 2007, for instance, stated that 98% of secondary and 100% of primary schools in the UK had interactive whiteboards.

[46] Janet Thomson, commenting on the SchoolNet SA experience, for instance, argues to 'beware of Interactive Whiteboards (IAW). IAW have proliferated in schools despite the expense and yet in many instances this has resulted in teaching methodology reverting back to being teacher-centred' ('Learning from the SchoolNet SA experience'. https://edutechdebate.org/teacher-professional-development/schoolnet-sa-is-learning-from-experience/). Similarly a Washington Post article states that many academics argue that interactive whiteboards 'locks teachers into a 19th-century lecture style of instruction counter to the more collaborative small-group models that many reformers favor' and that Larry Cuban states that 'there is hardly any research that will show clearly that any of these machines will improve academic achievement' ('Some educators question if whiteboards, other high tech tools raise achievement' Washington Post, June 2010, http://www.washingtonpost.com/wp-dyn/content/article/2010/06/10/AR2010061005522.html?referrer=emailarticle)

[47] Netbook computers are smaller, lighter weight and cheaper than laptops but also have smaller screens and keyboards and reduced computer power. http://en.wikipedia.org/wiki/Netbook

[48] 'Dell Delivers Industry Firsts with 10.1-inch Netbook Designed for Education', Dell, 2009, http://content.dell.com/us/en/corp/d/press-releases/2009-05-19-Latitude2100.aspx

and Samsung[49] have now designed netbooks for education which are more rugged than has been standard in the past. Initiatives such as OLPC[50] and Intel Classmate PC[51] are seeking to supply low-cost computers to children in developing countries.

These devices have variable features which impact on their use in education. The OLPC XO, for example, is specifically aimed at primary school learners and may not be suitable for older students. Commercial laptops may, likewise, not be as appropriate for primary school students. Some countries have policies to adopt or prefer certain operating systems and software, which may also impact on the selection of devices. There are many different government open source policies: a survey undertaken by the Centre for Strategic International Studies identified 364 open source policy initiatives when it was published in March 2010.[52]

Recycling continues to be an option for the provision of hardware, and organisations such as Computer Aid provide recycled computers to schools. However, the importation of recycled computers is controversial with some groups concerned that developing countries and emerging economies are being used as 'dumping grounds' for e-waste.

LCCD are falling in price, and this trend seems set to continue. Initiatives from governments and research institutions in developing countries also continue to prioritise their development. For example, in India the Union Minister for Human Resource Development recently announced a low-cost tablet PC, which it is hoped will cost US$35.[53] Other developing country governments are purchasing low-cost computers such as the Classmate PC and OLPC.

The lower price of these computing devices means that their use in education is almost certain to grow. There are, however, a number of issues concerning the use of low cost devices in developing countries. These include the following:

1) Localisation. Two trends act as barriers to localisation:
   a) Low-cost computing devices depend on large-scale production and a high degree of scalability, which limits the extent to which they can be customised to local needs.
   b) The dominance of Latin characters (with exceptions like Mandarin and Arabic) and lack of technical standards / solutions mitigate against the use of some local languages in software and hardware.

2) High-income consumers tend to be the target market for manufacturers. An analysis of low cost computing devices undertaken by Vital Wave Consulting in 2008 found that, while lower-income users in rural areas are often cited as the target market for low-cost computing devices, manufacturers in practice target higher-income customers (populations in developed countries and wealthier urban residents in developing

[49] 'Samsung toughens up netbooks for school', 2010, http://www.pcpro.co.uk/news/education/354802/samsung-toughens-up-netbooks-for-school
[50] http://laptop.org/en/
[51] http://www.intel.com/intel/learningseries.htm, http://en.wikipedia.org/wiki/Classmate_PC
[52] "Government Open Source Policies", March 2010, Centre for Strategic International Studies, http://csis.org/publication/government-open-source-policies
[53] 'India announces low cost tablet PCs', July 2010, http://www.techeye.net/hardware/india-announces-low-cost-tablet-pc

countries).[54] This has tended to lead to a focus on issues such as improving performance capabilities rather than on features that are particularly relevant for rural developing country environments (for example, alternative power options, more rugged devices).

3) Large scale deployment of low-cost computing devices has required government procurement support and subsidy. OLPC and Intel Classmate, for instance, have largely depended on government procurement. One of the largest deployments of Classmate is in Portugal, whose government has bought around half a million of these laptops.[55] National level partners of OLPC include the governments of Argentina, Mexico, and Rwanda. The Tamil Nadu government has recently issued a tender for 912,000 laptops to be provided free to students and envisages providing 6.8 million laptops to students over five years.[56] The costs of these deployments can be significant in terms of government budgets. For instance, Wayan Vota has written about the purchase of 100,000 OLPC laptops by the Ministry of Education of Rwanda as follows:

> *An order of 100,000 XO laptops means a minimum cost of $20,000,000, or 18% of Rwanda's $109 million education budget for 2008. If, as OLPC News calculates, the 5 year Total Cost of Ownership for an XO laptop is $1000, then the total cost for Rwanda will be $100 million, or 25% of the total educational budget over the next 5 years [57].*

2.2 Mobile phones

The use of mobile phones in education is relatively new, is evolving and will continue to do so as mobile phones themselves continue their trajectory of rapid change. There is growing interest in looking at the opportunities for m-learning, which is being driven by the high (and increasing) levels of access to mobile phones in the developing world. A number of pilot projects have targeted specific communities, testing the use of mobile phones to support educational activities. However, many schools do not allow students to bring mobile phones into the classroom, so projects often focus on use of mobile phones outside of school.

The exceptional growth in mobile phone subscriptions and use in the last five years has resulted in mobile phones bringing connectivity to populations in developing countries in a way that was not possible in the past. Mobile phones and mobile networks are now more accessible to individuals than any other ICT and are owned by very many more students and teachers than other computing devices. The ITU 'World in 2010 ICT Facts and Figures' report states that access to mobile networks is now available to 90% of the world population and 80% of the population living in rural areas.[58]

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[54] Vital Wave Consulting (2008), 'Landscape analysis of low cost computing devices', Vital Wave Consulting, http://www.vitalwaveconsulting.com/publications/pdf/Landscape_Analysis_of_Low-cost_Computing_Devices_Dec08.pdf

[55] 'Disseminating low-cost computing devices in schools', http://www.connectaschool.org/itu-html/8#177

[56] 'Free laptops will have Tamil Nadu logo burnt on chip', June 2011, http://www.deccanherald.com/content/169738/free-laptops-have-tamil-nadu.html

[57] Wayan Vota, '120,000 XO Laptops Headed to OLPC Rwanda', OLPC News, 2009, http://www.olpcnews.com/countries/rwanda/120000_xo_laptops_headed_to_ol.html

[58] 'The world in 2010: ICT facts and figures', ITU, http://www.itu.int/ITU-D/ict/material/FactsFigures2010.pdf

Developing countries, especially those in Africa and Asia, have been rapid adopters of mobile phones.[59] An increasing number of African Internet users are using their mobile phones to access the Internet – in Nigeria reports indicate that mobile phones are the primary access device to the Internet[60] and the 2010 Digital Life report by TSN Research International indicates that about 36% of Tanzanian Internet users access emails via mobile phones against 31% doing so through computers.[61]

Several features of mobile phones have made them attractive to those exploring their use in education:

- Levels of access to mobile phones mean that they are familiar to learners and educators, who already have the capacity to use them effectively.

- Mobile phones are relatively cheap compared with other computing devices, although costs, while falling, are still high in some parts of Africa. They are an affordable technology for many in the absence of government, private, or development sector support (on which many LCCD programmes have relied). This also provides an opportunity for stakeholders to invest more in content rather than provision of devices and services. The level of access to and use of mobile phones offers opportunities in terms of the reach as well as the scalability and sustainability of initiatives.

- Mobile phones allow people to chat, stay connected with peers, access applications, receive information in real time from around the world and, in some cases, access the Internet. They can support learning that is personalised and contextual which can make it more meaningful. They also include a range of other electronic functions – including those of a radio, MP3 player and camera – which can have educational uses.

Merryl Ford and Teemu Leinonen from the Meraka Institute[62] write that:

> *Contrary to trends in the developed world, where PC and Internet connectivity is almost ubiquitous, mobile phones are currently the most important networked knowledge-exchange technology used in the developing world. From a developing country perspective, features such as limited or no dependence on permanent electricity supply, easy maintenance, easy-to use audio and text interfaces, affordability and accessibility are the most important considerations for using mobile phones as potential learning tools.*[63]

Increased access to mobile phones has resulted in a growing number of projects exploring how they can be used in education. Significant uses include educational quizzes, multi-media content to solve puzzles (for example, for mathematics), interactive literacy programmes, simple question-and-answer activities, text- and/or audio-based short lessons,

[59] International Review of Research in Open and Distance Learning , Volume 9, Number 2: 63. Mobile Learning in Developing Nations, June 2008, http://www.irrodl.org/index.php/irrodl/article/view/564/1071
[60] 'Mobile phones now primary access to internet in Nigeria', October 2010, http://www.vanguardngr.com/2010/10/mobile-phones-now-primary-access-to-internet-in-nigeria/
[61] Balancing Act (June 2011), 'New business model to save African cybercafés – higher bandwidth, higher margins and transactions', http://www.balancingact-africa.com/news/en/issue-no-558/top-story/new-business-model-t/en
[62] http://www.csir.co.za/meraka/
[63] Ford, M. and T Leinonen, (2009), 'Chapter 10: MobilED – Mobile Tools and Services Platform for Formal and Informal Learning', Mobile Learning: Transforming the Delivery of Education and Training, http://www.aupress.ca/index.php/books/120155

alerts by schools/teachers to students or parents, and provision of support to teachers and learners. They can also play an important role in informal education, for example to provide health education information. USAID[64] and the Bill and Melinda Gates Foundation, for instance, are investing large sums to encourage behavioural change among women and immediate family members by using mobile phones to provide educational information on maternal health.

Details of example projects that are using mobile phones in education can be found in Annex 3. These include projects such as:

- Bridge IT Tanzania, which is using mobile phones to distribute educational videos in Tanzania so that these can be played on classroom TVs;
- Dr Math in South Africa, which started as an online tutoring service (in which students contacted tutors on Mxit for help with maths) and has expanded to include mathematics competitions and games;
- Math for Mobile, a project of the University of Haifa which provides free mathematics applications for Java J2ME capable mobile devices that can be downloaded globally;
- Yoza, which started in South Africa, but is now also available on Mxit in Kenya, which supports reading and writing by enabling students to interact with a novel as it unfolds on Mxit or a mobisite; and
- Text to Change, which started in Uganda, is operational in Kenya, Uganda, Madagascar, Cameroon, Namibia and Tanzania, and uses SMS and a toll free shortcode to educate people on health related issues.

In spite of the rapid growth of mobile telephony, issues of access continue to restrict educational potential. The price of service remains an issue, and, in some poorer sub-Saharan African countries, mobile penetration is still relatively low.[65] Some recent studies have indicated that there is a gender gap in access to mobile phones. A study published in February 2010 by the GSM Association (GSMA) and the Cherie Blair Foundation, for example, found that a woman was 23% less likely to own a phone than a man in Africa.[66] Earlier work by Research ICT Africa suggests that this gap is the result not of gender *per se* but of other socio-economic factors which vary between men and women (such as average income): i.e. that 'women with similar income, education, employment status etc. will be as likely to have a mobile phone as men.'[67]

[64] 'USAID: MAMA - New mobile health partnership launched to save lives at birth' http://www.who.int/pmnch/media/membernews/2011/20110503_usaid_mama/en/index.html

[65] Research ICT Africa (RIA), 'Comparative Sector Performance Review 2009/2010', http://www.researchictafrica.net/publications/Policy_Paper_Series_Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_2/Vol_2_Paper_2_-_Comparative_Sector_Performance_Review_2009_2010.pdf)

[66] GSMA and the Cherie Blair Foundation (2010), 'Women and Mobile: A Global Opportunity – a Study on the Mobile Phone Gender Gap in low and middle income countries', http://www.cherieblairfoundation.org/uploads/pdf/women_and_mobile_a_global_opportunity.pdf

67 Alison Gillwald, Anne Milek & Christoph Stork, Gender Assessment of ICT Access and Usage in Africa, Research ICT Africa, 2010, http://www.researchictafrica.net/publications/Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_1/RIA%20Policy%20Paper%20Vol%201%20Paper%205%20-%20Gender%20Assessment%20of%20ICT%20Access%20and%20Usage%20in%20Africa%202010.pdf

The Research ICT Africa (RIA) Comparative Sector Performance Review 2009/2010 states that:

> *Mobile penetration rates continue to demonstrate significant growth but these figures tend to mask the fact that millions of Africans still do not own their own means of communication. Despite the high proliferation of low costs handsets, in some poorer sub-Saharan African countries like Uganda and Tanzania penetration remains relatively low. While improved affordability of devices is driving up take, pricing of services remain a constraint on the usage, particularly when these are affected by the regressive special taxes levied on communications and equipment, which is as high as 30% in Uganda.*[68]

There are currently relatively low levels of use of smartphones in Africa, though this is likely to change in the next few years as smartphones replace previous generations of mobile handsets. Research conducted by Informa Telecoms and Media found that, at the end of 2009, India and Africa had the lowest penetration levels in the world, with only 5.1% of mobile subscribers in Africa owning smartphones.[69] That report argued that price is a principal reason for the low penetration of smartphones. The rapid take-up of an US$80 Android phone in Kenya highlights the importance of reducing prices.[70] The importance of cost of access is also shown by rapid adoption of platforms such as Mxit,[71] a very low-cost instant messaging service.

Some other issues affecting the use of mobile phones in education include the following:

- Software applications to run on mobile phones (for example, Frontline SMS, Mxit) are often free and less expensive. Mobile development practitioners often modify these applications to suit customers' needs. However, it can prove expensive if developers want to build special software, tailor content to customise their services to target users or ensure that those services are promoted by all providers.

- Ensuring compatibility on all phone types and provision by all national providers is a challenge. Support from national communications regulators to ensure the participation of all mobile operators in delivery of a service is often required, combined with a strong business case to attract operators to promote services as required.

- Text-based m-learning excludes text-illiterate people, but the introduction of Interactive Voice Response (IVR) and accompanying requirements for smartphones to use multimedia services can be more expensive.

- Lack of standards: Yerushalmy and Weizman write in their essay in Annex 10 of this report about the challenges of the Math4Mobile project that:

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[68] Research ICT Africa (RIA), 'Comparative Sector Performance Review 2009/2010', http://www.researchictafrica.net/publications/Policy_Paper_Series_Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_2/Vol_2_Paper_2_-_Comparative_Sector_Performance_Review_2009_2010.pdf)

[69] Informa, Telecoms and media, 'Smartphone success confined to developed markets as emerging markets lag behind', September 2010, http://blogs.informatandm.com/1519/press-release-smartphone-success-confined-to-developed-markets-as-emerging-markets-lag-behind-2/

[70] Ford, Jeremy, '$80 Android Phone Sells Like Hotcakes in Kenya, the World Next?', August 2011, http://singularityhub.com/2011/08/16/80-android-phone-sells-like-hotcakes-in-kenya-the-world-next/

[71] http://www.mxit.com/

Continuing fragmentation is a major obstacle for the scalability and sustainability of the development. It requires constant investment in parallel development (different languages and mathematical packages) for a variety of systems and hardware, that have different capabilities even when operating under similar system. It also requires software verifications and quality assurance that are not easy to do in educational environments.'

- Many schools and educators do not allow use of mobile phones in classrooms.

- There remain usability challenges due to issues such as the small screen size of mobile handsets.

2.3 Tablet PCs, iPads, and eReaders

Since the creation of the iPhone, a new range of devices has emerged which make use of touch screens, are multimedia-friendly, web-friendly and relatively intuitive to use. They include connectivity in order to upload content and connect to the internet so as to access the rapidly growing range of interactive, location-specific and customer-centric software applications ('apps'). These devices are at present predominantly tested in and produced for developed country markets and, although their use is being considered in education, have not been designed as educational devices. Current experiments using tablets PCs, eReaders, and iPads in education are largely confined to developed countries due to cost and connectivity factors.[72]

Proponents for their use in education argue that:

- The touch-interface combined with long battery life provides an intuitive experience for learning.[73]
- They are light, portable, and easy to hold or lay flat and pass around.
- There is a growing number of free and low-cost apps for tablets.
- They enable portability of large volumes of content, and therefore provide an opportunity to distribute a large volume of offline content to remote locations. They can also use the GSM mobile phone network to access content.
- Electronic texts and multimedia content tend to be less expensive to purchase than printed or hard-copy versions (for example, CD or DVD packs). WorldReader.org, which is testing the use of e-readers in schools in Ghana, argues that 'the cost of digital content is falling quickly: many current and classic digital books are priced at one-half or less of the hardcover list price, and many others are free.'[74]
- Some e-readers have additional functionality that can add value such as built-in dictionaries, access to Wikipedia, and text-to-speech (which can help, amongst others, new readers or the visually impaired).

[72] The issue of the use of tablet PCs, iPads and eReaders in education was looked at recently on the Educational Technology Debate site where there are a number of articles on the topic: 'Tablet PCs in Education', April 2011, https://edutechdebate.org/tablet-computers-in-education/

[73] The following shows a 2 year old trying an iPad for the first time: http://www.youtube.com/watch?v=pT4EbM7dCMs&feature=player_embedded

[74] http://www.worldreader.org/faq.php

However, as with other devices, cost is a critical barrier to the use of tablet PCs, e-readers, and iPads. Even though the cost of these devices is falling, they remain expensive. E-readers, the cheapest of them, currently cost half of what they did about eighteen months ago, but, even at less than US$200, they are too expensive for many to afford. Other issues relating to the use of these devices in education in developing countries include the following:

- They have not been designed and are not well suited to survive in dusty or tropical environments.
- They are intrinsically intended to be dynamic tools which function, interact and update content through the internet. Low levels of connectivity, slow bandwidth and high costs of access are therefore barriers to their use. Given these constraints, offline innovation and interactivity need to be developed to enhance their educational value.
- E-books and iPads have proprietary and closed standards and formats. The digital rights management of device content is restricted specific devices, not shared with other machines/readers. There is a need to consider how content is (un)locked to specific users or machines and how to introduce interoperable digital rights management arrangements for educational content. Innovative interoperable and unrestrictive versions for educational purposes may become available in future.
- Digitising content, developing new digital content, and distributing this content to users are also challenges in terms of costs, capacity, connectivity, establishing new policies and regulatory practices. Locally relevant content needs to be available at affordable prices. Digitising local content in different languages is likely to be a major constraint in developing countries.

The Worldreader.org project – to test the use of e-readers in schools – highlights some of the points made above. WorldReader.org is a not-for-profit organisation that supports the deployment of e-readers. Its donors help to subsidise the gap between the cost of the e-readers and the price that local governments are willing to pay. Its business model requires that books initially loaded on e-readers will be included in the donor-subsidised price paid by local schools and communities. Each community will decide which books are pre-loaded, based on its needs and interests.

WorldReader.org found, in a trial with OrphanAid Africa in Ghana,[75] that sixth grade students (*i.e.* those at the upper end of primary school) were able to learn to use a Kindle within several hours of training and several days of practice; that reading digital books was an acceptable alternative to reading paper books; and that children read more when using the Kindle. Readers also used its built-in dictionary to look up new words and its text-to-speech capability for pronunciation. The main challenges that the study observed concerned the preparation and set up of the e-readers; the cost of e-readers and books, along with digital rights management (DRM) policies; the lack of local content available for e-readers; bandwidth issues; and some usability problems (for example, the accidental loss of or hiding of texts and the use of setting which rapidly drain battery power).

[75] 'Worldreader.org E-reader Trial Report, OrphanAid Africa School, Ayenyah, Ghana,March, 2010', , Mike Sundermeyer, David Risher, Colin McElwee, http://blog.worldreader.org/wp-content/uploads/2010/05/WR-E-Reader-Trial-Report-Ghana.pdf

3 Emerging roles for digital learning resources

Providing access to technology is simply a starting point for the effective integration of ICT in education. A second important consideration is the provision of resources to use in educational processes with these technologies. In the past, education has relied on printed materials to deliver a content-rich teaching and learning environment. With the advent of ICT and its rapid and cost-effective publishing opportunities, content-rich materials are no longer static nor are they the exclusive domain of publishing companies. New ICTs allow all citizens – including and, for the purpose of this report, particularly those in education – to author and publish learning materials in digital formats. This report uses the term 'digital learning resources' to include all kinds of digital resources used for learning including: educational content (materials designed directly to support teaching and learning); software tools to produce, use and distribute content; and implementation resources such as copyright licences. This section of the chapter presents a broad overview of issues relevant to digital learning resources, with an emphasis on the development of open education resources (OER) that are responsive to development needs (as outlined in the terms of reference).

The very rapid growth of ICT has resulted in considerable change in the education sector, with the most powerful impacts of digitisation including the opportunities it has opened up for content creation, and an accompanying shift in the conception and value of content that has allowed it to be dynamically updated by several contributors. Rather than value being located in content itself, value is now also located in services that package and publish content that is both current and tailored for diverse audiences and purposes. This trend is clearly seen in the concept of OER which encompasses educational resources (including curriculum maps, course materials, textbooks, streaming videos, multimedia applications, podcasts, and any other materials that have been designed for use in teaching and learning) that are openly available for use by educators and students, without an accompanying need to pay royalties or licence fees.

While the educational value of OER lies in the idea of using *resources* as an integral method of communicating curriculum in educational courses (*i.e*. resource-based learning), its transformative power lies in the ease with which such resources, when digitised, can be shared via the Internet. Importantly, there is only one key differentiator between an OER and any other educational resource: its *licence*. Thus, an OER is an educational resource that incorporates a licence that facilitates re-use, and potentially adaptation, without first requesting permission from the copyright holder. An 'open licence' grants permission to access, re-use, and redistribute a work with few or no restrictions. A broad spectrum of legal frameworks is emerging to govern how OER is licensed for use. The best known of these is the Creative Commons licensing framework (see www.creativecommons.org). This provides legal mechanisms to ensure that authors of material can retain acknowledgement for their work while allowing it to be shared; can seek to restrict commercial use of their material if they so wish; and can aim to prevent people from adapting it if and where they consider this would be inappropriate.[76]

[76] Butcher, N.(2011). A Basic Guide to Open Educational Resources (OER). UNESCO and Commonwealth of Learning. Retrieved from http://www.col.org/resources/publications/Pages/detail.aspx?PID=357

3.1 OER repositories and collections

The rapid growth in OER is evident from the development of many online repositories that contain OER material. These range from complete courses to smaller learning resources. They demonstrate burgeoning interest in OER, as well as a rapidly emerging Web infrastructure to support further growth, sharing, and discovery of OER online.

One of the major approaches to promoting OER globally is by institutions using OpenCourseWare (OCW), where the focus is on developing and sharing freely available, stand-alone, online courses and teaching materials, predominantly in the higher education sector. Massachusetts Institute of Technology (MIT) has perhaps the best-known institutional OCW project. The concept of OCW has grown and resulted in a worldwide community of hundreds of universities and associated organisations committed to advancing OCW through the OpenCourseWare Consortium.[77] However, African participation in the consortium is very limited, with just six member institutions and organisations. Institutional involvement in OER creation and adaptation varies – from universities providing complete courses in the form of OCW (for example, MIT) to those using a mixture of resources provided by faculty members and external contributors (such as Connexions, run by Rice University,[78] and Open Learn, run by the Open University of the United Kingdom).[79] Others are 'community' driven, whereby community members contribute and collaborate in the development of materials. An example of this model is Curriki (http://www.curriki.org).

In addition to global OER initiatives such as these, there are several African OER initiatives such as OER Africa,[80] which is involved in promoting the use of OER in Africa and supporting individuals and organisations in creating OER. The University of the Western Cape, South Africa, agreed a Free Content, Free/Open Courseware Policy in 2005, which removed institutional obstacles to publication of open educational resources. The Free Courseware project[81] is part of the university's broader move towards implementation of this strategy. The University of Cape Town's OpenContent directory is the web portal for accessing open teaching and learning content from the University of Cape Town (UCT), South Africa.[82] The ELATE programme was initiated in May 2007 as a professional development initiative to enhance secondary teacher training in Uganda.[83] Materials found on the ELATE website have been prepared for senior years 1-4, which lead up to the Uganda National Examinations Board O-level. All materials are grouped by topic, but they do not require the use of computers by students. All topics include a teacher's guide and student activities in easily downloadable format.

There are numerous strengths of using OER in an African context. These include increased access to educational content, lower costs, new educational opportunities, increased efficiency in the development of materials, opportunities to re-examine the curriculum,

[77] http://www.ocwconsortium.org
[78] http://cnx.org
[79] http://openlearn.open.ac.uk
[80] http://www.oeafrica.org
[81] http://freecourseware.uwc.ac.za/freecourseware
[82] http://opencontent.uct.ac.za
[83] http://www.elateafrica.org)

increased familiarity with ICT and enhanced institutional reputation and brand image. However, there are also a number of challenges. These include the need for a fast and robust/reliable Internet connection, familiarity with the OER model, the need to train and build the capacity of educators to source and adapt OER, and the limited availability of OER materials which match local content needs. Both opportunities and challenges are discussed in more detail and illustrated by implementation examples in Chapter 3.

OER can play a meaningful role in supporting education in Africa by contributing to improvements in the quality and effectiveness of education. One problem, however, is that many people in the 'OER movement' seem to assume that simply making content freely available for use and adaptation will improve the delivery of education. This simplistic view ignores the reality that content is just one part of the educational puzzle, and that effective use of educational content requires, among other things, good educators to facilitate the process. Importantly, OER provides an opportunity to engage education institutions and academics in structured processes that build capacity to design and deliver high quality education programmes without increasing cost. The challenges of increasing access, together with the continuing roll-out of ICT infrastructure to educational institutions, indicate that it is becoming increasingly important for institutions to support, in a planned and deliberate manner, the development and improvement of curricula, ongoing programme and course design, planning of contact sessions with students, development of quality teaching and learning materials, and design of effective assessment. All these activities are aimed at improving the teaching and learning environment while managing cost through increased use of resource-based learning.

3.2 E-textbook and open access journals

The increasing availability of digital content is also resulting in a shift in the expectations of both educators and learners, as they look for more choice and flexibility about how to receive and use content. The demand for choice is stimulated by concerns over issues such as price and content portability. This has resulted in trends such as textbook publishers producing content simultaneously in multiple formats, including audio recordings and e-books, allowing for purchase by chapter, print-on-demand and traditional print. There is also a trend for periodicals to make access to their databases easier for end-users . In Africa, this allows content to be more readily accessible, particularly in a context where there is insufficient access to printed resources.

There are several international examples of e-textbook initiatives such as Textbook Revolution,[84] a student-run site that contains links to a number of freely available textbooks.; e-Campus[85] which provides cheap new and used textbooks, e-books, and the ability to rent textbooks; and Flat World Knowledge[86] where students can read electronic texts for free, or can pay a small fee for print-on-demand services. In South Africa, the Free High School Science Texts (FHSST) project website seeks to develop and disseminate free

[84] http://textbookrevolution.org/index.php/Main_Page
[85] http://www.ecampus.com
[86] http://www.flatworldknowledge.com

and open textbooks and supporting materials for use in the teaching of Science and Maths for grades 10-12, based on the South African school curriculum.[87]

The main benefit of e-books for African countries is that they allow content to be made more easily accessible, which means in turn that users can access books more quickly. Free e-books can be very beneficial for rural and poorer institutions that have inadequate access to traditional resources such as printed materials. However, there are constraints as the benefits are dependent on institutions having computers with good access to the Internet. In addition, e-books that rely on hardware such as e-readers (for example, the Kindle or iPad) have higher access costs and are therefore unlikely to spread widely beyond wealthier adopters.

University libraries are increasingly playing a significant role in the acquisition and distribution of institutionally-licensed web-based digital material. In addition, libraries and academics are making use of open access journals. Examples of well-known open access journal collections are the Directory of Open Access Journals (DOAJ), BioMedCentral, and Bentham Open.[88]

Journals have traditionally been sold to libraries on subscription because, when they were printed on paper, this was the only model available that enabled publishers to disseminate journals and recoup the cost. Unfortunately, this has meant that only researchers in institutions that could afford to pay subscription charges were able to read journal articles. In poorer countries, few institutions could afford these charges.[89]

The advantages of open access publications include the fast and worldwide spread of published articles at no subscription cost to readers and control of access to specific articles (*e.g.* by number of hits), as well as article ranking and evaluation of scientific interest of readers.[90] In African contexts, open access publications are particularly beneficial as they allow content to be made available at no cost to users in all jurisdictions regardless of affiliation with a subscribing library. Authors gain recognition as their papers are read and cited by others, while researchers and academics at institutions whose libraries cannot afford a journal or where that journal is out-of-scope can still access its content.[91] It is noteworthy that developing country repositories are also enjoying a high level of usage, as these provide to the rest of the world the outputs from scholars in developing countries who previously had difficulty publishing in global journals. For example, the Institutional Repository of the Universidad de Los Andes in Venezuela, with 14,000 records, registered 502,000 full text downloads in 2008 from both regional and international users.[92]

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[87] http://www.fhsst.org

[88] http://www.doaj.org; http://www.biomedcentral.com; http://www.benthamscience.com/open

[89] Swan, A and Chan, L. (no date). Benefits of Open Access for research dissemination. Open Access Scholarly Information Sourcebook. Retrieved from: http://www.openoasis.org/index.php?option=com_content&view=article&id=146&Itemid=308

[90] Kayser, K. (2011). Diagnostic Pathology in 2010: the successes and perspectives of open access publication. Diagn Pathol. 2011; 6: 2. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3022784

[91] Wikimedia. Open Access Journal. Retrieved from http://en.wikipedia.org/wiki/Open_access_journal

[92] Swan, A and Chan, L. (no date). Benefits of Open Access for research dissemination. Open Access Scholarly Information Sourcebook. Retrieved from: http://www.openoasis.org/index.php?option=com_content&view=article&id=146&Itemid=308

There are a few disadvantages of using open access journals. Not all fields of research, for example, have many or good open access journals available, while the 'author pays' model may be a deterrent to the submission of papers and thereby obstruct free and open exchange of scientific results (although it does ensure that the publisher is compensated for its work).[93]

The growing availability of e-books and open access journals has potential to meet the needs of African institutions which often work with limited resources. Their free availability allows content to be accessed quickly, and allows African researchers the opportunity of increased visibility when their articles are published. However, a prerequisite for effective use of such resources is access to computers linked to the Internet.

3.3 National education portals

The Internet provides access to a very wide range of educational resources. However, experience shows that there is a shortage of resources in a format that makes them easily accessible and relevant to most teachers and learners in Least Developed Countries (LDCs), especially as they relate to a particular country's current curriculum. Research also indicates that official guidelines and directives for Ministries of Education seek to enhance use of ICT-enabled content.[94] One way of resolving this is through the creation of national education portals that meet a country's specific educational needs. There are several international examples of such portals:

- Through the Thutong Portal,[95] the South African Department of Basic Education (DBE) seeks to lead the drive to improve learning in the country through the appropriate use of technology. The Thutong Portal is the online point of entry to a comprehensive array of free educational resources, policy information and interactive services concerning all aspects of the South African schooling sector. It provides relevant information and services about the South African school curriculum, teacher development, school administration and management.
- The Enlaces Programme in Chile[96] has created a website which offers educational content and services for teachers and students. The website is considered a portal through which teachers can access curriculum-oriented content, fora and up-to-date educational information.
- Australia has a robust environment in digital content with different state education departments having their own portals (for example, the Queensland government's education portal, http://education.qld.gov.au/).
- Iceland's national education portal, The Educational Gateway,[97] seeks to help teachers, learners and parents to identify educational content, especially content available on the Internet, which is relevant to specific parts of the national curriculum, grouped by grade

[93] Wikipedia. Open Access Journal. Retrieved from http://en.wikipedia.org/wiki/Open_access_journal
[94] Trucano, M.(2005). Knowledge Maps: ICT in Education. Washington, DC: infoDev / World Bank. Available at: http://www.infodev.org/en/Publication.8.html
[95] http://www.thutong.doe.gov.za/
[96] http://www.enlaces.cl
[97] http://www.menntagatt.is

level and subject. It is a clearinghouse for news, for school-related information, information on education projects and initiatives, and it also hosts online discussions

There are a number of challenges in establishing national repositories. These include funding difficulties, reliance on collating what is already developed and available for free, and the reality that educational content is often limited to material available in English. African countries can nevertheless benefit by establishing national education portals as these can serve as clearing houses or digital libraries for content linked to the national curriculum. This will promote better use of ICT in teaching and facilitate quick and easy access to resources for making lesson plans and for teaching. They also provide an opportunity for 'imported content' to be evaluated.

3.4 New and emerging technologies

Digital learning resources also include software tools to produce, use and distribute content. The range of available digital content creation tools is dynamic, evolving rapidly in relation to technological development and user innovation. This technology makes informative content easier to find, to access, to manipulate and remix, and to disseminate. In line with OER philosophy, the most relevant software tools are open source.

3.4.1 Open Source software applications in education

Open Source Software/Free Software (OSS/FS) refers to any software which may be copied and used freely, and for which the source code (the human-readable instructions defining the software's behaviour) is available. OSS/FS software is often available free of charge on the Internet and can be copied, used, studied, modified, distributed, *etc*., with few or no copyright restrictions.[98] This enables both developers and users to modify or add features to the source code and redistribute it. As a result, collaboration and circulation are central tenets of the open source movement. One of the most common open source applications in education is Learning Management Systems (LMS), which is a software application for the administration, documentation, tracking, and reporting of training programmes, classroom and online events, e-learning programmes, and training content.[99]

Several African universities are making use of open source LMS, but the most popular systems in Africa appear to be Sakai and Moodle. The University of Cape Town, the North West University in South Africa and the University of Cairo, for example, use Sakai. Higher education institutions participating in the Partnership for Higher Education (PHEA) Educational Technology Initiative (ETI) make use of Moodle. These include Kenyatta University, Kenya; The University of Dar es Salaam, Tanzania (UDSM); The University of Ibadan, Nigeria (UI); the University of Education, Winneba, Ghana (UEW); the University of Jos, Nigeria (UJ) and the Catholic University of Mozambique (UCM). Work with the PHEA-ETI institutions[100] shows that formal institutional policies provide a useful basis for implementation, practice and procedure. Where policies are comprehensive (*i.e*. where

[98] Bruggink. M. (2003). Open Source in Africa: Towards Informed Decision-Making. IICD Research Brief – No 7, August 2003. Retrieved from: http://www.iicd.org/files/Brief7.pdf
[99] Wikipedia. Learning Management System. Retrieved from http://en.wikipedia.org/wiki/Learning_management_system
[100] See http://www.oerafrica.org/technology/UsingTechnologyHome/tabid/883/Default.aspx

they address all the layers and areas of implementation), they are more likely to ensure greater coherence and, therefore, smooth operations.

There are several advantages in using Open Source LMS. These include the absence of a licence fee, the avoidance of 'vendor lock-in', adaptation of open source code to meet local needs, the ability to customise features and tools, and access to global support options. However, there are also a number of challenges. These include limited advocacy of open source approaches, poor Internet connectivity, a lack of trained technical support staff, and aggressive marketing by proprietary software companies with alternative products. A more detailed discussion of the advantages and disadvantages of using open source LMS can be found in Annex 4.

There is a need for greater advocacy around how to use various open source products, supporting decision makers with models, toolkits, and case studies relating to choice of technology and system migration in an African content. In addition, motivating institutions to make use of open source software can help in developing the IT skills of the next generation.

3.4.2 The new face of open source: Web 2.0 – moving to student-centred learning

Web 2.0 refers to applications that facilitate participatory information sharing, interoperability, user-centred design and collaboration on the World Wide Web.[101] While first generation websites provide information to users, premised on assumptions that the teacher (or textbook) is an authoritative source which can provide information to learners, with Web 2.0 platforms knowledge transfer becomes a two-way process, in which users both receive and contribute information. This levels the playing field so that all users and contributors have a potentially equal 'voice' within the community. It also undermines established principles of intellectual property, with the result that much content becomes more widely accessible and can be used to continue development of the community, without being ring-fenced by copyright laws. Although Web 2.0 technologies are not designed specifically for digital learning, the education community has been looking to Web 2.0 for interactive models. The incorporation of Web 2.0 technologies has changed digital education from a medium to a platform, and many believe Web 2.0 technologies will help digital learning evolve into a mainstream concern.[102]

The Web 2.0 tools most commonly used in education are blogs and wikis, although podcasting and media-sharing sites are also common.

Blogging

A blog or 'weblog' is a frequently-updated personal website featuring diary-type commentary and links to articles or other websites (and, in the case, of video-blogging, video material). Blogs provide diverse, alternative sources of information for education, as

[101] Wikipedia. (no date). Web 2.0. Retrieved from: http://en.wikipedia.org/wiki/Web_2.0

[102] Lakhan, S.E and Jhunjhunwala, K. (2008). Open Source Software in Education. *EDUCAUSE Quarterly,* vol. 31, no. 2 (April–June 2008). Retrieved from: http://www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolum/OpenSourceSoftwareinEducation/162873

well as tools that can be used by academics and students for a wide range of educational purposes. Teachers and students can collect, create, and share their own online knowledge resources. Examples include the St Cyprian's School Technology Blog,[103] and the Maggie Verster's School 2.0 in South Africa blog, which focuses on how Web 2.0 can transform teaching and learning.[104]

Wikis

A wiki enables documents to be written collaboratively, in a simple mark-up language using a web browser. A defining characteristic of wiki technology is the ease with which pages can be created and updated, making it an effective tool for collaborative authorship. The best-known example of this is Wikipedia, a globally popular encyclopaedia website that has challenged notions of what constitutes 'expertise' and raised questions about the reliability of information (its own and that elsewhere). Wikis are extensively used in higher education programmes for educational purposes, and are among the authoring tools being used to generate open content. For example, WikiEducator[105] is an international online community project for the collaborative development of OER. A variety of learning resources are available on WikiEducator, including direct instructional resources such as lesson plans and full courses, as well as learning-support resources such as individual school portals and funding proposals.[106] Other interesting wikis are Wikibooks,[107] which allows users to edit open content textbook collections, and Wikitionary,[108] a collaborative project to develop a free-content multilingual dictionary.

Podcasting

'Podcasting' refers to any combination of hardware, software and connectivity that permits automatic download of (usually free) audio and video files to a computer, smartphone or MP3/MP4 player for listening or watching at the user's convenience. Podcasting has made available a wide spectrum of educationally useful audio and video material, including radio programmes from around the world, lectures, conference speeches, and custom-produced podcasts created by enthusiasts. More and more universities and academics are making lectures available as podcast series, usually providing these freely to anyone around the world with Internet access.[109] For example, Stanford University has joined forces with Apple to develop the podcast-based iTunes University.[110] Other universities - including Cambridge University, Duke University, Harvard, MIT and the University of Melbourne – have followed this initiative. No African universities have done so as yet, though some have made podcasts available. The University of Stellenbosch has made available a series of podcast

[103] http://techblog.stcyprians.net
[104] http://maggiev.edublogs.org
[105] www.wikieducator.org
[106] http://en.wikipedia.org/wiki/WikiEducator
[107] http://en.wikibooks.org
[108] http://en.wiktionary.org
[109] Educause Leaning Initiative . 7 things you should know about...series. retrieved from: http://www.educause.edu/ELI7Things
[110] http://itunes.stanford.edu/content/overview.html

lectures which are concerned with musculoskeletal subjects,[111] while the University of Pretoria has given access to podcasts on a variety of topics.[112]

Social networking sites

Social networking sites are web-based services that allow individuals to construct a public or semi-public profile within a bounded system, define a list of other users with whom they share a connection, and view and traverse their connections and those made by others within the system. The best-known and most widely used of these services are Facebook and Twitter, although many others have been established. Some focus on specific dimensions of social networking. For example, photo-sharing websites such as Flickr allow users to upload, tag, browse and annotate digital photographs, as well as participating in self-organised topical groups. One example of a social network in education is awareNet,[113] a social networking programme for schools which addresses issues of personal self-worth in an innovative digital manner. This expression is channelled into wiki-style projects that explore the cultural and historical heritage of young people in addition to allowing free-flowing conversations.[114]

The potential impact of Web 2.0 services and technologies on education in Africa is promising as it fosters a more open approach to learning. The availability of such technology enables users to produce content, readily access and share educational materials, create derivative works, and republish and redistribute these to others. It enables people to participate easily in the creation of new knowledge rather than merely consuming pre-existing knowledge, and in particular allows students to become participants in the development and distribution of learning content. There are challenges with using such applications in the African context such as the need for good Internet connectivity. However it can be argued that, if the benefits of Web 2.0 technology are recognised and used well in educational environments, this could increase demand for Internet access and so help to bring about improved connectivity.

Progress towards making information available to a larger section of the global learning community through the Internet and Web 2.0 has enabled greater democracy in the education system as a whole and is one of the strongest arguments for digitisation of education. The benefits of Web 2.0 technology in enabling users to produce, access, share, rework, republish and redistribute educational materials foster a more open and democratic approach to learning.

[111] http://www0.sun.ac.za/ortho/audio
[112] http://eduvation.up.ac.za/podcasts
[113] http://awarenet.eu
[114] Kasumuni, L. (2011). Unleashing Web 2.0 for African Education. Retrieved from: http://www.elearning-africa.com/eLA_Newsportal/unleashing-web-2-0-for-african-learning

4 A focus on teachers: the growing importance of professional development in ICT integration

Cost and accessibility remain challenges to the successful adoption and use of technologies in education. Even where these barriers have been surmounted and technologies can be accessed, along with relevant digital learning resources, lack of teacher knowledge and confidence to use new technologies presents a challenge to their use. Research in the United States of America, United Kingdom and Australia, as well as other countries, suggests that computer anxiety and lack of confidence are serious impediments to teachers' willingness and effectiveness in using computers and other technologies in the classroom.[115] As a result, teacher professional development in the use of available technologies is an important factor in their successful and effective deployment and integration into teaching and learning. The most important issues relating to teacher professional development are:

- the competencies required for teachers to be able to integrate technology successfully in their teaching;
- the options with which professional development can be advanced;
- models that have emerged in the implementation of professional development initiatives; and
- enablers of professional development.

4.1 Teacher competencies for ICT integration

Because of the proliferation of technologies in society, young people and teachers themselves already have skills which are needed to make use of technologies. However, the skills required for technology use for social purposes do not necessarily equate to digital literacy which is adequate for educational and professional purposes.[116] Teachers need specific competencies to be able to integrate technology into teaching successfully, in ways that will enhance the educational experiences of their learners.

The professional development of teachers concerning the integration of ICT into teaching and learning should ideally be located within a broader framework of teacher professional development based on a national, provincial, district, and/or school strategy for professional development. Teacher professional development strategies should include technology integration to support the notion that professional development of teachers for ICT integration should be an ongoing, lifelong process. To this end, in many countries – examples of which are as diverse as Australia, Chile, Namibia and Guyana – traditional, one-off workshop training is now regarded as inadequate and is being replaced by lifelong professional development of teachers. This focuses on at least three dimensions:

1) Pre-service training – integrating technology into the teacher training course – enables teacher educators to model use of technology to trainee teachers. It also helps trainee teachers to start thinking about practical ways of using technology for teaching that they

[115] Pelgrum, W.J. and Law, N. (2003). ICT in Education Around the World: Trends, Problems and Prospects. UNESCO International Institute for Education Planning: Paris.
[116] Pegrum, M. (2010). Modified, multiplied and (re)-mixed: social media and digital literacies. Available at: http://e-language.wikispaces.com/file/view/Pegrum+-+Modified,+multiplied+and+remixed+(Draft+Feb+2010).pdf

can try out during teaching practice, if their schools have access to the necessary technology.

2) In-service training – as a way to reinforce the training offered at pre-service level, or for new induction of serving teachers who did not receive this in initial teacher training. Training can be offered using structured workshops, seminars, short courses and independent self-paced online learning. Informal training can also take the form of peer collaboration in communities of practice where teachers exchange ideas, showcase successful examples of integration, and offer support and encouragement to one another on how to integrate technology into teaching. These structured and informal activities and processes help develop and enhance teachers' skills, knowledge and confidence in the use of technology in the classroom.

3) Sustained formal and informal pedagogical and technical support for teachers using technologies. This support can open opportunities for broader networking by teachers, connecting them to colleagues, mentors, curriculum experts, and the global teaching community, which can both critique and support their work in a manner that enhances their teaching and ultimately improves the quality of learning for their learners.[117]

Evolving technology trends provide impetus for professional development as a process of ongoing capacity-building activities aimed at assisting teachers to develop basic and advanced skills to use technologies comfortably, as well as integrating them successfully into their teaching.[118] As technology changes, so do culture and the values that shape culture. Education, as a cultural relay for societal values, plays a role in preparing citizens to confront the challenges of change processes that are happening globally, including technological drivers of the economy such as the Information Society. UNESCO's ICT Competency Framework for Teachers[119] provides guidance on how education should respond to the global technological requirements of most global economies. Its standards are based on the premise that educational change through ICT should be perceived in three dimensions: technology literacy, knowledge deepening and knowledge creation. These dimensions have different repercussions for pedagogy, teaching practice and professional development, curriculum and assessment, and school organisation and administration.

Teacher professional development needs to focus on developing teachers' knowledge and skills for technology literacy, knowledge deepening, and knowledge creation.[120] A focus on technology literacy prepares teachers to encourage and facilitate student uptake of new technologies to support social and economic development. Professional development of teachers seeks to equip them with technological literacy to integrate basic ICT tools into the curriculum. However, in order to do this, teachers need access to technologies to apply their skills and knowledge. Provision of technological tools is therefore a necessary requirement for any teacher professional development for ICT integration.

[117] Carlson, S. and Gadio, C.T. (2002). Teacher Professional Development in the Use of ICT. Available at: http://www.ictinedtoolkit.org/usere/library/tech_for_ed_chapters/08.pdf
[118] Trucano, M. (2005). Knowledge Maps: ICTs in Education. Washington: The International Bank for Reconstruction and Development / The World Bank.
[119] UNESCO. (2011). UNESCO ICT Competency Framework for Teachers. Paris: UNESCO.
[120] UNESCO. (2011). UNESCO ICT Competency Framework for Teachers. Paris: UNESCO, p.3.

To achieve knowledge deepening, which enables students to apply school knowledge for complex problem-solving in the workplace, teacher professional development should focus on facilitating teachers' knowledge and skills to use complex methodologies and technologies. Some of the approaches that teachers need to adopt in classroom teaching include establishing a complex relationship between school knowledge and real world problems, and fostering collaboration between students at local and global levels – with the teacher mediating this learning process.

Inculcating skills in collaboration, communication, creative thinking, innovation and critical thinking can lead to knowledge creation. Teachers can model these skills to their students through their own professional development by developing sophisticated skills in using technology, and collaborating with peers to design projects that challenge students to be critical and innovative.

The interplay between these various factors - technology literacy, knowledge deepening and knowledge creating approaches and policy, curriculum and assessment, pedagogy, the use of technology, school organisation and administration, and teacher professional development – is illustrated in Table 2.2. Each cell in this table represents a module in the UNESCO ICT Competency Framework for Teachers.[121]

Table 2.2 - UNESCO ICT Competency Framework for Teachers

	Technology Literacy	Knowledge Deepening	Knowledge Creation
Understanding ICT in education	Policy awareness	Policy understanding	Policy Innovation
Curriculum and Assessment	Basic knowledge	Knowledge application	Knowledge society skills
Pedagogy	Integrate technology	Complex problem solving	Self-management
ICT	Basic tools	Complex tools	Pervasive tools
Organisation and Administration	Standard classroom	Collaborative groups	Learning organisations
Teacher Professional Learning	Digital literacy	Manage and guide	Teachers as model learners

4.2 Options for delivery of professional development

Having determined that professional development for ICT integration should be seen as an ongoing undertaking, it is useful to consider how it can best be conducted, as there are various options for the delivery of training. Some of these options are more suited to formal training, while others are useful for informal professional development. The choice of which option to pursue will depend on the level and purpose of the professional development

[121]UNESCO. (2011). UNESCO ICT Competency Framework for Teachers. Paris: UNESCO, p.13.

intervention. Some approaches are presented in Table 2.3, along with their characteristics, advantages and disadvantages.

These options are useful for building a professional development strategy, as 'ideal' professional development is based on ongoing efforts, plus a mix of options for different stages of professional development that will appeal to different teachers' learning styles and working lives. Varied offerings of professional development are most likely to attract greater participation from teachers, who will be given an opportunity to choose what suits them best.

Table 2.3 - Options for professional development[122]

Option	Characteristics	Advantages	Disadvantages
Centralised face-to-face delivery	• Training takes place at a central venue • Training is focused on a small group of teachers (10 -20) • One-off training for a specific number of days, usually with no follow-up support	• Trainers can be ICT and integration specialists who can answer questions and troubleshoot • Participants can share experiences and learn from one another • Training can cluster participants from different schools for post-workshop networking and support	• Expensive. Only a few teachers can be trained at a time • Inflexible. Training is at a specific time and place • Training venues away from school can impede the transfer of skills due to different systems being used • If no post-training support is incorporated, training effects can be short-lived
Cascade delivery	• A core team of lead trainers is developed to train teachers in their schools • After teacher face-to-face training, cascade training can refresh skills	• Many teachers can be reached through direct training of only a few trainers	• Skills transfer depends on the proficiency of the lead trainer • The quality of the training, and therefore skills and knowledge acquired by teachers, cannot be guaranteed
E-learning delivery	• Technologies are used to support teachers to complete modules • Collaboration between trainees and between trainer and trainees can be facilitated through online tools	• Creates confidence through use of technologies for learning • Online presence can facilitate use of digital resources • Teachers are exposed to a range of e-learning tools and types	• This model can be expensive • Basic computer skills are a prerequisite for effective participation • Self-paced learning can be difficult and requires discipline to sustain training

[122] Data for this table is drawn from: UNESCO Bangkok. No date. Implementing SchoolNet Programmes. http://www.unescobkk.org/fileadmin/user_upload/ict/e-books/SchoolNetKit/guidebook3.pdf; and SchoolNet Africa. (2004). Towards a Strategy on Developing African Teacher Capabilities in the Use of ICT. Draft report.

Option	Characteristics	Advantages	Disadvantages
Mentoring	• Mentoring occurs when a more skilled and knowledgeable person guides, supports and coaches novices. Mentoring includes explicating knowledge, sharing resources and encouraging novices in their integration efforts	• Mentoring can be mutually beneficial for the mentor and the individuals being mentored • Mentoring can occur across borders, through e-mentoring	• Finding time to act as mentor may be a challenge • Some mentors are not good at explicating principles of practice and may think those being mentored should understand only through observation
Communities of practice	• Communities of practice (CoPs) are formed by mutual interest. Most CoPs are sustained through electronic fora and are based on collaboration and sharing of ideas and resources. CoP members also meet for conferences, where they showcase and discuss their work.	• Inexpensive model as there are no tuition fees • Participation is voluntary and this may foster sustainability • Promotes teacher agency • Teachers share ideas and resources in a non-threatening environment	• For online CoPs, participants require high levels of computer literacy • Because of the voluntary nature of participation, there may be sustainability challenges • Self-selected leader is needed to encourage participation
Action research	• Teachers can participate in reflective practice where they introduce an intervention, reflect on it, and use the findings of their reflection to enhance their intervention's effectiveness.	• Teachers become critical of their work and so can improve it • Teachers can gain qualifications from their research if they decide to make it an academic study	• Requires high level of self-critique to observe shortcomings and find ways to improve • May also require outsider input for 'fresh' critique and perspective • Needs a high degree of discipline to sustain critique, reflection and change

4.3 Models of implementation of professional development

There are five main models of implementation of professional development for ICT integration that emerge from the literature and from a review of implementation of initiatives by different countries. These are as follows:

- *Worldwide and regional programmes* are based on specific teacher-training curricula or models, such as cascading, communities of practice, and networks, which are replicated in many countries globally and are usually driven by ICT corporations or donor agencies. Examples of such programmes include Microsoft Partners in Learning (PiL), Intel Teach, IEARN, Teacher Education in Sub-Saharan Africa (TESSA) and World Links, which are used

in Africa in countries including Botswana, Burkina Faso, Ghana, Mauritania, Mozambique, Nigeria, Rwanda, Senegal, South Africa, The Gambia, Egypt, Uganda, and Zimbabwe.

- *Resources and guides* are teaching and learning resources provided freely for use by teachers and in some cases, if they are open educational resources (OER) such as those produced by TESSA, for adaptation and reuse. A large proportion of such teaching and learning resources is provided through worldwide and regional programmes. Examples of these include Microsoft Innovative Schools and Innovative Teacher Toolkits, and Intel Teach Thinking Tools. In South Africa, free curriculum resources for Grades 9 to 12 are provided through the Mindset Learn programme.[123]

- *Large-scale national projects* are guided by a national strategy and implementation plan, with the Ministry of Education driving the overall project. Government provides a large proportion of the funding required or raises funds to support roll-out. Professional development is part of ICT integration which is supported by an ICT-in-Education policy. In this model, the Ministry of Education promotes ICT through a national computer curriculum, and implements systems that make use of ICT for educational management, for example EMIS. Government-driven programmes on ICT typically include provision of digital content and radio broadcasting among others.[124]

  Several countries have implemented their professional development efforts based on a national strategy focused on improving uptake of ICTs.

  - Australia has a Digital Strategy for Teachers, funded to the tune of AU$40 million for two years (2010 – 2012), for the professional development of teachers and school leaders in the use of ICT. The Australian strategy focuses on both pre-service and in-service teacher training.[125] The Australian Learning and Teaching Council has also dedicated AU$7.8 million to focus initially on training pre-service teachers at all 37 Australian universities, particularly in subject integration training.[126]
  - Chile's Enlaces, a nationwide initiative to drive ICT adoption and use in the country, has a strong teacher professional development component which is focused on initial training, follow-up technical assistance, and educational information technology encounters in the form of conferences.
  - The Technological Plan for Education in Portugal outlines an integrated education modernisation plan that focuses on provision of infrastructure, content, and teacher training to improve ICT integration. ICT use in schools is located within a continuum of lifelong training in the knowledge society where ICT is seen as reaching beyond schooling and as providing a career option. Teacher training is based on a

[123] Available at: http://www.mindset.co.za
[124] Dzidonu, D. (no date). Costing ICT integration in education. Available at: http://www.schoolnetafrica.org/fileadmin/resources/Costing%20ICT%20Integration%20in%20Education.pdf
[125] Australian Government Department of Education, Employment and Workplace Relations. Digital Strategy for Teachers and School Leaders, Fact Sheet. Available at: http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/DigitalStrategyforTeachers/Pages/Home.aspx
[126] Australian Learning and Teaching Council. Teaching teachers for the future. Available at: http://www.altc.edu.au/november2010-teaching-teachers-future

modularised structure to accommodate teachers' needs and skill levels. The focus of training is on the certification of teacher competencies.[127]

- Guyana's national strategy for teacher professional development for ICT integration[128] and Egypt's Professional Development Roadmap[129] are informed by the UNESCO ICT competency standards for teachers.
- Namibia's strategy, TECH/NA!, has as its priority ICT integration training at pre-service and in-service level.[130] The focus of training for ICT integration extends to the whole education sector and includes training of regional staff, school principals, administrative staff, teachers, librarians, students and learners so that they all have skills to enable the effective use of available technologies.
- Senegal also has a nationwide strategy which is based on ICT integration training for all pre-service teachers and the adoption of several pathways to reach teachers for in-service training.[131]

- *Funder-driven small scale pilot projects*, where self-selection by schools is a major criterion for involvement. Only those teachers with an interest will pursue training and integrate ICT into their teaching. They may not have leadership support and this threatens sustainability of this model.[132] One example of such a model can be found in Uganda, which does not have a national strategy for professional development for ICT integration but has seen a series of short term funder-driven initiatives - for example Connect-Ed, funded by USAID and implemented from 2000-2003, which focused on pre-service primary school teachers. This project could not be sustained beyond the funded period.[133]

- *Mix of donor and government funded projects* – In this case there is no action plan but a high degree of commitment from government for ICT integration. Most projects are donor-funded and efforts are made to equip schools with technologies as well as training teachers in the effective use of equipment.[134] Governments also fund some projects. India and South Africa are examples of countries which have achieved a good spread of professional development for ICT integration through several uncoordinated initiatives. Both countries have national ICT in education policies. India's interventions include the Navodaya Vidyalaya Samiti (NVS) scheme, which offers training to teachers and principals on ICT integration and management in collaboration with other partners, for example Intel.[135] In South Africa, professional development for ICT integration is driven through SchoolNet South Africa, which offers Intel, Microsoft and the

[127] Rocha, F. (2009). Technological plan for education: The Portuguese initiative for ICT in education.
[128] Ministry of Education, Guyana. (2010). An ICT Professional Development Strategy for Teachers in Guyana. Unpublished report.
[129] Egyptian Education Initiative. EEI in numbers. Available at: http://www.eei.gov.eg/Pages/02%20Achievments/EEI%20in%20numbers.aspx
[130] TECH/NA! Namibia's ICTs in Education Initiative. Available at: http://www.tech.na/
[131] Salimata Sene Mbodji. (June 2011). Senegal Country Report prepared for etransform Africa.
[132] Dzidonu, D. (no date). Costing ICT integration in education. Available at: http://www.schoolnetafrica.org/fileadmin/resources/Costing%20ICT%20Integration%20in%20Education.pdf
[133] http://learnlink.aed.org/ConnectED/
[134] Dzidonu, D. (no date). Costing ICT integration in education. Available at: http://www.schoolnetafrica.org/fileadmin/resources/Costing%20ICT%20Integration%20in%20Education.pdf
[135] PricewaterhouseCoopers (2010). Survey of ICTs for Education in India and South Asia, Country Studies. Available at: http://www.infodev.org/en/Project.103.html

Commonwealth Certificate for ICT Integration courses;[136] provincial education initiatives, in particular Khanya and GautengOnline;[137] and university training by the Universities of Pretoria and Johannesburg, at pre-service and in-service levels.

4.4 Enablers of professional development

Teacher training does not provide a guarantee that ICT integration in the classroom will take place. In some cases, even when teachers have been trained, they may still not be motivated to use technology in the classroom. Conditions within schools have to be supportive of ICT integration in order for this to take place. These conditions include the availability of equipment, support from other school stakeholders, and incentives.

Teachers' interest in ICT integration can be sustained if they are provided with computers, training materials, and software for classroom use.[138] Projects like the South African Teacher Laptop Initiative[139] can motivate teachers, sustain their interest and assist them in applying skills learned from training as they have permanent access to a computer. Access to technology to enable integration in everyday teaching and learning activities, rather than technical computer courses taken as subject options, facilitates higher levels of student ICT-related skills and experience.[140]

Most professional development in technology adoption focuses on teacher training alone, overlooking the fact that teachers are part of a complex educational system that includes district officials, principals, administrators and learners. Successful ICT integration may depend heavily on the support that teachers receive from other education stakeholders. More focus is being put on leadership training as part of professional development for ICT integration in Australia, India, Egypt, Namibia and South Africa. The worldwide and regional ICT professional development programmes also treat training of principals as a core objective.[141]

The diversity of ICT equipment in some schools requires dedicated technology coordinators and technical support staff. In Japan and Hong Kong, the critical role of ICT coordinators in schools is acknowledged through provision of training for such roles. In other schooling contexts, without formally appointed ICT coordinators, more competent ICT teachers have become the coordinators.[142]

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[136] SchoolNet South Africa. (2010). Empowering teachers through ICT integration. Available at: http://www.schoolnet.org.za/

[137] Gauteng Provincial Government: Department of Education. (2010). Gauteng Department of Education Annual Report and Audited Financial Statements 2009/10. Johannesburg: GDE.

[138] UNESCO Bangkok. (2004). Integrating ICTs into Education: Lessons Learned - A Collective Case Study of Six Asian Countries. Thailand: UNESCO Asia and Pacific Regional Bureau for Education

[139] http://www.teacher-laptop.co.za/

[140] Pelgrum, W.J. and Law, N. (2003). ICT in Education Around the World: Trends, Problems and Prospects. UNESCO International Institute for Education Planning: Paris.

[141] See Annex Two.

[142] Pelgrum, W.J. and Law, N. (2003). ICT in Education Around the World: Trends, Problems and Prospects. UNESCO International Institute for Education Planning: Paris.

Incentives such as certification, professional advancement, pay increases, and paid time-off to participate in professional development can also motivate teachers and sustain their interest in ICT integration.[143]

5 Educational Management Information Systems (EMIS) and improved education systems management

Having considered the three important e-learning pillars of technology, content and professional development, the next step in this chapter is to consider the role of ICT in supporting educational administration and management.

Collection of data has been a focus of both national and region-wide effort in Africa over the last three decades, with initial attention to educational statistics. The scope of educational data has been widening, and now covers qualitative, quantitative and geographical information. However, educational data did not receive the anticipated attention from policy-makers, primarily due to limited interest in information-based decision making. Donors, rather than governments, have been the most important actors in EMIS development. Organic growth towards data-driven planning has therefore been largely absent from Africa. Important players in what has occurred have included UNESCO, the European Union, the UK Department for International Development (DFID), the Swedish Agency for International Development (SIDA), GTZ, the French development cooperation agency, the United Nations Children's Fund (UNICEF), the World Bank, and the United States Agency for International Development (USAID).

5.1 Overview of EMIS

At an Africa-wide level, EMIS has been promoted under the National Education Statistical Information Systems (NESIS) project which has been implemented by the Association of Development in Africa (ADEA)'s Working Group on Education Statistics (WGES). NESIS has worked to develop EMIS capacity in sub-Saharan Africa for over a decade. Some progress has been made in building capacity for the collection and organisation of educational statistics at national levels through the NESIS project. In addition, initiatives by donor agencies have focused on national EMIS development, though these have often yielded disappointing results.

A survey of EMIS development in Southern African Development Community (SADC) member-states has found that 'fragmentation of the education sector across a number of ministries, coupled with a fragmented and incomplete EMIS has hampered the effectiveness of EMIS systems.'[144] Critical challenges facing EMIS are summarised in Table 2.4.

[143] Trucano, M. (2005). Knowledge Maps: ICTs in Education. Washington: The International Bank for Reconstruction and Development / The World Bank

[144] Southern African Development Community, EMIS Assessment Report, 2008, http://nesis.intoweb.co.za/en/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=23

Table 2.4 - EMIS data challenges[145]

Challenge	Explanation
Slow release of data by schools and universities that can be used as input to EMIS	It takes a longer period than expected to release data at the end of the school year. Such delays reduce the value of data for policy making and implementation.
Inaccurate data at central EMIS Unit	Data collected centrally have often been inaccurate and not adjusted to compensate for missing data.
Distorted data because of administrative data use	Data have often been deliberately distorted where resource allocation to schools (or, sometimes, revenue collection from them) depends on the returns made.
Lack of analysis and inadequate publication	There has been limited analysis of collected data to support decision making. Data are often collected to produce statistical abstracts that prove to be unusable.
Lack of feedback to data providers	Data providers such as school principals are often not consulted and do not have the capacities to use data for local planning. This denies them potentially useful comparative information and weakens their motivation to supply data in future

Other challenges encountered include:

- difficulty in pulling together data from different sources and recasting it into meaningful information;
- lack of capacity and integration problems where data are only available to a handful of analysts and statisticians in the Ministries of Education;[146] and
- attracting and retaining staff with the required technical skills in EMIS.

In addition, most countries lack data on early childhood, non-formal, vocational and higher education, and information on financial expenditure. Capacity-building of data providers as well as training on web design and methods for estimating and projection of data have been found to be very important.[147]

An Asian Development Bank review of EMIS in Asia reveals a similar picture, in which donors and international institutions have played a critical role in EMIS deployment. As in Africa, while data in the primary and secondary education sector are widely available, there is a lack of information on tertiary institutions.[148] For example, while India has moved forward in the design of a District Information System for Education (DISE), which has reduced the time lag for organisation and dissemination of information on primary and secondary education, it lacks the necessary management information system on higher education institutions.[149]

[145] Based on: Ellison, Robin, A practical guide to working with the Education Management Systems, Guidelines for DFID advisors, 2008.
[146] Knoxville Chamber of Commerce, The Knox model: Education Management Information System, www.knoxvillechamber.com/pdf/EMIS-knox-model.pdf
[147] Association for Development of Education in Africa, EMIS Capacity and Priority Identification, A Report of an Online Survey, http://www.adeanet.org/adeaPortal/publications/WGES/WGESSurveyReport_Feb07_Fnl.pdf
[148] Asian Development Bank, 2004, Information and Communication Technology in Education and Training in the Asia and Pacific, http://www.adb.org/Documents/Reports/ICT-Education-Training/default.asp
[149] Mehta, Arun, DISE II – HMIS - Higher Education Information Management System, www.educationforallinindia.com/HEMIS.pdf

In the Caribbean, EMIS initiatives have been launched in Jamaica, Barbados, Antigua and St Lucia. Jamaica has been cited as an example of best practice in the collection, management and use of educational information, as well as in the development of ICT policy in education.[150] The overall goal of EMIS in Jamaica has been to strengthen information-based decision-making through improved access to school census data, system-wide introduction of computer-based record-keeping, and development of a school-based geographic information system (GIS) to link school data with spatial coordinates. Jamaica has also implemented a school administration software (JSAS) package to meet local-level information needs at school and district levels.

The EMIS in Jamaica has been used to produce school profiles that include summary data on enrolments, qualifications of teachers and the condition of facilities. Profiles also include some basic indicators including student-teacher ratios, class sizes, and male/female enrolment ratios. EMIS data have been used to generate policy briefs which provide a short, focused analysis using readily available data in response to specific immediate information requests by education leaders. The objective has been to provide leadership with an initial assessment of a particular question or issue in a very short period using readily available data. Between1994 and 1996, the Jamaican EMIS was used as the basis for generating a series of seventeen policy briefs. Although the practice did not hold for a longer time, the development of school profiles and policy briefs was a powerful example of what EMIS can achieve.

A further review of EMIS in the Caribbean and Latin American countries shows that, apart from the development of individual EMIS at central government levels, there is an increasing trend towards interactive online information systems for routine management and administration of educational services at schools, district and municipal levels.[151] This is in contrast with African countries where EMIS remains underfunded and generally centralised within the federal government.

In summary, progress in Africa and elsewhere shows mixed outcomes of EMIS deployment at national levels. While there has been improvement in the collection of data, actual use of data remains limited. The challenges cited include lack of funds, inadequate connectivity, teachers' limited access to computers in schools, and limited capacity and experience with EMIS.

Nevertheless, increasing attention has been paid to educational data thanks to growing interest in monitoring education outcomes, in particular within the framework of internationally agreed targets such as the Millennium Development Goals (MDGs), and to the increased availability of ICT tools and capacities at school level in recent years.

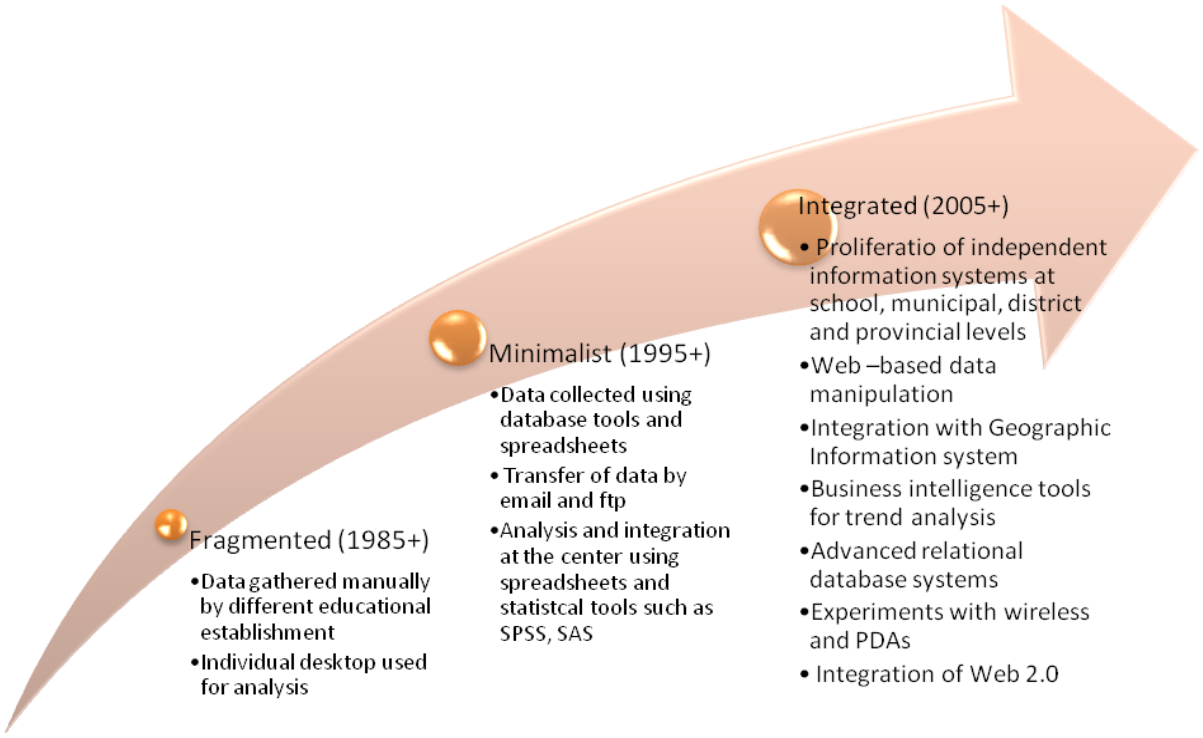
[150] Tomas Cassidy, (2005) Education Management Information System (EMIS) Development in Latin America and the Caribbean: Lessons and Challenges

[151] Cassidy, Tom, (2005), Education Management Information System (EMIS) Development in Latin America and the Caribbean: Lessons and Challenges, http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=741813

5.2 Technical trends

Technical implementation of EMIS has been evolving with the development of the Internet and distributed databases. EMIS has seen a significant transformation over the last three decades, from an initially fragmented approach in which data were collected using tools such as Microsoft Access and disseminated through hard drives, to the situation today in which large distributed databases are interconnected through the World Wide Web, providing access to information at school, district, regional and national levels. Figure 2.1 illustrates this progress from the past fragmented operation of EMIS through a minimalist phase to the current position where decentralised information systems can be integrated using interoperable Web-based tools.

Figure 2.1 - Progress with ICT Applications in EMIS



The majority of African countries are still in the minimalist phase, in which data are collected using database tools provided by donor agencies, and analysis and integration take place centrally at Ministries of Education using spreadsheets and statistical tools such as SPSS and SAS/STAT. UNESCO, the World Bank and USAID have forged a strong collaboration in the area of EMIS and have played a significant role in providing assistance in using different software tools, such as the EDucation Automated StatiStical Information Toolkit (ED*Assist) software[152] that is widely used in English speaking African countries.

The ED*Assist system was developed by the Academy for Educational Development (AED) in Washington and funded by a USAID Africa regional programme. The software features

[152] www.aed.org/edassist

modules for data gathering, data processing and data use.[153] ED*Assist funding supports joint needs assessment, technology, training, and ongoing support for building the capacities of Ministries of Education and local stakeholders.

ED*Assist was originally used in a number of African countries, including Djibouti, Liberia, Malawi, Uganda and Zambia. However, the discontinuation of support by USAID after initial introduction of ED*Assist in certain countries has made it one of the less successful ventures in promoting EMIS in Africa. In Uganda for example, difficulties with the LAN, lack of technical expertise, inaccurate and incomplete data and absence of resources have dissipated the gains that were made in early years.

Another tool used in the region and promoted by ADEA is the Statistical Information System (SIS), which has been used in Francophone countries on the continent. The NESIS SIS was originally developed by the Dakar node of ADEA, and was piloted in Burkina Faso. The system has three elements: data collection and data capture ('StatEduc'), data reporting ('Annuaire' – to produce an annual abstract) and data exploration ('Exploram'). A GIS module to support school mapping was also developed as an integral part of the NESIS SIS.[154]

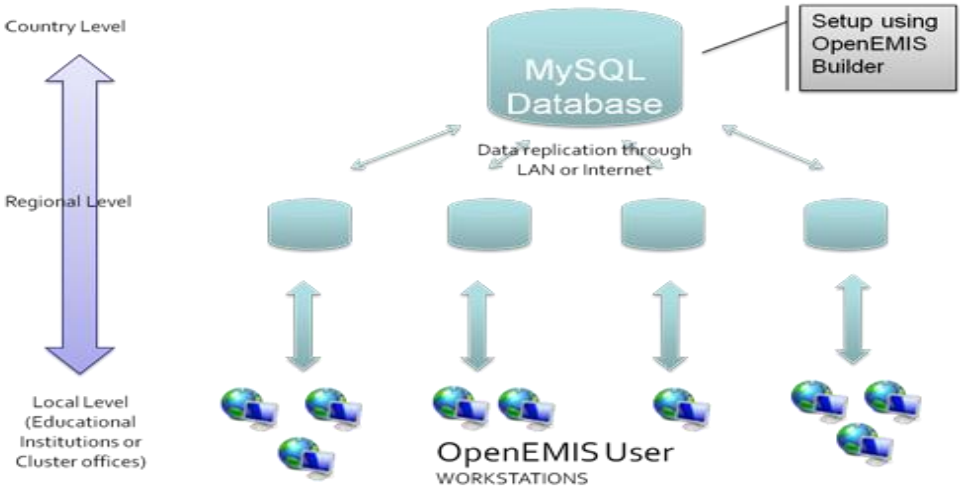
Education administrations in other countries – including Botswana, Ethiopia and Kenya – have had donor support to develop customised EMIS software. While this has increased the opportunity to tailor software for local needs, it creates a significant burden on the capacity of these countries to upgrade their systems.

While commercially-developed EMIS software is increasingly available, there has also been a trend towards the use of open source software for managing educational data in developing countries. UNESCO is at the forefront of this effort with the development of OpenEMIS software. A revised version of OpenEMIS was released in January 2011.[155] It comprises two modules: EMIS Builder and EMIS User. The former allows database administrators to adapt the generic tool to the particular characteristics of a national education system. The latter enables data inputs and queries, as well as production of reports, charts and indicators.

OpenEMIS provides tools for information management and data collection at several levels, including school level, operating in both online and offline environments. It is a multilingual and multi-sector system for handling multi-year data on students, educational programmes, teaching and non-teaching staff, educational resources such as facilities and text books, financial resources and test results. It features tools for automatic calculation, query, reporting and aggregation. OpenEMIS has interfaces to GIS and automatic geo-localisation of educational institutions with GPS. The transition from a minimalist approach to more integrated EMIS is imminent with the adoption of open source, integrated and customisable tools such as OpenEMIS. It is illustrated in Figure 2.2.[156]

[153] http://www.ed-assist.net/
[154] http://nesis.easynet.fr/
[155] http://openemis.codeplex.com/
[156] Derived from OpenEMIS.

Figure 2.2 - OpenEMIS Model



Geographic Information Systems have been a major component of EMIS since the beginning of the 1990s. In South Africa and Lesotho, the Ministries of Education incorporated GIS into EMIS to plot schools and educational institutions.[157] Other applications of GIS in EMIS include capturing, storing, analysing and managing data and associated attributes which are spatially referenced, and creating static maps from these data.[158] GIS have been applied in Hungary, Jamaica, Namibia and Nepal, among other countries, for planning, scenario-building and geographically weighted analysis.[159]

One significant development in recent years has been the availability of web-based student information systems, also known as Student Record Systems (SRS), which are intended to manage information about students. SRS are used for entering student test and other assessment scores, building student schedules, tracking student attendance and managing other student-related data needs in schools. The Higher Education Management Information System (HEMIS) addresses the requirements of tertiary education levels. Online education content management systems such as Moodle, WebCT and Blackboard have in-built tools that can generate student test records, which in turn can easily be integrated into HEMIS.

This growing decentralisation implies that schools, colleges and universities can take on the responsibility of record-keeping, managing their resources in an efficient and transparent manner, and improving local administration. The development of National Research and Education Networks (NRENs) provides further impetus to the establishment of HEMIS. Districts, provinces and central governments can then focus on integrating their various data sources in order to formulate operational plans and implementation projects at their levels.

A Public-Private Partnership framework which was developed between the Government of Rwanda, the Agile Learning Company and Microsoft has been one of the most interesting

[157] World Bank, Survey of ICT Use in Education, Lesotho Country Report, www.infodev.org/en/Document.410.pdf
[158] http://www.education.gov.za/EMIS/tabid/57/Default.aspx
[159] UNESCO, School Mapping and GIS in Education Micro-planning
http://www.iiep.unesco.org/fileadmin/user_upload/Research_Challenges_and_Trends/pdf/symposium/StevenHite.pdf

examples of the roll-out of EMIS to schools in order to generate national educational data.[160] The EMIS platform in this instance digitises information that has traditionally been completed by schools by allowing teachers and administrators to input information directly into a database. Schools were provided with computers/laptops to collect data at source. These data include information on the number of students attending each school, grades, teachers, resources such as books, and infrastructure. School principals are required to collect these data as a matter of routine. The programme's roll-out phase has been used to provide the country's 5000 schools with computers, Internet connectivity, EMIS databases, and relevant training by the end of 2011. Rwanda has seen substantial progress in the availability of broadband, which has facilitated access to the Internet for easy data transfer from schools to the central database in Kigali. This increasing access to the Internet and the availability of a broadband network are making it easier for schools to enter data on a real-time basis. The EMIS tool also provides a programme to generate school profiles that promote effective decision-making at local level. The data can be aggregated to facilitate planning at district and national levels.

The widespread use of mobile and wireless technologies has brought about another potential opportunity for data-gathering and uploading at school level. The possibilities for integrating wireless tools with GIS and GPS to facilitate school mapping are considerable, although actual implementation is still very limited in Africa. Further, integration of GIS enables planners to relate EMIS data and information to geographic, physical characteristics, infrastructures, population and other spatial elements. This will enable schools to move beyond mapping their location towards producing geographically sensitive information such as the distance that teachers travel to exchange information, carrying out spatial analysis of disadvantaged regions in relation to factors such as language, ethnicity and road infrastructure, and developing plans for upgrading primary and secondary schools based on local requirements.

The use of mobile phones for gathering EMIS data is being explored in Ghana, Kenya, Rwanda, South Africa and Uganda, as well as other countries. Recognising the potential of mobile devices for collecting education data in developing countries, the Academy for Educational Development (AED) of the United States has created a software package of applications, called GATHER, which can be downloaded to mobile phones, PDAs, laptops or other electronic devices. It enables cost-effective and efficient data collection, analysis and reporting.

However, the use of mobile and wireless devices for EMIS data gathering is still at an early stage, often constrained by costs, security and inadequate technical support. Despite their potential, mobile handheld devices have inherent limitations such as limited bandwidth, small screen display, poor colour resolution, and limited application capabilities.

Other ICT opportunities lie within the area of social networking, which can be exploited to facilitate real-time reporting on school data and related matters, including resource usage. Social networking applications such as Checkmyschool.org in the Philippines have shown

[160] Technology Helping to Transform Education in Africa, http://www.agilelearning.com/latest_news.aspx

high potential for the participation of students, teachers and principals in updating information on schools on a real-time basis, so improving planning and decision-making.

The overall landscape of EMIS development indicates that, while distributed databases which are interconnected through the Web have been progressing, the majority of African EMIS implementation still relies on donor-funded database management systems. Progress at institutional levels, in particular colleges and universities, will probably pave the way for advanced database systems that will be interoperable with emerging EMIS.

6 The emergence of National Research and Education Networks

The final section of this chapter considers the emergence of National Research and Education Networks (NRENs), which cut across all of the aspects of ICT in education which have been discussed in earlier sections. NRENs started to emerge in Africa just over ten years ago, and are rapidly becoming an established feature of the educational and academic sectors. They play the critical role of providing dedicated broadband connectivity to support (primarily) university-level research and education institutions, but increasingly also extend connectivity to lower level educational institutions[161] and other non-government non-commercial entities. This section of the chapter examines the structure and practices among NRENs in order to point to ways in which they can be enabled and supported to play their role in educational and national development on the continent.

In addition to dedicated connectivity, NRENs enable sharing of digital learning resources, applications and specialist resources (expert human resource, e-learning platforms, management information systems, i-labs, video-conference platforms, and computers, *etc.*), as well as implementation of and access to advanced applications and high capacity on demand. These multiple roles are well captured in the following comment by Louis Fox from an article commissioned for this report:

> *NRENs serve many functions. They create leading-edge network capability for the international research community; they enable revolutionary Internet applications; they ensure the rapid transfer of new network services and applications to the broader Internet community; they provide a platform for sharing scientific (and other) applications and resources; they aggregate demand for bandwidth and thereby create 'buying clubs, ' drive down the cost of bandwidth; and they create social value by including communities outside their primary research university constituencies, like primary and secondary schools, libraries, museums, scientific and cultural institutions. In order to flourish, NRENs must focus on the technical dimensions of data networks and they must also attend to the human dimension, the creation of shareable expertise for support and collaboration across many fields of research and education.*[162]

A crucial driver of NREN development has been the inadequacy of the commercial Internet in addressing, on demand, the often specialised needs and very high bandwidth requirements of the global research community. While they have points of interconnection with the commercial Internet for purposes of exchanging traffic, NRENs operate entirely independently of the commercial cloud. A defining aspect of the operation of NRENs, put in

[161] http://siteresources.worldbank.org/SOUTHASIAEXT/Resources/223546-1181699473021/3876782-1191373775504/indiainnovationchapter6.pdf

[162] Taken from commissioned blog essay: see Annex Ten.

place to ensure that they do not compete with commercial service providers, is the Acceptable Use Policy (AUP) which spells out what can and cannot be done by users of the NREN. An important part of this Policy is that one end of any transmission handled by NRENs (*i.e*. originating or receiving communication) must be someone within the education and research community.

NRENs start at the campus level. Campuses therefore need to have high quality data networks, sufficient user devices for user access, and competent personnel to assure the availability and integrity of both the network and the content to which it provides access. At the national level, these campus networks are interconnected using a high speed data backbone to form the National Research and Education Network – such as the Joint Academic Network (JANET)[163] in the United Kingdom or the Kenya Education Network Trust (KENET)[164] in Kenya. As the need for collaboration extends beyond national borders, NRENs, typically those within the same geopolitical sphere, have created regional overlays, the Regional Research and Education Networks (RRENs) which enable collaboration across national borders. Internet2[165] and the National Lambda Rail,[166] for example interconnect the state research and education networks in the USA, GÉANT[167] interconnects NRENs in the European Union, CLARA[168] interconnects NRENs in South America, and the UbuntuNet Alliance[169] has started to interconnect countries in Eastern and Southern Africa. The regional networks, connected together, form a global research and education network which serves the global research and education community.

NRENs typically follow one of three models.

The first consists of NRENs that are initiated, owned and funded by universities and research institutions, using a bottom-up approach. Examples of these are Internet2 (USA), the Tertiary Education Network (TENET)[170] of South Africa, and the Research and Education Network of Uganda (RENU).[171] These NRENs have the benefit of organisational structures that permit rapid decision-making and organisational agility in consonance with the nature of the sector in which they work. They are more responsive to members' needs. However, they find it harder, especially in the initial stages, to gain recognition and acceptance by governments, and they will always have to lobby hard where public sector funding is required. This kind of NREN can also face competition – which is not necessarily negative but can be challenging. In the USA, the National Lambda Rail (NLR)[172] is a competitor to Internet2, even if necessity requires them to work together in some instances. In South Africa, TENET is very well established as an NREN owned by universities and research institutions, and running the most advanced NREN network in Africa. The government has, however, also set up the South Africa Research and Education Network (SANReN),[173] which

[163] www.ja.net
[164] www.kenet.or.ke
[165] http://www.internet2.edu/
[166] http://www.nlr.net/
[167] www.dante.net
[168] www.redclara.net
[169] www.ubuntunet.net
[170] http://www.tenet.ac.za/
[171] www.renu.ac.ug
[172] http://www.nlr.net/
[173] http://www.sanren.ac.za/

in reality is still just the high speed backbone that TENET has been contracted to operate. While there is functional collaboration between the two, there remains tension about which of the two is the South African NREN.

The second model uses a top-down approach. In this model, NRENs are initiated and owned by governments. Examples include the Ethiopia Education and Research Network (EthERNet)[174] and the Sudan Universities Information Network (SUIN).[175] Top-down NRENs are sometimes subject to bureaucratic procedures that can disable tactical decision-making. They also tend to lack responsiveness to the needs of the institutions which they serve. However, they have the advantage of immediate recognition and acceptance by governments.

The third model involves close cooperation between bottom-up NRENs and governments. SUIN, for example, is now moving to a position in which government will continue to provide funding support while devolving management and control to universities. In France, RENATER[176] was initiated and is funded by government but is independently managed.

Typically the national environment, in terms of the political systems and macro-policies around the funding of the education sector, will be the determining factor regarding which model will work best. It is, however, worth noting that the cooperative model, if well handled, could produce the best of both worlds: availability of funding from government, ideally through the member institutions, and management and control by the universities through a board selected and executive arrangements determined by members.

6.1 Lessons from around the world

The following paragraphs describe two examples of NREN experience: Internet2 in the USA, from a highly developed economy, and CLARA in South America, a region which, likeAfrica, has a mixture of economies at different levels of development.

6.1.1 Internet2, USA[177]

Internet2 is organised as a not-for-profit organisation, and takes pride in being community-led and member-focused. Its core mission is 'to ensure that scholars and researchers have access to the advanced networks, tools and support required for the next generation of collaborative discovery and innovation and for effectively preparing the next generation of innovators, our students.'[178] Started in 1996 with 34 universities, Internet2 now has 372 members and 131 sponsored education group participants. Members include US universities, corporations, government research agencies, and not-for-profit networking organisations representing over 50 countries.

Internet2 has developed a K20 Initiative to connect university members to the broader education community through a process called Sponsored Education Group Participants.

[174] www.ubuntunet.net/ethernet
[175] http://www.suin.edu.sd/
[176] http://www.renater.fr/
[177] See Blog Essay by Maria Beebe and Internet2 – http://www.internet2.edu/
[178] *Ibid.*

The result has been connection to the Internet2 backbone network of 66,000 Community Anchor Institutions (CAI) in 38 US states. CAIs are community-based organisations including K-12 schools, libraries, community colleges, health centres, hospitals, and public safety organisations.

Opening Internet2 membership to industry partners has had reciprocal benefits. Benefits to the NREN from industry have included significant contributions in support of the development and deployment of advanced Internet applications and services, including donations of equipment, cash, software, personnel, consulting and services. Industry members make available valuable input and strategic guidance on advanced networking in research and education. Benefits from the NREN to industry partners have included the ability to interact with current and prospective customers, showcase products and services, acquire market and user intelligence, tap and recruit university talent, and discover new market openings.

Opportunities for membership engagement arise through a variety of working group activities such as development efforts in network infrastructure, network performance, middleware, applications and security, and discovery, research, and collaboration in different disciplines of the arts and humanities, health, sciences and engineering. Members also have access to a comprehensive menu of services, tools, capacity building, and research and development.

African countries can draw two important lessons from Internet2.

- Firstly, it is the provision of a critical suite of services and opportunities to members, going beyond connectivity, which has sustained interest and involvement.
- Secondly, close collaboration with industry, including the creation of a membership class for businesses, has helped to build the kind of university-industry linkages that many African governments wish to bring about. Members' ownership and direction has much to do with the achievements of Internet2.

6.1.2 RedCLARA – the South American Regional REN[179]

The impetus to form RedCLARA or CLARA, the RREN of South America, was provided by funding from the European Union (EU) under the ALICE[180] project, with implementation through DANTE, the organisation that manages the European RREN, GÉANT. The bigger NRENs in South America, those in Brazil and Argentina, have played a major role in enabling the region's weaker NRENs to reach the necessary level of participation and start to benefit from the services that CLARA offers, by providing expert support and assuming a disproportionately large financial burden.

A very strong focus on setting up an engineering community around the initiative has been one of the recognised positive attributes of CLARA. It was this community that kept the network going during a time when it faced major funding challenges. This followed the end of the ALICE programme, and resulted from the fact that sustainability had not been

[179] http://www.redclara.net/
[180] http://global.dante.net/server.php?show=nav.1413&PHPSESSID=2c1a3aade08678c7074f46328f7b7b76

factored into network planning by the member countries at an early stage. The start of a second phase of EU support, ALICE2, arrested this challenge but is has nevertheless been an important learning point for CLARA and other RENs (including the UbuntuNet Alliance).

Africa can learn three major lessons from CLARA.

- The first is the role that established NRENs played in supporting those that were weaker or just starting at the time of CLARA's establishment. This was one of CLARA's success factors, and extends to both expert and (in-kind) financial support.
- The second is the need to have a strong engineering group that creates the operational human layer.
- The third is the need to plan for sustainability rather than relying on ongoing external funding.

6.2 NREN growth in Africa: access to more bandwidth at lower cost

The growth of NRENs in Africa began just over ten years ago, and was initially motivated by the high cost of bandwidth that has led to intellectual isolation of researchers and academics in Africa. Towards the end of 2008, data from TeleGeography's[181] Wholesale Bandwidth Pricing Database showed that the median price of a 2Mbps circuit between London and Johannesburg was nearly US$15,000 – the same price that could lease 10Gbps between London and New York. While costs have dropped in some locations to US$300 and lower per full duplex Mbps per month (about 3% of those three years ago), costs remain well above what is typical in developed countries (of the order of US$20-30 for the same capacity), and some countries such as Zambia are still paying the old rates.[182]

One of the earlier cooperative initiatives on the continent was the African Universities Bandwidth Consortium (AUBC).[183] AUBC was supported by the Partnership for Higher Education in Africa, and was able to negotiate costs for participating institutions down to less than 50% of the original VSAT prices. By 2006, the only NRENs that were operational in sub-Saharan Africa, in the sense that they were consolidating and delivering local and international connectivity to their members, were TENET in South Africa and, at a start-up stage, KENET in Kenya. Librarians in Sudan and Malawi had also set up infrastructure for sharing resources, though these had not yet evolved into NRENs.

The creation of the UbuntuNet Alliance, the pioneer RREN in Africa,[184] was motivated by a combination of factors:

- the conclusions of a Southern African Regional Universities Association (SARUA) Fibre Study,[185] which brought to light the substantial reservoir of unused optical fibre capacity in Africa, especially that owned by utility companies;

[181] http://www.telegeography.com/research-services/globalcomms-database-service/index.html
[182] UbuntuNet Alliance for Research and Education Networking – Data Collected from member NRENs
[183] http://www.foundation-partnership.org/index.php?id=29
[184] Tusubira, F.F., "Creating the human and infrastructure networks research and education networks in Africa", Proc TERENA Networking Conference, 2009, Malaga
[185] www.**sarua**.org/files/publications/**Sarua_Fibre**_Report_2006.pdf

- a new wave of liberalisation in telecommunications as monopoly and other limited competition provisions stipulated during the first wave of liberalisation in the late 1990s expired, creating opportunities for third party fibre capacity to come to market; and
- plans for the first east coast submarine cable, known as the East African Submarine System (EASSy), which has since been followed by a number of other submarine cable deployments.

Embryonic and developed NRENs in five countries came together during late 2005 to initiate the development of an African regional REN,[186] leading to the birth of the UbuntuNet Alliance. The primary motivation was again connectivity to gain access to cheaper bandwidth.

Bandwidth consortia still remain a viable approach to seeding NRENs in those countries where they do not exist or where they remain weak. RENU in Uganda, for example, was able in 2010 to negotiate a consortium price of US$600 per full duplex MBPs/month delivered by Uganda Telecom to its different member universities – a saving of more than 50% for most of the universities.[187] This has stimulated more buy-in to RENU than had been achieved in its first three years of operation.

While bandwidth has been underscored in this account as the principal driver for the establishment of NRENs in Africa, the long term goal of NRENs must be more extensive than simply addressing bandwidth shortages. The UbuntuNet Alliance, for example, has as its *principal* objective the aim of enabling integration of African universities and research centres into the global research and education community through the provision of intra-African connectivity and access to sufficient and affordable international Internet bandwidth. The underlying hypothesis for this is that:

> *Improved and affordable connectivity will enable African researchers to produce proportionate intellectual output and generate a proportionate amount of intellectual property goods*.[188]

Over the last four years, there has been a surge of growth of NRENs, though most of these are still at the organisational level and are not yet delivering services. The UbuntuNet Alliance covers 24 countries in Eastern and Southern Africa, with 13 full members and the rest in various stages of formation. The West and Central African and Education Network (WACREN)[189] was founded during the last quarter of 2010 and covers non-Arabic-speaking West and Central African countries. Only the NRENs in Ghana and Senegal in this region have reached operational stage. The Arab States Research and Education Network (ASREN)[190] covers Arab states both in and outside Africa.

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[186] The pioneers were Victor Kyalo of KENET, Kenya; Margaret Ngwira of MAREN, Malawi; Duncan Martin of TENET, South Africa; Americo Muchanga of MoRENet, Mozambique; Albert Nsengiyumva of RwEdNet, Rwanda. The author was part of the initial discussions, but could not participate formally: there was no formal NREN in Uganda at the time.
[187] http://www.renu.ac.ug/images/stories/pdf/issues%20in%20operationalization%20of%20renu-utl%20bandwidth%20consortium-20apr2011.pdf
[188] Consolidating Research and Education Networking in Africa, UbuntuNet Alliance Internal Document (available on request).
[189] http://www.wacren.net/
[190] http://www.asrenorg.net/

While many NRENs have been established at the organisational level, most of these are just beginning to implement their data networks. Only South Africa, Kenya, Senegal, and Sudan had operational networks in Sub-Saharan Africa at the time of this study, with only South Africa having a truly advanced network.

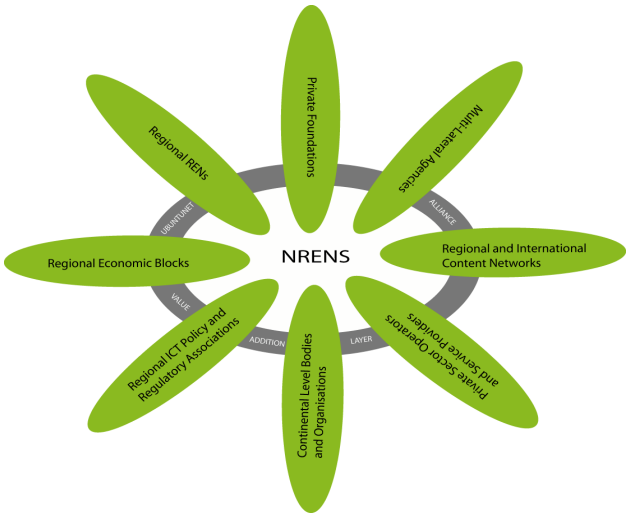
6.3 Lessons from Africa

The following paragraphs describe a selection of examples and lessons from Africa. These include the UbuntuNet Alliance, KENET, TENET, and XNet.

6.3.1 The UbuntuNet Alliance for Research and Education Networking[191]

UbuntuNet has put very strong emphasis on creating awareness and enabling the start and growth of NRENs in its membership region, creating value at each stage of their development, and offering them network services as well as the opportunity to collaborate. A further emphasis has been on stakeholder identification and engagement, focusing on roles that provide value for members without violating their autonomy. This is illustrated in the UbuntuNet Alliance Stakeholder Map which is illustrated in Figure 2.3.[192]

Figure 2.3 - UbuntuNet Alliance Stakeholders Map showing Value Addition Layer of the Alliance



The Alliance was able to gain initial support from the International Development Research Centre (IDRC)[193] of Canada to support operations, a donation of equipment from Cisco to set up a Point of Presence (POP), and support from the NREN Policy Committee of GÉANT to connect to its pan-European network and enable transit to the rest of the world. DANTE, which operates GÉANT, offered free location of the UbuntuNet POP within its cage at one of the major London Internet exchanges, and TENET, the South African NREN, established another POP for the Alliance in Johannesburg.

[191] www.ubuntunet.net
[192] Derived from the UbuntuNet Alliance.
[193] http://www.idrc.ca/EN/Pages/default.aspx

The Alliance focused on an operational presence from the start and gained credibility very early in its existence. The total connected capacity through the UbuntuNet router in London has increased from less than 1Gbps when it was set up about three years ago to 12Gbps in 2011. The interconnection arrangement with GÉANT has also been increased from an initial 1Gbps to 20Gbps in 2011, including a 10Gbps point to point route to handle the kind of high capacity data transfers required by very large aperture antenna arrays.[194]

During May 2011, a contract for implementation of a regional network for the Alliance membership region, with a total value of €14.8million, was signed between the European Commission and DANTE, with the Alliance as the main implementing beneficiary. This is aimed at establishing regional connectivity among Alliance member NRENs. The Alliance, through its members, will meet 20% of the total cost. AfricaConnect was agreed as one of a set of priority projects at the African Union and European Union Commission level within the EU–ACP Economic Partnership framework.[195]

In addition to an operational presence from the start and strong development partner engagement, the other important lesson from the Alliance is the establishment of a strong human network on which the NRENs draw for support and guidance in their growth and operations. At the NREN level, these would be the member institutions.

Related lessons include:

- the importane of sustaining members' interest through capacity building and support, creating value beyond bandwidth alone;
- planning for sustainability as part of strategic plan priorities, insisting that members pay their contributions without fail; and
- active stakeholder engagement that has earned the Alliance international recognition.

Part of sustainability, especially in the early stages of operation, has been the operation of a decentralised secretariat, using the World Wide Web as a channel of operational communications. Many board meetings take place over the Internet using free platforms such as Skype. This both enables full participation and greatly reduces the direct and indirect costs of meetings. The support of TENET has also been critical to the growth of the Alliance along the same lines as that played by the larger and more established NRENs in the growth of CLARA, described earlier in this section.

6.3.2 KENET, Kenya's NREN[196]

The Kenya Education Network (KENET) is a member-founded organisation that, since it was initiated during 1999, has enjoyed government goodwill and support. It received an initial grant of US$300,000 through the Kenya government under the Leland Initiative to connect universities.[197] This enabled operations to begin when there was very limited connectivity within Kenya. Until recently, KENET was run by a CEO and support staff whose time was

[194] UbuntuNet Alliance Internal Documents; Contact info@ubuntunet.net
[195] http://www.ist-africa.org/home/files/IST-Africa2011_Overview_P8InformationSociety_020511.pdf
[196] www.kenet.or.ke
[197] http://www.kenet.or.ke/index.php/en/projects/grants

donated by its member institutions, saving it human resource costs during its start-up and stabilisation phases.

KENET operates in an country whose government is fully committed to ICT. The Kenya ICT Board (whose founding executive vice chair is the founding CEO of KENET) is charged with the responsibility for cross-cutting ICT strategy and interventions. Both the Ministry responsible for ICT and the Ministry responsible for Science and Technology (under which support to KENET falls) are active in its support. KENET received a donation from Government of an STM-4 international bandwidth on the TEAMs submarine cable, and a US$20million grant to roll out high capacity connectivity to universities in Kenya and to reinforce external connectivity. From a total distributed capacity of less than 20Mbps for all universities two years ago, KENET has increased to 5xSTM-1 of external connectivity, with a very much improved internal network and a modern data centre. Prices for member institutions have gone down from US$4,800 to US$300 per Mbps per month in two years.[198]

What stands out very strongly with regards to KENET's success is committed government support in an environment that has taken an holistic approach to ICT. Low operational overheads at the start also emerge as a lesson from KENET's experience. Like CLARA and the UbuntuNet Alliance, KENET was enabled by a start-up grant. Indeed, the experience of the Alliance in Africa is that the lack of start-up funding before an NREN is able to offer any services will be a major barrier. This is especially true in environments where universities themselves are underfunded.

KENET also has the situational benefits of a large membership base that distributes overheads, and a coastal location. Although the latter creates opportunities, these have not necessarily been seized in other countries – as evidenced by the slow progress of NRENs in Mozambique, Tanzania, and Sudan, in each of which proximity to submarine cables has been counteracted by other factors.

6.3.3 TENET, South Africa[199]

TENET, the oldest operational NREN in sub-Saharan Africa, was founded some twelve years ago by member universities that wanted to tackle the challenge of bandwidth cost. It received a start-up grant of US$1million from the Andrew W. Mellon Foundation. TENET began with an agency model, obtaining price reductions through aggregation and negotiation with service providers. It underwent a major change when, through guarantees provided by member universities, it was able to secure a US$20million bank loan to purchase 10Gbps 20-year IRU on the SEACOM cable.[200] With the need to distribute this bandwidth, TENET moved into operating infrastructure, enabled, like more than 300 commercial Internet Service Providers, by a South African court decision that permitted it to own and operate infrastructure including international gateways.[201]

At about the same time that TENET acquired its external capacity, the government of South Africa decided to establish the South Africa Research and Education Network (SANReN),

[198] UbuntuNet Alliance internal communication; contact info@ubuntunet.net
[199] www.tenet.ac.za
[200] TENET internal documents; contact ceo@tenet.ac.za
[201] http://thornton.co.za/resources/lti-bna-altech%20court%20ruling.pdf

through which a 10Gbps backbone would be rolled out to universities and research institutions. TENET was engaged by SANReN to operate this capacity which, combined with TENET's external capacity, has caused end-user prices of TENET members to drop to about US$130 per Mbps per month, from US$1,200 during 2008.[202] TENET also hosts Google caches in South Africa, and this has boosted its negotiating power with commercial providers.

Like KENET, though it does not enjoy the same close relationship with government, TENET is in a country where there is a clear government focus on education, ICT, and the use of ICT in education, creating an enabling environment for NREN success. TENET has also been exemplary in reaching out to the rest of East and Southern Africa through the UbuntuNet Alliance. This outreach has included offering access to the bandwidth it controls to Alliance member NRENs that border South Africa at the same price that it charges to South African universities.

TENET also benefited from a start-up grant, and gained access to high speed connectivity funded by government. TENET runs a very small organisation, taking advantage of the vibrant private sector in South Africa to outsource many of its operations.

6.3.4 XNet, Namibia

XNet was formed as a partnership between SchoolNet Namibia and Telecom Namibia in 2003 as a vehicle to provide affordable bandwidth connectivity to a variety of social sectors, including agriculture, health and small businesses, but beginning with the education sector. Schools could connect through a dial-up modem or through wireless links using high masts owned by SchoolNet Namibia or Telecom Namibia. Subsidised dial-up rates were negotiated for poorer schools.[203]

SchoolNet Namibia also played a pioneering role in experimenting with low-cost options to connect rural schools to the Internet. One of these experiments involved a narrow-band radio network connected through a series of forty five towers which brought coverage to about 900 schools.[204] Through the Xnet structure, SchoolNet was able to provide affordable connectivity to more than 1000 schools throughout the country. Telecom Namibia is the main provider of the access network between institutions and the national backbone and is also the major provider with access to international gateway in Namibia.[205] Connectivity through Telecom Namibia comes with guaranteed fixed access rates for all schools, irrespective of how they connect.[206]

Xnet still has a long way to go in terms of becoming an effective NREN. It nevertheless provides lessons that could be emulated under the right circumstances. An emphasis on open source software and Creative Commons content has been central to its success. Working with open source software has stimulated SchoolNet to explore the real costs of

[202] TENET internal documents; contact ceo@tenet.ac.za
[203] http://wikieducator.org/The_Case_of_SchoolNet_Namibia/Operations/Activities/Connectivity
[204] http://www.schoolnetafrica.org/fileadmin/resources/School_Networking_Initiatives.pdf
[205] http://www.powershow.com/view/5690-ZTdhN/Telecom_Namibia_is_main_provider_for_the_access_network_b_flash_ppt_presentation
[206] *Empowering Youth and Connecting Schools: Lessons from the SchoolNet Namibia Approach* , INASP infobrief 2: School Networking: February 2004

ownership of ICT in schools and has ensured that the technical solutions SchoolNet Namibia provides are affordable and therefore viable in the longer term.[207] Xnet also maintains strong relationships with stakeholders. It operates in line with Namibia's ICT policy for education and has built a strong relationship with the Ministry of Education. Similarly, a symbiotic relationship with Telecom Namibia, plus lengthy negotiations, resulted in agreement on discounted Internet connectivity rates for schools.[208] This arrangement is, however, not without its problems, including overdependence on Telecom Namibia, which has denied Xnet access to cheaper connectivity that would take advantage of TENET's offer to institutions outside South Africa (see above).

During late 2010, Xnet became the first member of the UbuntuNet Alliance to evolve from a Schoolnet. It still faces the challenge of full acceptance by higher-level institutions, especially the University of Namibia, the largest public university. This is a challenge that must be tackled before Xnet can become a fully effective NREN.

7 Conclusion

As the landscape analysis in this chapter has illustrated, the field of ICT in education is both complex and dynamic. There are many different aspects to effective integration of ICT in education, as well as rapidly evolving practices around the world from which educators and educational planners are learning as they seek to grapple with the ways in which ICT can be used to the greatest benefit of learners. However, there are also opportunities arising within this landscape that are worth considering at both national and regional/continental levels in Africa. Chapter 3 highlights innovations, experiences and practices, including many of those illustrated in this chapter, that encapsulate some of these opportunities.

[207] http://www2.unescobkk.org/elib/publications/111/Schoolnet_LLVol.3.pdf
[208] http://www2.unescobkk.org/elib/publications/111/Schoolnet_LLVol.3.pdf

Chapter 3: Opportunities and Challenges

1 Introduction

Chapter 2 of this report has described the broad landscape of ICT in education, both globally and within Africa, with a specific focus on the five themes identified in the terms of reference for this report. This chapter narrows this focus in order to identify a number of significant opportunities that the consultant team believes have particular relevance in African contexts and offer scope for appropriate interventions by African Ministries of Education and their development partners (including donors and development banks). In doing so, it draws on the material in Chapter 2, together with the detailed analyses which have been undertaken for each of the five themes in the terms of reference, which are included in annexes to the report, the country case studies and blog essays, which also appear in annexes, and evidence from interviews, questionnaires and other desk research. This chapter describes only some of the innovations and practices which have been identified through the research, which are explored in greater detail in these other documents. Readers who wish to consider the full range of practices reviewed are directed to the Annexes 2 to 6.

It is important, before beginning the discussion in this chapter, to stress the limitations of any analysis that draws on illustrative examples as a basis for decision-making on policy and practice. As is now widely recognised, there have been many examples in the history of development and aid funding in Africa of failed initiatives which were implemented on the fallacious assumption that good practice identified in one context or country can necessarily be successfully replicated in another. This is not just a problem which arises from efforts to export successful practices from economically developed countries to Africa without sufficient attention being paid to critical contextual differences. Africa itself is a continent with several diverse regions and more than fifty distinct countries. What has worked well in one African context may fail entirely in another for any of a number of complex reasons rooted in diverse educational systems and capabilities, social and economic structures, political and administrative cultures, and relationships with donors and other stakeholders.

Presentation of the opportunities discussed in this chapter should not therefore be taken as a tacit recommendation that these constitute 'best practices' that justify replication across the continent. They provide, rather, indicative evidence of applications that should be considered within the contextual framework of different countries and different ICT and educational environments. In addition, when considering opportunities, it is more important to look for adaptability than to advocate the primacy of any specific technology or application. The rapid pace of change in ICT technology and markets means that innovation is continually taking place in the technologies that can be deployed, while the costs of different opportunities are also changing rapidly. The technologies and resources that are in use at any one time will also change rapidly and new set of tools will be developed which have not yet even been considered.

In all instances, planning of new interventions aimed at harnessing ICT to improve education should begin with contextualised needs analysis and with careful planning that takes account of the realities within which implementation will take place, including rapid and continual innovation. Within this perspective, the consultant team hopes that the opportunities presented in this chapter and documented in greater detail in the annexes will provide a useful guide for planning processes, offering ideas that can be integrated, with suitable adaptation, into carefully considered implementation plans.

The opportunities described in this chapter are not presented strictly according to the themes defined in the terms of reference for the study because (although there is significant overlap) they do not fall neatly into these thematic areas. The policy and implementation context for this analysis is inherently holistic, concerned with educational delivery and provision overall. Discussion of opportunities has been sequenced in a way which reflects the overview of effective systemic integration of ICT into education which was presented in Chapter 1.

2 Identifying opportunities

2.1 Establishing an enabling policy environment

It is not by chance that, where there has been significant scaling up of ICT integration in teaching and learning, implementation initiatives have generally been carried out through cross-sectoral collaboration between Ministries of Education, the ICT sector and those responsible for other policy domains. This cross-sectoral collaboration has been achieved through consultative processes leading to the development, publishing, and systematic advocacy of a clear and detailed set of policies, laws, and regulations that most effectively support the integration of ICT into education systems.[209] Broadly speaking, an enabling policy environment includes policies and initiatives that help to drive the national ICT agenda, as well as policy on ICTs in education, bandwidth and connectivity.

A country's National ICT Policy should outline broadly what the vision of the country is in relation to ICT, as well as the broad vision for each major social or economic sector, including education. Some countries, for example South Africa, have multiple policies at national level dealing with the opportunities of ICT.

A national policy for ICT in education will typically (or should) comprise a strategy, clear policy goals, and an implementation plan that covers, among others, the following aspects:

- criteria for school readiness;
- acquisition of basic infrastructure;
- models of affordable and appropriate ICT for schools;
- standards for procurement and installation of ICT;
- professional development in a wide range of uses of ICT;
- provision for regional, district, and school policy planning;

[209] Ernst & Young. (2006). Chapter 5: NEPAD e-Schools guidelines for Good practice. Unpublished report.

- access to and local development of educational content;
- strategies to guide and protect learners from the negative consequences and dangers associated with increased use of ICT and Internet access;
- technical support and maintenance;
- strategies for managing the changes created through systematic introduction of ICT; and
- an environmentally sound policy governing purchasing, use and disposal of ICT.[210]

Existing education strategies need to be thoroughly reviewed and updated to ensure that the ICT education policy supports and is supported by complementary education policies. Education legislation also needs to be reviewed and updated to safeguard against legal contradictions created by ICT in education policies. The ICT in education policy should provide for those responsible for the national curriculum to review policy and legislation, with a view to including ICT skills as a critical learner competence. This can be achieved through multiple pathways, including dedicated courses on ICT literacy, definitions of generic ICT skills and competencies and their integration across the entire school curriculum, as well as examinable, ICT-related subjects such as computer science, technical administration, repair and maintenance.[211]

Affordable broadband infrastructure facilitates connectivity by schools, teacher training institutions, and government departments, enabling fast and reliable completion of managerial, administrative or educational activities online. The telecommunications policy and regulatory framework should aim to stimulate the deployment of a competitive range of broadband infrastructure and services for procurement by the education system, and to create good conditions for connectivity to all areas, including remote rural areas. There should also be a drive to negotiate deals with service providers to offer connectivity products and services at a discounted rate to schools, with strategies for upgrading and replacement of technological options as new and cheaper alternatives become available.

South Africa and Egypt are examples of countries in Africa that have enabling policy environments for ICT integration in education. In Egypt, the enabling environment has been created through policy initiatives to support the national ICT strategy rather than in policy pronouncements, as was the case in South Africa. Table 3.1 summarises national ICT policies in these countries, as well as other policies/policy initiatives that have promoted or supported ICT integration in education.

[210] Ernst & Young. (2006). Chapter 5: NEPAD e-Schools guidelines for Good practice. Unpublished report.
[211] Ernst & Young. (2006). Chapter 5: NEPAD e-Schools guidelines for Good practice. Unpublished report.

Table 3.1 - Examples of enabling policy environments

Country	National ICT policies	ICT in education policy and supportive policies/initiatives
Egypt	Egypt's 2010 ICT Strategy maps out a vision for Egypt's development through ICT, with specific reference to the use of ICT for education and lifelong learning.[212]	• The Ministry of Communication and Information Technology has coordinated all ICT initiatives in Egypt. • The Egyptian Education Initiative drives all educational ICT projects. • A Schools Development Initiative aims to provide students with ICT skills. • The Smart Schools Project focuses on equipping schools with labs and training teachers and students to use the technologies provided.[213]
South Africa	• The Electronic Communications Act 2005 sought at removing policies that hinder the development of cross-sector applications, services and businesses to provide citizens with better access to knowledge and information.[214] The Act formalised an e-rate for schools to access connectivity and pronounced that broadcasting should also cater for education. The Act further specified that schools can apply for money from the Universal Service and Access Fund for procurement of electronic communication services.[215] • The Universal Service and Access Policy and Strategy aims to promote universal access to ICT and ICT services by all South Africans.[216]	• The e-Education White Paper, 2004, advocates the benefits of ICT for education, and maps out vision for achieving a digitally enabled education system. • The White Paper on Science and Technology, 1996, describes the expected benefits of ICT for national innovation • The Public Service IT Policy Framework, 2001, promotes ICT for efficient service delivery. • The National Education Policy Act, 1996, emphasises that educational experience can be enhanced through ICT. • The Department of Education's Guidelines for the use of Open Source Software in Schools' promote affordable access to software by harnessing the potential of FOSS. • The Telecommunications Amendment Act, 2001, has enabled the liberalisation of the telecoms sector, with increased competition, reducing the cost of communications and encouraging growth of the sector.[217]

Egypt's successes with the integration of ICT in education include the following:

- By May 2011, the Egyptian Ministry of Communication and Information Technology (MCIT) had established 2163 IT Clubs out of a target of 2500 clubs set out in the strategy. These clubs were equipped with 25,919 computers and peripheral devices,

[212] MCIT Egypt. (May 2007). Egypt's ICT strategy 2007 – 2010.
[213] MCIT. (2010). MCIT Yearbook 2010.
[214] SouthAfrica Online. Communications. Accessed 2 September 2011. Available at: http://www.southafrica.co.za/about-south-africa/science-and-technology/communications/
[215] Government of South Africa. (April 2006). Electronic Communications Act, No. 36, 2005. Government Gazette No. 28743
[216] SouthAfrica Online. Communications. Accessed 2 September 2011. Available at: http://www.southafrica.co.za/about-south-africa/science-and-technology/communications/
[217] SouthAfrica Online. Communications. Accessed 2 September 2011. Available at: http://www.southafrica.co.za/about-south-africa/science-and-technology/communications/

while 1,955 of them offered Internet access. About 2,200 graduates had completed training through the IT Skills Development programme.[218]

- In 2010, through the Computers-to-Excel Initiative, 20,000 laptop computers with a year's free internet subscription were given to top achievers in primary school. 2,000 teachers also received laptop packages.[219]
- Through the Egyptian Educational Initiative (EEI), Microsoft and Intel have trained 136,470 teachers in basic ICT skills; IBM has trained 42 teachers on e-content development; Oracle has trained 633 teachers on ICT tools; and Microsoft has trained 7402 teachers on ICT Advanced tools. The EEI is also training parents to support their children in the use of technology. So far, 13,809 parents have been trained in ICT tools.[220]
- Egyptian learners perform extremely well in maths- and technology-related Olympiads and competitions.[221]
- The EEI was, in 2011, equipping 1700 schools with three modern classrooms each, installing computer laboratories in 2000 schools, and connecting 1120 schools to the Internet.[222]

South Africa has made progress in implementation that is highlighted by the following:

- Government Departments of Communication, Health and Education have invested significantly in the development of openly distributed educational content by Mindset.[223]
- The Department of Basic Education has invested in the development of a national portal for schools, the Thutong portal,[224] which supports teachers by providing content and professional development as well as administration and management tools.
- A teacher laptop initiative has been launched, which aims to achieve universal access to laptop ownership among teachers in public schools.
- In 2009, 2,449 schools had computer centres that were adequately equipped, and 3,161 schools had internet connectivity.[225] The provincial initiative GautengOnline (GoL) had 1,665 schools with fully functional computer laboratories in 2010.[226]
- There are 500 Dinaledi schools, equipped with ICTs to enhance performance in mathematics.[227]
- In addition to ICT integration training taking place in universities, SchoolNet South Africa has trained over 20,000 teachers on Microsoft PiL courses.[228] By 2010, GoL had trained

[218] MCIT. Egypt ICT indicators portal, IT Clubs. Available at: http://www.mcit.gov.eg/Indicators/club_tech.aspx
[219] http://xn----rmckbbajlc6dj7bxne2c.xn--wgbh1c/Media_Center/Press_Room/Press_Releases/1797.
[220] Egyptian Education Initiative. EEI in numbers. Available at: http://www.eei.gov.eg/Pages/02%20Achievments/EEI%20in%20numbers.aspx
[221] MCIT. (2010). MCIT Yearbook 2010.
[222] EEI. EEI in numbers – Access to technology. Available at: http://www.eei.gov.eg/Pages/02%20Achievments/EEI%20in%20numbers.aspx
[223] Mindset. Our partners. Available at: http://www.mindset.co.za/partners/content
[224] http://www.thutong.doe.gov.za/
[225] DBE. (2009). National Education Infrastructure Management System Report, 2009. Available at: http://www.education.gov.za/LinkClick.aspx?fileticket=p8%2F3b6jxko0%3D&tabid=358&mid=1263
[226] Gauteng Provincial Government: Department of Education. (2010). Gauteng Department of Education Annual Report and Audited Financial Statements 2009/10. Johannesburg: GDE.
[227] Sibiya, S. (2009). Dinaledi school project performance report for the 2008 national senior certificate Mathematics and physical science. Available at: http://www.thutong.doe.gov.za/Default.aspx?alias=www.thutong.doe.gov.za/dinaledischools

20,260 teachers on how to use the GoL laboratory,[229] and another provincially driven project, Khanya, had trained 27,943 teachers in the Western Cape province on ICT integration.[230]

While South Africa's and Egypt's telecommunications infrastructures are significantly better than most of those in Africa, the fact that these countries have an enabling policy environment, as well as supportive institutions and structures, provides a good lesson for ICT integration in education on the continent.[231]

2.2 Widening access to ICT infrastructure and connectivity

2.2.1 Harnessing devices that teachers and learners already own

The proliferation of mobile phones has meant that more learners have access to ICT devices than ever before. There are also a number of communications platforms which reduce the cost of access and, as a result, have become popular with users. These include Mxit,[232] a very low cost instant messaging service developed in South Africa that works on close to 3000 mobile handsets, including those using Java, Android, iPhone, BlackBerry, Nokia, and Windows Mobile, By October 2010 it had gained 27 million users, adding an additional 40,000 each day.[233] High levels of access to mobile phones have resulted in an increasing number of projects exploring how they can be used in education, including several that seek to build on low-cost channels such as SMS, Unstructured Supplementary Service Data (USSD) and Mxit. Examples of projects that seek to take advantage of the high levels of ownership of mobile phones are described below. In addition, as technology costs continue to fall, there will be increased affordability and choice of devices used by and accessible to teachers and learners. As a result, in the future, there will be opportunities to take advantage of higher levels of ownership of other devices, including netbooks and emerging new technologies.

The fact that users already have access to mobile phones offers opportunities in terms of sustainability and scalability. As Professor Traxler writes in his blog essay in Annex 10:

> *One obvious way to enhance sustainability and scale is to consciously exploit learners' own devices, to base national or institutional strategy around the phones that individuals choose, own and carry everywhere'. He writes that 'mobile phones hold out enormous promise as the single ICT most likely to deliver education in Africa, and to do so on a sustainable, equitable and scalable basis. I think however that so far, we have not often seen much progress beyond fixed-term, small-scale and subsidised pilots and it is worth exploring whether mobile phones can really deliver their promise'.*

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[228] SchoolNet South Africa. (2010). Empowering teachers through ICT integration. Available at: http://www.schoolnet.org.za/

[229] Gauteng Provincial Government: Department of Education. (2010). Gauteng Department of Education Annual Report and Audited Financial Statements 2009/10. Johannesburg: GDE.

[230] SchoolNet South Africa. (2010). Empowering teachers through ICT integration. Available at: http://www.schoolnet.org.za/

[231] See Annex 7 for a broad overview of South Africa's ICT in education integration efforts

[232] http://www.mxit.com/

[233] 'At 27 Million MXit is Africa's largest social network', WebAddiCT, October 2010, http://www.webaddict.co.za/2010/10/22/mxit-africa-largest-social-network/

The following paragraphs describe examples of the use of mobile phones to support teaching and learning:

- *Using IVR (Interactive Voice Response) to support language learning*. BBC Janala, which is being implemented by the BBC World Service Trust in Bangladesh, and seeks to increase the number of people able to speak English in that country. This project delivers educational content using mobile phones, the Internet, television, and print media. Mobile phone users who dial '3000' can access English language audio lessons and quizzes. Content is updated weekly and each lesson lasts three minutes. Through a special agreement, facilitated in part by coordination with the communications regulatory authority BTRC, all six mobile operators have agreed to charge the same (reduced) tariffs for voice and SMS traffic to BBC Janala. The result has been a 50% reduction in the standard value-added service voice and SMS rates, which means that individual calls cost users a little less than a cup of tea (or three pence). Over two million audio lessons were accessed between the project's launch in November 2009 and October 2010.[234]

- *Using mobile phones to distribute educational videos to teachers.* The BridgeIT project in Tanzania is the result of a partnership that includes the Pearson Foundation, Nokia, the International Youth Foundation, and the United Nations Development Programme (UNDP). Teachers who take part in it download educational videos onto mobile phones, which can then be connected to classroom televisions to display them. Students watch these videos, which usually run from four to seven minutes, and then teachers use BridgeIT-designed lesson plans to build on the ideas presented in them. BridgeIT aims to use mobile phone and digital technology to increase the quality of teacher instruction and pupil achievement in primary school in mathematics, science, and life skills. Many schools are in rural locations, and mobile phones allow for the on-going dissemination of new content. Phones also serve as a link between BridgeIT and teachers.

- *Using mobile phones to support reading and writing*. The Yoza Project[235] sets out to explore the viability of using mobile phones to support reading and writing by young people in South Africa. Yoza cellphone stories are short and free. Some are published every day, while a new group of stories is published on the first day of each month on a mobisite and on MXit, in both South Africa and Kenya. Readers are encouraged to leave comments and vote on issues. Another example is the Young Africa Live (YAL) mobile portal developed by the Praekelt Foundation,[236] which combines regularly updated, dynamic stories and live chats with a range of permanent content pieces. It aims to share information, generate discussion, and promote HIV testing. YAL is hosted by Vodafone Live, South Africa's largest digital portal, with over three million unique visitors per month. The portal is available to Vodacom subscribers who can visit it free with no download or bandwidth charges. Uptake has been high. From September 2009 to September 2010, the m-novels on the site were read more than 60,000 times while readers posted more than 40,000 comments and submitted more than 10,000

[234] "Press One for English: BBC Janala Offers English Language Courses over Mobile", Mobile Active 2010, http://www.mobileactive.org/press-one-english-bbc-janala-offers-english-language-courses-over-mobiles
[235] http://yozaproject.com/
[236] ://www.praekeltfoundation.org/young-africa-live.html

competition entries (these figures include readers using Mxit, Mobi and YAL).[237] Steve Volsoo, project leader of Yoza, has identified the following comments as lessons from the project:

- 'Mobile is a content monster';
- 'Mobile is always on' (and there is therefore a need for continuous moderation);
- 'Mobile is instant' (and the project did not always moderate in time);
- 'Platform matters' (use someone else's platform which has an established user base if you can);
- 'Marketing matters';
- 'It is hard to sustain interest';
- 'General audience is fickle, fans are loyal';
- 'When reading becomes 'snacky', it's hard (but not impossible) to make it 'sticky'';
- 'Comments can be rich feedback or absolute rubbish';
- 'You might end up with something you didn't expect'; and
- 'For us it's not come cheap'.

Costs include marketing, content development, hosting, and software development.[238]

- *Use of mobile phones to support learning in mathematics*. The Math for Mobile Project of the University of Haifa provides free maths applications for Java J2ME capable mobile devices. Since 2008/2009, applications have been available for download globally and the number of downloads has ranged from hundreds to thousands monthly, the most frequently downloaded applications being Graph2Go and Solve2Go. Feedback to the project team indicates that these applications are being used by secondary and higher education students, as well as by teachers for professional development at teachers' workshops.[239] Project managers report that the development challenges include:

  - lack of technical standards, with continuing fragmentation of the market an important obstacle for scalability and sustainability (requiring constant investment in parallel development for a variety of systems and hardware);
  - the cost of developing high-quality applications;
  - designing human-computer interfaces that take into account the uncertain health effects of extensive use of mobile phones by children; and
  - investing in a variety of application types such as games and location-based applications.[240]

- *Using mobile phones to support tutoring*. Dr Math was launched in South Africa in early 2007 by the Meraka Institute of the Council for Scientific and Industrial Research (CSIR). It explored whether or not secondary school pupils would use their personal mobile phones and their own airtime to discuss their mathematics homework with a tutor available through MXit. Users send a mathematics question to a Dr Math Jabber account and enter into discussion with a tutor who is ready to answer any question from

[237] http://m4lit.files.wordpress.com/2010/10/m4lit_unesco_barcelona_oct2010_2.pdf
[238] Ibid.
[239] See Annex Ten.
[240] See Annex 3 for more detail.

the entire high-school mathematics syllabus. After one year the initiative had 1000 learners, while 19,000 children are currently registered on the server, which last year made use of 30 volunteers in its online tutoring service.[241] Dr Math also provides games and competitions using Mxit to entice pupils to practise mathematics skills.

- *Using mobile phones to support health education*. Text to Change (TTC), which is operational in Kenya, Uganda, Madagascar, Cameroon, Namibia and Tanzania, uses incentive based quizzes, sent by SMS, to educate, engage, and empower people on health-related issues. It also collects participants' data for analysis, which helps it to plan campaigns more effectively. It uses a toll free short code, which ensures there is no cost to users. A report by the Ugandan AIDS Information Centre and TTC notes the importance of multiple forms of media in public education efforts. The authors write that 'The program needs to be complemented with other media approaches such as radio announcements, DJ mentions, posters, testimonies and experiences from those who have accessed services to realise its full potential.'[242]

High rates of growth in mobile user access are creating educational opportunities which had not previously been available. However, this should not be taken to imply that mobile phones are, or will necessarily become, the most relevant devices for helping to address a particular educational need. There are important constraints arising from continued access problems in some areas and from the cost of usage. Other challenges include usability constraints due to small screen size, the cost of developing applications and content, the difficulty of ensuring compatibility on all phone types, and the fact that many schools and teachers do not allow mobile phones in classrooms. At present, mobile phones are mostly being used to support learning outside of school and in informal education, with the exception of a few projects such as Bridge IT. It is important that the assessment and design of any technology intervention is based on a clear understanding of both educational need and context.

Another important point to note is that user devices such as mobile phones are merely tools, and it is of equal importance to consider what existing or new content and applications are required for user engagement with mobile-enabled education. These can include resources in the form of educational quizzes, multi-media applications, text- and/or audio-based short lessons, mentoring support and collaboration, examples of which have been illustrated above.

2.2.2 Access models

Models of shared access to mobile devices, as well as those focused on teacher access, can be more realistic from a cost and support perspective than one-to-one computer access. Both of these access models move away from what has been the more traditional model of ICT in education, that of deploying computers in dedicated computer laboratories, and can help to enable improved integration of ICT in teaching and learning by providing access in the classroom. Having technology in the classroom provides more opportunities to integrate it into teaching and learning across the curriculum and teaching day rather than

[241] http://mg.co.za/article/2011-03-11-mastering-maths-with-mxit
[242] Report: Text to Change/AIDS Information Centre, HIV/AIDS Program, Arua, Uganda', 2009, http://www.texttochange.com/AIC-TTC%20Arua.pdf

limiting use of these tools to scheduled times in laboratories. Using mobile devices also provides opportunities for educators and learners to take devices home, which can extend their access and enable them to be used to support learning in the home environment. It is, however, critical that these access approaches are effectively evaluated to understand their impact and learn lessons from experience.

Shared access models

The most common access model for computers in school in Africa has been the roll-out of computer laboratories (either networked through a thin or fat client or standalone PCs). However, there are many[243] who argue that it is better to integrate rather than isolate computers and that 'a smaller amount of computers in classrooms may enable more actual use than a greater number of computers located in separate computer labs.'[244]

The falling cost of mobile computing devices means that there is an increasing number of opportunities for devices such as laptops and netbooks to be used in schools. These devices can be moved around within school premises, which makes it easier to integrate them into classroom teaching than has been the case with computers located in laboratories. Shared use of these devices also provides opportunities for lowering cost, for increasing access and reach, and for reducing infrastructure and resource burdens in terms of support and maintenance.

These shared access models usually make use of devices such as laptops and netbooks. However, organisations such as WorldReader.org and libraries are exploring models for shared use of e-readers in order to extend reach at reduced cost. As noted in Chapter 2, WorldReader.org is piloting the deployment of e-readers in schools in Ghana and reports that it is considering moving from a single-user e-reader model to a library model following successful piloting of this approach. WorldReader.org has also put mechanisms in place to allow students to take e-readers home in order to enable them both to do further reading and to prepare more effectively for class.[245] Other pilots involving shared use of iPads are underway, but there have been more difficulties with these because they are not designed to be shared. As one pilot project has reported, the way they work 'has made it virtually impossible to use many apps and web services' if shared.[246]

Teacher Access Models

While one-to-one computing strategies for students remain problematic, there may be better opportunities for providing such access to teachers. These are being explored in countries including South Africa and Kenya. Owning laptops is likely to lead teachers to

[243] The following publication provides a review of some of the literature on this issue: Rule, Audrey et al, 'Comparing technology in computer lab versus classroom settings of two sixth grade classes', http://www.ncolr.org/jiol/issues/pdf/1.1.5.pdf

[244] Trucano, Michael. 2005. Knowledge Maps: ICT in Education. Washington, DC: infoDev / World Bank, http://www.infodev.org/en/Publication.8.html

[245] 'Worldreader.org iREAD progress report/Student training, Eastern Region Ghana, November 29 to December 3, 2010', Worldreader Team, http://www.worldreader.org/uploads/trials_31_652558281.pdf

[246] Sam Gliksman, 'What do Students Think of Using iPads in Class? Pilot Survey Results', January 2011, http://ipadeducators.ning.com/profiles/blogs/what-do-students-think-of

engage in informal learning at their own pace, in their own time, thereby improving their ICT skills in ways that will benefit their learners. Teacher laptop initiatives can lessen the disadvantage that is created by lack of universal access to computers by schools. If teachers have laptops, they can use them to source materials, develop new resources for their learners, and enhance lesson delivery. These initiatives also have the potential to enhance teacher uptake of ICT integration.

In South Africa, the Teacher Laptop Initiative (TLI) managed by the Education Labour Relations Council (ELRC),[247] was officially launched in May, 2009. The TLI is open to all permanently employed teachers, and sets out minimum specifications for teacher laptops to suppliers as well as the minimum purchase price for those supplied. The government pays teachers on the scheme a monthly allowance for assistance with repayment for their laptops.[248] A monitoring and evaluation process would be able to explore the extent to which these laptops are changing personal and teaching practices through ICT, and in what ways.

In Kenya, the Laptops for Teachers programme,[249] announced in 2010, seeks to provide teachers with laptops at affordable rates. It involves a number of partners including Safaricom, Intel, the Kenya Institute of Education (KIE), Equity Bank, the Teachers Service Commission (TSC) and Microsoft. Laptops are bundled with Internet usage and come loaded with software, educational content and basic ICT training. They are available through a TSC-assisted check-off system whereby teachers pay in monthly instalments. Teachers can also acquire loans from Equity Bank which are then used to purchase laptops. As with the South African Teacher Laptop Initiative, it is important that this initiative should be evaluated, so that lessons can be learnt from the approach taken.

2.2.3 NRENs: providing increased connectivity to support education and learning

The level of connectivity available to both educational institutions and learners is growing throughout the continent. This is due to the increasing rollout of competitive fibre networks to Africa and within African countries, and to increased penetration of wireless and mobile platforms. Increased connectivity provides important opportunities since connectivity is critical to realising the full potential of ICT in education, including collaboration as well as access to content.

During the last five years, many governments (including those of Uganda, Kenya, Rwanda and Tanzania) have moved to establish extensive national data backbones, supplementing private sector investment. Access for the education and research sector has been made a priority in most cases. All of these countries have received support from bilateral and/or multi-lateral development agencies, which now consider data backbones to be part of critical development infrastructure. Regulatory decisions have meanwhile allowed fibre from utility companies (especially those managing power, railways and oil pipelines) to come on to the market in some countries. During the same period, there has been a sharp

[247] Teacher Laptop Initiative: http://www.teacher-laptop.co.za/#
[248] Department of Education. (2009). *Teacher Laptop Initiative Policy*. Government Gazette No 32007, 8 May 2009.
[249] 'Teachers to get laptops with financing under new PPP', CIO East Africa, August 2010, http://www.cio.co.ke/Main-Stories/teachers-to-get-laptops-with-financing-under-new-ppp.html

rise in submarine fibre construction projects targeting Africa,[250] creating real competition within the international bandwidth market. Increased competition has led to reductions in prices as well as to increases in capacity.

The liberalisation of telecommunications markets and the development of regional operating companies have increased competition in the mobile sector. Most countries in Africa have at least three operators. This has led to rapid roll-out of network infrastructure, competitive price offerings and improvements in capability, with more providers offering 3G services that enable much faster Internet access than was previously available. In addition to mobile platforms, WiFi and WiMAX penetration is increasing rapidly, creating more opportunities for large-scale deployment of wireless access devices.

Some examples of national innovations are described in the following paragraphs.

Uganda

The Uganda National Fibre Backbone was funded by a concessionary loan from the government of China through Exxim Bank. After the National Fibre Backbone Project was signed off, the Minister of ICT pledged the availability of a dark fibre pair to the Research and Education Network of Uganda (RENU). With most of the fibre completed, RENU has reached a formal agreement in principle with the National Information Technology Agency (which manages the backbone) for access to this fibre, with the understanding that the capacity made available will be available to all education institutions at all levels. While meeting the backbone needs of the universities will be comparatively easy, there will be challenges in serving other education institutions. It is more than likely that this will be addressed through SchoolNet Uganda, which will manage user groups and needs while RENU gives the required support in ensuring availability of connectivity.

Uganda also offers a good illustration of a public-private partnership initiative in this area. The Internet Educational Equal Access Foundation (IEEAF), a non-profit organisation, worked with USAID to provide equipment that has been used to light up Phase 1 of the RENU backbone at 10Gbps. The fibre used belongs to Uganda Telecom Ltd (UTL), a commercial service provider, through a negotiation led by the Global Medical Research Exchange, a business based in the USA. Through the agreement, RENU has been granted access to the UTL dark fibre wherever it exists at no cost.

RENU has only recently begun to implement its data backbone, and there is no visible impact yet on the cost or volume of access.

Kenya

Kenya's experience provides evidence concerning both internal and external connectivity. The history of KENET was described in Chapter 2, along with the Kenyan environment and the connectivity support given to research and education networking through KENET, enabling it to provide member institutions with national and international bandwidth at prices that are less than 10% of those two years ago.

[250] http://www.manypossibilities.net

Increased connectivity also requires human resources with the capacity to ensure availability and security of the network. KENET has worked closely with the Network Start-up Resource Centre (NSRC) based at the University of Oregon, and twinned with the German NREN DFN, in order to build advanced capacity within its team.

South Africa

The support of the South African government for educational connectivity through the establishment of SANReN,[251] and the impact on volume and pricing of bandwidth for universities, have been described in Chapter 2. In addition to this, the innovative approach used by TENET to secure a bank loan of US$20million for its external 10Gbps capacity should be highlighted. At the time TENET was using an agency model, and did not have even 5% of the assets that would have been required to secure a bank loan of the necessary magnitude. However, TENET obtained written guarantees from its member institutions, which the bank was prepared to accept as sufficient security. Indeed, it is the repayment of this loan over a short period (compared to the 20 years duration covered by the USD20million payment) that is keeping current prices at $130 per full duplex Mbps per month. Once the bank loan is paid off, South African universities will start obtaining bandwidth at prices that are comparable to those in Europe and the United States of America.

The biggest challenges for TENET have concerned (a) the establishment of last-mile connectivity to more remote campuses at reasonable bandwidth, and (b) addressing the ability of many of the universities to absorb such bandwidth. Fibre has become the standard transmission infrastructure wherever possible.

It should be noted that the availability of high bandwidth at low cost has also positioned the Southern Africa region to be competitive in the location of the Square Kilometre Array radio telescope.[252] The success of this project would boost the already high credibility of South Africa as a country capable of hosting high-end research initiatives and should lead to increased inflow of research funding and opportunities for universities.

TENET has now embarked on a programme reaching out to schools at lower level. The intention is to work on this through SchoolNet South Africa.

2.2.4 Power

Power supply remains a critical constraint in Africa. However, there is a drive to reduce the power consumption of electronic equipment which has resulted in a growing range of low-power devices. Battery life is also increasing. Lower power consumption at improved computing performance has been achieved due to developments in the chipset industry. There are now low-power solutions for laptops, netbooks, desktops and LCD display, as well as efforts to develop low-power servers without a trade-off in processing power.[253] Further

[251] http://www.southafrica.info/about/science/sanren-171209.htm ; http://www.tenet.ac.za/sanren_high_level_v_red_for_geoff.png/view?searchterm=SANREN
[252] http://www.ska.ac.za/
[253] Michael Miller, ''Lower power servers: a coming trend', March 2011, http://forwardthinking.pcmag.com/chips/282347-low-power-servers-a-coming-trend.

technology improvements can be anticipated. The selection of the device used can have a significant impact on power consumption and therefore total cost of ownership. For instance, netbooks typically have lower power consumption than laptops which in turn have lower power consumption than desktops.[254] The adoption of approaches which share the processing power of a single device between multiple users (for example, thin clients) also results in significant energy savings.[255]

There is ongoing research into alternative power sources for IT[256] and development in areas such as solar technology.[257] It is, for instance, reported that companies such as Apple and Samsung are exploring the possibility of releasing lines of products that are solar-powered[258] and that the OLPC XO-3 tablet scheduled for market in 2012 will use just 1 watt of power and will include a solar panel.[259] The low power demands of most individual devices make it relatively easy for small start-ups to provide charging solutions to meet the needs of individual devices.

2.3 Harnessing ICT to improve management and administration

Providing access to technologies and connectivity creates an environment in which ICT can be harnessed to support education more effectively. Providing technology is, however, of no real value unless it forms part of a broader strategy to integrate use of ICT into education systems. An important starting point for this is the management and administration of education. Several opportunities can be highlighted from this perspective.

2.3.1 Education management policy support and knowledge-sharing programmes

One major problem with current management information systems is the lack of adequate policy and well thought-out planning for the collection and use of educational information. Despite some progress, African countries still require knowledge on:

- formulating cost-effective and sustainable strategies on educational data collection and use;
- developing indicators that enable the monitoring of national and regional performance;
- the adoption of Web-enabled education management information system tools; and
- sharing of knowledge on requirements, challenges and opportunities.

[254] Some statistics on power usage of different devices: 'Laptops' Wikipedia, http://en.wikipedia.org/wiki/Laptop#Advantages; 'Approximate Desktop, Notebook, & Netbook Power Usage', Penn Computing, http://www.upenn.edu/computing/provider/docs/hardware/powerusage.html, 'Report on Low-Power PC Research Project', ComputerAid, http://www.computeraid.org/uploads/Report-on-Low-Power-PC-Research-Project-April-2009.pdf

[255] Figures showing energy savings from multipoint type solutions are included on the following pages: http://www.slideshare.net/robynfisher7/unhcr-community-technology-access-program ; http://userful.com/green-pcs

[256] http://wiki.laptop.org/go/Peripherals#Power

[257] 'Market for solar-powered consumer products needs more development, says Taiwan-based solar firms', DigiTimes, July 2011, http://www.digitimes.com/news/a20110727PD207.html

[258] Apple and Samsung said to have big plans for solar gadgets, but industry isn't ready', Digital Trends 2011, http://www.digitaltrends.com/apple/apple-and-samsung-have-big-plans-for-solar-gadgets-but-industry-isnt-ready/

[259] 'OLPC cuts XO 1.75 laptop to $165, power use by half', Computerworld, January 2011, http://www.computerworld.com/s/article/9203838/OLPC_cuts_XO_1.75_laptop_to_165_power_use_by_half

The National Education Statistical Information System (NESIS) programme that has been promoted by the Association for Education Development in Africa (ADEA) provides an innovative platform to promote policy and other capacity support to EMIS development in Africa.[260] NESIS has been engaged in capacity building in sub-Saharan Africa for over a decade under a theme of country leadership, ownership and partnership. Through a Working Group on Education Management Information Systems, ADEA has provided policy and capacity-building support for the development of a coherent and mutually supportive EMIS across Africa. In the end, ADEA felt that it was important to extend its nodes to different regions (Harare in Southern Africa, Addis Ababa in East Africa, and Dakar in West Africa) in order to provide contextual support to EMIS development. The ADEA NESIS support has:

- created a forum for decision makers and implementers of EMIS to exchange information on sound EMIS policies, indicators, tools, challenges, and opportunities for better planning and management of educational resources;
- made it possible to hold capacity-building workshops to facilitate experience sharing;
- promoted the development of a network of experts and institutions for collaborative training and mutual assistance;
- generated knowledge that is tailored to current African needs; and
- facilitated the dissemination of relevant information and good practices to stakeholders, including Ministries of Education, Finance and Planning, civil society, development agencies and the research community.

The train-the-trainer programme of ADEA NESIS has been beneficial in skills transfer at local levels. The programme has also improved the capacity of EMIS staff in Africa to plan and launch new data collection methodologies and tools, and to secure political support from decision makers in Ministries of Education. Strengthening the ADEA NESIS programme to facilitate capacity building and knowledge sharing would:

- strengthen the capacities of EMIS nodes in Africa;
- create a platform for exchange of experiences and mutual learning in policy formulation, adoption of state-of-the-art tools and discussion of opportunities and challenges;
- enable tailoring of EMIS to the capacity and knowledge exchange needs of different regions, taking linguistic and regional diversity into account;
- provide support for the development of EMIS policies and practices at regional levels which can be adapted to local settings; and
- create conditions for the development of a continental EMIS development and monitoring system.

A regional EMIS policy and capacity-building programme built on the experiences of ADEA requires adequate financial resources to carry out training programmes, run the different networks, and create platforms and fora for knowledge exchange. It is important that such an initiative works closely not only with Ministries of Education but also with national statistical offices, in order to avoid duplication of tasks, ease the collection and exchange of data, and define a consistent methodology.

[260] See - ADEA EMIS working group for SADC countries - http://nesis.intoweb.co.za/en/index.php?module=pagemaster&PAGE_user_op=view_page&PAGE_id=43

2.3.2 District Education Management Information Systems

District Education Management Information Systems have become increasingly popular in meeting the need for decentralisation of educational planning and data gathering at local levels. Governments in a number of African countries – including Ghana, Mozambique, South Africa and Uganda – have realised the importance of district management information systems to manage and plan school resources and carry out analysis of student, school, attendance area and demographic data.

The Indian District Information System for Education (DISE) is an example of such a system that has been instrumental for planning at local levels. The DISE was developed jointly by the National University for Education Planning and Administration (NUEPA), the Government of India, and the United Nations Children's Fund (UNICEF). DISE has greatly reduced the time lag in availability of educational statistics in elementary and secondary education. It has made data available at different levels, from school to cluster, block, district, state and national levels. DISE has been used as a basis for school, district, and state report cards, and in a number of publications containing information on different aspects of the universalisation of education.[261]

In the United States of America, a district information management tool known as Proximity[262] is used to analyse school district revenue and expenditure patterns, student demographics and resource usage. Proximity helps schools, school districts, education agencies and decision makers to develop, integrate and use geo-demographics and related decision-making information.

Implementation of school-driven district EMIS enables schools to take responsibility for record keeping, managing their resources in an efficient and transparent manner and improving local administration. District based initiatives can also support the roll-out of open source EMIS tools, such as the UNESCO-sponsored OpenEMIS, which integrates Geographic Information Systems (GIS) into schools on a phase-by-phase basis and provides training to teachers, school and district school administrators in data gathering, management and use.

The experience of India and other countries shows that roll-out of district-based management information systems requires significant financial and dedicated human resources, as well as ongoing training. It is also important to tackle resistance to change at school level. School administrators should not only be trained in the provision of data, but also in the use of information for benchmarking and planning purposes. There is a need to define the technical and organisational requirements for each school, including the specification of staffing requirements for such tasks (job description of an employee responsible for data submission, working hours needed for the job, yearly calendar of data entry), deadlines for transmission of data, time periods and formats in which data need to be produced and other quality requirements.

[261] Arun Mehta – DISE II – Higher Education Management Information System, http://www.educationforallinindia.com/HEMIS.pdf

[262] http://proximityone.com/.

2.3.3 EduStore Higher Education Management Information System

Tertiary education institutions are adopting student record management systems, but there has been a significant lack to date of consolidated Higher Education Management Information Systems (HEMIS). Many countries are looking into the establishment of HEMIS to complement data from schools and fill in data gaps on tertiary education. A Sri Lankan National Higher Education Management Information System (NHEMIS), which consolidates data from tertiary institutions, provides one useful approach that can be emulated by African countries wanting to adopt such a system.

The NHEMIS is a Web-based management information system that provides access to a large set of data and statistics about higher education in Sri Lanka. Instead of centralising data-gathering at the Ministry of Education, NHEMIS uses the services of the School of Computing at the University of Colombo to collect and analyse data. NHEMIS uses an open source platform known as eduStore which provides a Web-based information system to support higher education policy decision-making. The tool is based on open standard formats such as (X)HTML, Open Document and XML that facilitate the exchange of data with other information systems. NHEMIS has enabled the collection of series of data from higher education institutions and the generation of tables.

The deployment of open standard systems such as that described in Sri Lanka could bring considerable benefits to tertiary institutional planning in African countries, filling current data gaps in this area. HEMIS requires resources and sharing of experience between tertiary institutions. Raising the awareness of policy-makers, university leaders and regulators of tertiary institutions is essential for the success of a national HEMIS.

2.3.4 OpenEMIS

The growing reliance on Internet and distributed database tools that facilitate remote data entry, analysis and integration of different data sources requires that EMIS tools should be Web-enabled. Future EMIS tools should be based on open standards such as XML, web services, and open source software. One such tool is OpenEMIS, which was sponsored by UNESCO and is composed of two modules: EMIS Builder and EMIS User. EMIS Builder allows database administrators to adapt the generic tool to the specific characteristics of a national education system, to customise components of the information system, and to create data entry forms. EMIS User enables data entry and queries, together with the production of reports, charts and indicators.

OpenEMIS is seen as a useful tool in multilingual environments: a French version is used, for example, in Haiti and a Portuguese version in Brazil. Although evaluation of OpenEMIS has not yet been undertaken, its potential to enhance the collection and analysis of data appears to be substantial. The major benefits of using OpenEMIS include the ability to write interfaces that integrate mobile and PDA-based data collection. OpenEMIS also provides an interface to GIS. It is freely available and can be adapted to different needs, including interfaces with social networks. However, the viable adoption of open source tools requires a significant open source community to be available at national level, which is not yet the case in many African countries. This implies that resources are required to build local capacity and customise tools for different needs.

2.3.5 CU@School

CU@School is a project piloted in two districts of Uganda by the Netherlands development organisation, Stichting Nederlandse Vrijwilligers (SNV) in collaboration with the School of Computing and IT at Makerere University.[263] Its goal is to use mobile phones to monitor teacher and student attendance or absenteeism in about 100 schools on a weekly basis.

School head teachers submit attendance figures of students and staff, using a form on their mobile phones, to a central database hosted at the district level. Local information is then aggregated in real time at the district level and presented to the district administration in a variety of graphical formats (graphs, tables, geographical maps), with the help of a Web interface, giving the district education office actionable, real-time information displayed in a manner that facilitates easy comprehension. To verify data accuracy, District Education Officers (DEOs) perform spot checks at randomly selected schools to ensure that submitted data tally with the physical attendance of staff and students. The community is also kept informed of school performance through local newspapers and radio programmes, in order to encourage participation and increase engagement between schools and parents.

The project uses openXdata[264] — an open source platform for data collection that can be used on a wide range of mobile phones, from high-end handsets that support GPS to low-end handsets that only support voice and SMS. The use of open source software has allowed customisation and maintenance using expertise from a consortium of universities led by the School of Computing and IT at Makerere University.

CU@School relies on near ubiquity of the mobile phone network infrastructure, as well as the wide availability of individual mobile phones among teachers, creating the potential for easy transitioning from pilot project to full scale deployment. More expensive infrastructure such as the data server is centralised at district head-quarters. Using standard forms on the mobile phone to collect data across primary schools helps to improve quality and consistency in data collection, organisation and dissemination of information.

One challenge for the project is that the data collected are still intended for the local administration and higher levels of management. Schools have not been given priority to access data or training in order to leverage the data for their own decision-making processes. This reduces the incentive for head teachers to engage, as it can be seen as just another bureaucratic reporting requirement. In addition, the project was not conceived as part of an holistic approach to EMIS.

Power outages are a major problem, as is the challenge of sustainability that does not appear to have been addressed. Reliance on GPRS to send data entered into the forms, rather than SMS, results in lower running costs but the initial investment in mobile phone hardware is higher.

Projects like this have potential to change the way in which EMIS data are collected, aggregated, and disseminated within developing countries. Instead of relying on one or two

[263] http://www.snvworld.org/en/countries/uganda/Pages/default.aspx ; http://cit.mak.ac.ug
[264] http://www.openxdata.org

annual school censuses to collect relevant education data, EMIS data could be collected on an ongoing basis by different stakeholders spread across the country. In addition, EMIS could rely on existing mobile networks within a country to aggregate and disseminate data, rather than requiring expensive dedicated networks.

2.3.6 SMS examination results

A project of the Uganda Ministry of Education and Sports (MoES) and Uganda National Examination Board (UNEB), this initiative allows students to access their O and A level results by SMS using a unique personal index number. The project is a collaboration between the private and public sectors, highlighting how the two can work together to deliver a sustainable ICT project. In addition, it affords an opening into how mobile phones can be used to interact with complex information systems, affording cheap access opportunities for both students and staff to different kinds of relevant information. The value of this example lies not so much in the technology behind it, but in the apparent simplicity of using readily available tools to address a need in the education sector. This project has had significant impact, bringing to the fore the potential of mobile phones to change the way government services are provided. It has received a formal award from the Uganda Communications Commission which, in its citation, said as follows:

> *Communications is about creating value and convenience. Uganda Communications Commission has enabled nationwide penetration of telecommunication services through effective sector regulation, and using the Rural Communications Development Fund to provide access to areas that would not have been economically viable for operators. The challenge is then left to innovators to utilze this extensive platform to make money by creating value and convenience for users. For a very long time, tens of thousands of students have had to travel long distances and tolerate impossible queues in trying to get their examination results. In what sounded like the usual political announcement, the Minister of Education said that students would in future get their results by SMS. This was received with scepticism by many, until the reality was demonstrated. For breaking the mindset barriers in Uganda and enabling students to get results by SMS from the convenience of their localities anywhere in Uganda, SMS Media Uganda Limited is awarded the Product Developer Award for 2010 for their product 'EXAMSMS' developed for the Uganda National Examinations Board.*[265]

As noted above, this initiative is a public-private partnership. The service is offered in collaboration with SMS Media.[266] Each SMS query costs UGX 500 (less than US$0.25 but five times the cost of an ordinary SMS), a very small fraction of what it would cost the student in direct transport costs to collect results, without even factoring in time spent and the load on education offices.

2.4 Harnessing digital learning resources

2.4.1 The potential of Open Educational Resources (OER)

OER has emerged as a concept with great potential to support educational transformation, and recent years have seen a very considerable increase in the creation and use of OER materials. There is growing interest in OER around the world, as well as a fast-emerging Web infrastructure to support further growth, sharing and discovery of OER online. There

[265] www.ucc.co.ug/e-newsletter.pdf
[266] http://www.smsmedia.ug

are also African OER initiatives, such as OER Africa[267] and the African Virtual University,[268] which are involved in promoting the use of OER in Africa and supporting individuals and organisations in creating OER materials.

OER initiatives recognise that the transformative educational potential of OER revolves around three linked opportunities:

1) Increased availability of high-quality, relevant learning materials can contribute to more productive students and educators. Because OER removes restrictions around copying resources, it can reduce the cost of accessing educational materials. In many systems, royalty payments for textbooks and other educational materials constitute a significant proportion of the overall cost, while processes for obtaining permission to use copyrighted material can be time-consuming and expensive.

2) The principle of allowing adaptation of materials provides one of a number of mechanisms that construct roles for students as active participants in educational processes, where they can learn by doing and creating, rather than just by passive reading and absorption. Content licences that encourage activity and creation by students through re-use and adaptation of content can make a significant contribution to creating more effective learning environments.

3) OER has the potential to build capacity by providing institutions and educators with access, at low or no cost, to the means of production to develop their competence in producing educational materials and carrying out the necessary instructional design to integrate such materials into high quality programmes of learning.[269]

There have been a number of regional efforts focused to generate OER through collaborative materials development, two notable examples being the Teacher Education in Sub-Saharan Africa (TESSA) initiative[270] and the AVU's ICT-integrated Teacher Education programme for Mathematics and Sciences.[271]

TESSA is a research and development initiative providing OER and course design guidance for teachers and teacher educators working in sub-Saharan African countries. Since its inception in 2005, the TESSA consortium of 18 institutions has worked collaboratively to design and build a multilingual OER bank to support school-based teacher education and training. These materials are modular in form and focus on classroom practice in the critical areas of literacy, numeracy, science, social studies and the arts, and life skills. Each of the 75 study units is designed directly to improve teacher classroom practice and contains a series of activities for teachers to carry out with their pupils.

Likewise, the focus of the AVU's project has been to increase the quantity and quality of mathematics, science, and ICT teachers through the use of ICT. It has completed the

[267] http://www.oerafrica.org
[268] www.avu.org
[269] Butcher, N.(2011). A Basic Guide to Open Educational Resources (OER). UNESCO and Commonwealth of Learning. Retrieved from http://www.col.org/resources/publications/Pages/detail.aspx?PID=357
[270] http://www.tessafrica.net
[271] The AVU OER Strategy. Retrieved from http://oer.avu.org/about

development of four full Bachelors of Education programmes in mathematics, physics, chemistry, and biology. These programmes were developed using a collaborative approach, involving twelve universities, with 146 authors and peer reviewers from ten countries (Anglophone, Francophone and Lusophone). The AVU has developed 73 modules, including 46 in mathematics and sciences, four in ICT basic skills, 19 in teacher education professional courses, and four related to the integration of ICT in education and in respective subject areas.[272]

Regional initiatives such as these have helped to raise the profile of OER on the continent and led to production of content, although often with significant logistical challenges. There are often sustainability challenges with supply-driven projects of this kind once they are completed, given the degree of reliance on donor funding to produce materials. In consequence, responsibility for ongoing maintenance of content is often not integrated into the activities of the institutions.

Interestingly, though, there has now been some growth in demand-driven OER initiatives, led by institutions themselves. One notable project is that of the University of Malawi (UNIMA), which embarked on an OER project at the Bunda College of Agriculture (BCA) to develop a textbook on communication skills.[273] In this project, staff of BCA's Language and Communication for Development Department intended to use OER to address specific problems.

While communication skills was a core course for all first-year students, they did not have access to all of the textbooks used by the staff. This was because there was no set textbook for the syllabus. In addition, lecturers tended to use more than one text to teach the course, and students generally did not have access to all of these titles. Students could not always access the 'recommended reading' textbooks that accompany the syllabus outline, as the library did not have or had only an insufficient number of these texts.

BCA staff decided to create a paper textbook from freely available OER that would cover at least 75% of the first semester course content and would be easily replicable for up to 200 students and staff each year. A series of writing workshops facilitated by OER Africa/International Association for Digital Publications (IADP) assisted BCA staff to source, analyse and adapt a variety of existing OER materials to help them craft the textbook. The workshops were also intended to act as a model for expansion into other departments in the college facing similar needs. The team members wrote new materials but also used and adapted material from all around the English-speaking world to suit the specific needs of this course.[274] The project resulted in the compilation of a first year communication skills textbook.[275]

[272] Diallo, B. (2011). Experience of the AVU in Developing OERs in Math and Science Teacher Education Collaboratively with 12 African Universities and 10 African Countries. DETA Conference: Maputo August 4th - 2011
[273] Moore, A and Preston, D. (2010). The Use of Open Education Resources at the University of Malawi (UNIMA). Retrieved from: http://www.oerafrica.org/ResourceResults/tabid/1562/mctl/Details/id/38573/Default.aspx
[274] Moore, A and Preston, D. (2010). The Use of Open Education Resources at the University of Malawi (UNIMA). Retrieved from: http://www.oerafrica.org/ResourceResults/tabid/1562/mctl/Details/id/38573/Default.aspx
[275] The textbook can be retrieved at: http://www.oerafrica.org/foundation/FoundationOERHome/BundaCollegeofAgriculture/tabid/878/Default.aspx

Another noteworthy project has been undertaken by the Kwame Nkrumah University of Science and Technology (KNUST) located in Kumasi, Ghana.[276] The College of Health Sciences (CHS) at KNUST launched an OER initiative, supporting the production and use of OER. This project, funded by the Hewlett Foundation, began in 2008 as a collaboration between KNUST, the Universities of Ghana, Michigan, Cape Town and the Western Cape, and OER Africa. KNUST's CHS identified three strategic priorities for health education, which are the basis for its OER activities:

- To develop contextually relevant textbooks, as many medical textbooks and publications originate in Western countries and use photographs and examples that are not necessarily suitable for the Ghanaian context.
- To increase student engagement with the local curriculum, as increases in class sizes have limited face-to-face interaction between lecturers and their students. In order to supplement the limited time they have with students for classroom and clinical training, several CHS faculty members were interested in creating interactive, self-guided learning materials that students could work through on their own and in their own time.
- To strengthen the core curriculum, as the limited contact time and faculty availability just described make it difficult to cover all of the necessary topics within the confines of the classroom and with locally developed resources. OER was seen as an alternative method for delivering difficult topics to students.

One of the most significant accomplishments of the KNUST OER team is that it has successfully adopted a new policy in support of OER. In addition, the team has trained faculty and other staff in OER policy and production, content development, open licensing and fostered the creation of a dozen comprehensive, interactive OER modules. KNUST distributes OER electronically, either online or via CD-ROM, which enables students to access the materials by computer at their convenience. To date, CHS has completed twelve OER modules which include learning objectives, animations, lab demonstrations, surgery videos, case studies and self-assessment quizzes.[277] An additional 18 modules are currently in development, with a further 17 proposed by the end of 2011. Furthermore, KNUST has purchased video cameras, drawing pads, laptops and software licences to enable multimedia production for OER and has developed its own OER production process. The project has seen many other positive results, including increased awareness and support for OER. Many early participants have now become advocates for OER, and those who have created OER are keen to produce additional modules.[278]

These examples illustrate the following benefits of OER:

- OER projects result in a freely available resource.
- They create opportunities to develop local capacity in educational materials development.

[276] http://web.knust.edu.gh/oer

[277] These resources can be found on the KNUST OER site (http://web.knust.edu.gh/oer) as well as on the African Health OER Network space on the OER Africa website (www.oerafrica.org/healthoer).

[278] Ludewig-Omollo, K. (2011). Growing an Institutional Health OER Initiative: A Case Study of the Kwame Nkrumah University of Science and Technology. Retrieved from http://www.oerafrica.org/FTPFolder/Website%20Materials/Health/case_studies/2011.05%20Knust_Low_Res.pdf

- The intellectual property is opened to the public (by applying a relevant Creative Commons licence). In this way, changes can be made to materials without incurring additional costs from publishers and authors in licensing fees and royalties.
- Teachers and instructional designers may adapt and improve materials and distribute them under the Creative Commons licence. This creates more resources that have been tailored for specific contexts and that can be freely used across the system.

In addition, these initiatives have recorded a number of other benefits:

- They have increased student and educator access to educational materials as, when OER are distributed electronically, they are easy to access via a computer, to copy and to share.
- They have generated new educational opportunities by enabling teachers to access material to use in teaching their classes or to complement a course.
- They have promoted innovation and the improvement of teaching resources used by instructors. The OER work at the University of Malawi revealed that re-using quality OER helps staff to grow in confidence in teaching the content of the materials.
- They have provided an opportunity to re-examine the curriculum, learn new teaching methods and rethink teaching approaches. Instructors may use OER from elsewhere to inform their own teaching. Creating OER for a global audience may encourage faculty members to re-examine their own teaching practices before codifying them as OER.
- They have provided an opportunity for author recognition for those creating and sharing OER. For example, at KNUST CHS faculty members view OER as a way to enhance their personal reputations since publishing OER presents an opportunity for them to showcase their expertise.
- They have enhanced institutional reputation and brand image. At KNUST OER was seen as a way to enhance the reputation of the institution by sharing its curriculum. In late 2009, KNUST added a Creative Commons Attribution licence to the university's website footer as part of a broader strategy to use Wikipedia and Google to help increase the institution's web traffic. The KNUST webmaster believes that this licence is responsible, in part, for raising the university's ranking in the *Webometrics Ranking of World Universities*.
- They have lowered the cost of student access to educational materials. Unlike traditional textbooks and journals, OER do not require licensing fees. Although OER are not free to produce, they are free to access. There may still be a marginal cost for distributing OER (*e.g*. for printing or for removable media such as CDs), but it is a fraction of that of standard licensing fees.
- They have decreased faculty time spent on materials development. OER makes it easier for educators to preview how others in their field teach a given topic. Faculty members can use OER created by others – in whole or in part – to develop their own lecture slides or other teaching aids.
- They have eased the development of new programmes. OER may be particularly useful when a university is looking to expand its curriculum by offering new courses and degree programmes. OER allows faculty members to preview how a topic is taught at other institutions, while open licensing allows them to contextualise and translate OER to suit local needs.

- They have enabled students to use OER for review and revision purposes, to complement class material, plan a course of study and prepare for formal studies.
- They have created the opportunity for anyone to study a course to develop personal knowledge.
- They have provided additional information on subject matter, as an alternative for thousands of students with HE interests.
- They have provided access to content to alumni. The KNUST provost has seen OER as a means to create and sustain the university's alumni networks. Alumni can use OER as a means of sharpening their skills, whether informally or formally (*e.g*. through continuing medical education), or simply to stay connected to their *alma mater*.[279]

There are, however, also a number of challenges in using and creating OER in an African context, including the following:

- One important challenge is the need to ensure that the products resulting for OER development are educationally effective and of a high standard.
- Being able to access OER requires adequate infrastructure and a robust and fast connection to the Internet. This is still lacking in many African institutions. The UNIMA case study has shown that problems with Internet connectivity often make access difficult while the KNUST case study has highlighted problems arising because the network can be slow and experiences power outages.
- Due to unfamiliarity with the OER model, there is a need for lobbying about the benefits of OER to encourage buy-in from African academics. This was noted in the UNIMA case study, which recommended that faculty members and other staff undergo a general sensitisation programme outlining the benefits of this model. Some academics also see 'open licences' as a threat to their intellectual property and traditional methods of teaching, as was noted at KNUST.
- The staff workload needs to include time to source and adapt materials, as most lecturers have to balance teaching obligations, clinical service requirements and research expectations.
- Available OER may not always match methods or subject matter as taught locally.
- There is a need to train and build the capacity of additional staff to source and adapt OER.
- OER is free to access but not free to produce. African institutions may face the challenge of lack of funding to cover the time required to undertake research for materials and adaptation.

Nevertheless, harnessing OER in an African context can have positive impacts on the teaching and learning environment, as adopting this model requires institutions to invest in programmes, course and materials development. Costs include the time needed for people to develop curricula and materials, adapt existing OER and deal with copyright licensing, as

[279] Carson, S. (2010). Benefits of the Use of MIT Courseware. eMadrid. Retrieved from http://www.emadridnet.org/en/emadrid-seminar-on-open-educational-content/benefits-use-of-mit-courseware; Mestre, R. (2009). Toward a Utopia: Open Educational Resources in Higher Education. Paper presented at Virtual conference - International Technology, Education and Development Conference. Valencia. Retrieved from http://uv.academia.edu/RosannaMestrePerez/Papers/90311/Foward_a_Utopia_Open_Educational_Resources_in_Higher_Education; Miyagawa , S. (2006). OpenCourseWare at Home. MIT Faculty Newsletter (Vol. XVIII No. 3 January / February) retrieved from http://web.mit.edu/fnl/volume/183/miyagawa.html

well as associated costs such as ICT infrastructure (for authoring and content-sharing purposes), bandwidth, content development workshops and meetings, *etc.* However, these costs are a function of investing in better teaching and learning environments, not a function of investing in OER. All governments and educational institutions, regardless of their primary modes of delivery, need to make these investments on an ongoing basis if they are serious about improving the quality of teaching and learning. Within the framework of investing in materials design and development, the most cost-effective approach is to harness OER. This is because:

- it eliminates unnecessary duplication of effort by building on what already exists elsewhere;
- it removes costs of copyright negotiation and clearance; and
- over time, it can engage open communities of practice in ongoing quality improvement and assurance.

To be effective and sustainable, institutional decisions to harness OER will probably need to be accompanied by a review of policies. There are at least four important policy issues to address:

- *Clarity on IPR/copyright* on works created during the course of employment (or study) and how these may be shared with and used by others. A clear policy would, for example, lay out the respective intellectual property rights of the institution and its employees and sub-contractors, as well as students (who might become involved in the process directly or indirectly through use of some of their assignment materials as examples). As part of this process, it is worth considering the relative merits of copyright policies that automatically apply open licences to content unless there are compelling reasons to retain all-rights-reserved copyright over those materials. Equally, however, these policies should not make it difficult for staff to invoke all-rights-reserved copyright where this is justified.

- *Human resource policy guidelines* regarding whether or not the creation of certain kinds of work (*e.g*. learning resources) constitute part of the job description for staff and what the implications of this are for development, performance management, remuneration and promotion purposes.

- *ICT policy guidelines* regarding access to and use of appropriate software, hardware, the Internet and technical support, as well as provision for version control and back-up of any storage systems for an institution's educational resources.

- *Materials development and quality assurance policy guidelines* to ensure appropriate selection, development, quality assurance and copyright clearance of works that may be shared.[280]

OER can play a meaningful role in supporting education in Africa by contributing to improving the quality and effectiveness of education, particularly by providing an

[280] Butcher, N.(2011). A Basic Guide to Open Educational Resources (OER). UNESCO and Commonwealth of Learning. Retrieved from http://www.col.org/resources/publications/Pages/detail.aspx?PID=357

opportunity to engage educational institutions and academics in structured processes that build capacity to design and deliver high-quality education programmes without increasing cost.

2.4.2 Investing in national education portals

While the Internet provides access to very extensive sets of educational resources, experience shows that there is a shortage of educational resources in formats that make them easily accessible and relevant to most teachers and learners in Least Developed Countries (LDCs), especially as they relate to a given country's current curriculum. Unless electronic educational resources are directly related to the curriculum and to assessment methods used to evaluate educational outcomes (especially standardised testing), lack of appropriate and relevant educational content is an important barrier to ICT use in schools. Research also indicates that official guidelines and directives from Ministries of Education enhance use of ICT-enabled content.[281]

This provides compelling reasons to invest in national education portals. Doing so can entail investment in sourcing and cataloguing existing materials against the national curriculum framework. This is required in recognition of the wealth of educational materials already available on the Internet to support teaching and learning, many of which are currently inaccessible to busy educators. Given this, there is value in appointing teams of materials evaluators to review, approve and catalogue materials according to their relevance to national curriculum frameworks. In this way, educators may quickly locate quality materials, which have already been reviewed, at the point at which they are required in the curriculum. Work along these lines can also include investment in developing OER resources.

The approach of sourcing, reviewing and cataloguing OER was adopted by the Education Network Australia (EDNA),[282] whose aim was to 'place at your fingertips Australia's leading quality-assured online resources'.[283] Another EDNA focus was to support educator collaboration and networking. EDNA was 'a large repository referencing thousands of online resources for education, training and research.' Materials were organised by topic and by education sector: early childhood, school, vocational education and training, adult and community education and higher education. As a joint initiative of the state/territory governments and the federal (Commonwealth of Australia) government, EDNA's aim was to provide free resources to its educators. The intention was for Australian educators to be able to find what they needed quickly, as they needed it, and at no cost.

The South African Department of Basic Education aims to adopt a similar approach through the Thutong Portal[284] which seeks to lead the drive to improve learning in the country through appropriate use of technology. The Thutong Portal is the online point of entry to a comprehensive array of free educational resources, policy information and interactive

[281] Trucano, M.(2005). Knowledge Maps: ICT in Education. Washington, DC: infoDev / World Bank. Available at: http://www.infodev.org/en/Publication.8.html
[282] Note that EDNA has been closed down from June 2011
[283] EDNA, Frequently Asked Questions, What is Edna?.Retrieved from http://www.edna.edu.au/edna/go/about/faq/cache/offonce;jsessionid=0CC73F156BC8C17CEC2655F907BB67CC
[284] http://www.thutong.doe.gov.za/

services concerning all aspects of the South African school sector. It provides relevant information and services about the South African school curriculum, teacher development, school administration, and management.

Another example is the Enlaces Programme in Chile[285], which offers educational content and services for teachers and students. Its website is seen as an education portal where teachers can access curriculum-oriented content, fora and up-to-date educational information.

Iceland's national education portal, The Educational Gateway,[286] seeks to help teachers, learners and parents to identify educational content, especially that available on the Internet, which is relevant to specific parts of the national curriculum, grouped by grade level and subject. It is also a clearinghouse for news, school-related information, information on education projects and initiatives, and hosts on-line discussions.

Strengths of this approach include the following:

- A wealth of existing materials can be reviewed and organised against a local curriculum framework, with the result that users can obtain appropriate curriculum-related content which has been sourced or developed for inclusion in the repository.
- Resources are free for educators and learners to use as they require them.
- Relatively small upfront and ongoing investments can result in a very large repository of content.
- A wide variety of resources is available which makes use of different styles and tends to support a range of learning techniques.
- Educators may select resources that suit their specific pedagogical requirements. This is a strength where there are experienced and skilled educators. It may, however, be a weakness in contexts where educators are not sufficiently skilled and require the support of structured learning pathways (such as those provided by textbooks) through which to guide their learners.
- The resources located may commonly be adapted for new contexts and re-published under a Creative Commons licence.
- They can provide a platform for communities reviewing content for local contexts.
- They can house materials in the languages of the country.
- They have the potential to make available a wide variety of resources which make use of different styles and support a range of learning techniques.
- The repository can be made available offline, thereby affording institutions with limited connectivity access to digital learning material.
- They can promote better use of ICT in teaching and facilitate quick and easy access to resources for making lesson plans and for teaching.

The challenges of national repositories in an African context include the following:

[285] www.enlaces.cl
[286] http://www.menntagatt.is

- The model relies on collating what is already developed and available free. If there arespecific resource requirements that have not been developed already, these topics are not covered within this model.
- There may not be the necessary core competencies and funding programmes to provide repositories and to develop the necessary infrastructure.
- As this is a collection of resources for specific topics, it is unlikely to provide an overall structured and sequenced learning pathway through a curriculum area. Such investments require significant instructional design and production processes and are seldom then made available for free distribution. These investments are usually facilitated through publishers (as in school textbook publishing processes) or through government investments in specific content areas.
- As much educational content available on the Internet is in English, this language tends to be the dominant medium of instruction in the repository.
- Where repositories are online, this may limit access in cases with limited or no Internet connectivity.

2.4.3 Content development partnerships between government and NGOs

NGOs are often involved in developing digital content. Partnership between them and governments can help to ensure the development and adaptation of content to suit local requirements. In particular, governments can commission specialist content development projects for priority intervention which may involve:

- developing materials from scratch;
- adapting internationally developed content to suit a local context; and/or
- translating and adapting existing content to be presented in languages other than English and/or to suit the local African context.

In South Africa, Mindset Learn, a division of the Mindset Network,[287] is aimed at high school learners and educators in the FET band (Grades 9, 10, 11 and 12). Materials are distributed on a mass scale in South Africa and other African countries through various technology platforms including broadcast and datacast. They are made available in video, print and in computer-based multimedia formats. 'Learn' materials are curriculum-based and available both on television (DStv Channel 319) and on the Web.[288] Mindset Learn has also created a series of teacher development videos. Users are able to download past-year examination papers that are hosted on the Department of Education's website. Furthermore, Mindset has a helpdesk where learners have the opportunity to ask questions (via Mxit, Facebook, email or telephone) to a panel of experts who will respond within 48 hours.

Strengths of working with these types of agencies include the following:

- NGOs generally have a developmental rather than a profit motive and so, other things being equal, may be more cost-effective than private sector agencies.
- NGOs often join up materials development with distribution and uptake – frequently coupling research, training and orientation services with materials development.

[287] http://www.mindset.co.za
[288] www.mindset.co.za/learn

- NGOs are less likely to aim to protect intellectual property for future sales revenue of the Learner Teacher Support Material (LTSM). The intellectual property involved may be open (for example, by applying a relevant Creative Commons licence). In this way, changes can be made to the materials without incurring additional costs from publishers and authors in licensing fees and royalties.
- NGOs frequently specialise in niche areas and often have their own experts, or are able to draw on a network of experts, that suit those areas. Some NGOs – such as SchoolNet South Africa – focus specifically on ICT in schooling) and have gained a depth of research, contextual experience and materials on which they can draw for content development.
- Governments can define priority areas and ensure that appropriate – Government-approved – content is developed. In addition, materials may be developed in the languages of the Ministry's choosing, as language choices are not left to the commercial market.

Weaknesses include the following:

- Some NGOs may not offer market-related salaries, and so may not be able to attract the best materials developers and experts in an area.
- NGOs' capacity may be stretched by their existing core functions, and they may not have the management capacity to scale up to that required for large-scale materials development.
- NGOs may depend on the expertise of a few experienced individuals and find it difficult to manage a large production team while maintaining quality.
- NGOs sometimes find it difficult to alter their established ways of approaching their work to take new client requirements into account.

2.4.4 Collaborative Content Development

Collaborative content is created, reviewed, refined, enhanced and shared by interactions and contributions of a number of people, usually using Web 2.0 technologies. One of the ways in which this occurs is through communities of practice which provide sustained platforms where educators 'share resources that enhance their curriculum, get peer reviews of lesson plans they have created, and exchange ideas and good practices with other teachers of their subject.'[289]

In such communities, educators share, adapt, and develop resources through interest groups or content focus areas. They may perform different functions within the content development process such as rating and/or reviewing content that they access, with their ratings and reviews becoming available to other educators when they are selecting online resources. They may provide feedback on the quality of content which is being developed independently. Educators may be encouraged to submit and contribute materials to their online communities. Finally, educators may be structurally involved in an agreed materials development and production process – designing, reviewing, piloting, and/or translating and adapting materials as required. Educators know and understand their local teaching

[289] Hawkins, R. J. (no date). Ten Lessons for ICT and Education in the Developing World. World Links for Development Program: The World Bank Institute

contexts and the environments in which the content that is created is to be used. African educators who are multilingual may play a valuable content development role in translation and language adaptation support for multiple African languages.

One notable African collaborative OER project, which has already been discussed in this chapter, is the Teacher Education in Sub-Saharan Africa (TESSA) initiative.[290] TESSA is a research and development initiative creating OER and course design guidance for teachers and teacher educators working in Sub-Saharan African countries. The TESSA initiative aims to achieve the MDGs and EFA goals and to ensure that, by the year 2015, every African child should have access to primary education. In order to reach these goals, sub-Saharan countries need four million trained teachers, which cannot be achieved through presently available conventional modes of teacher training. The TESSA initiative therefore stands on three pillars:

- affordability and accessibility of ICT;
- OER philosophy which allows materials to be made available over the Internet and freely accessible to all; and
- research studies in cognitive science which provide current information on how learning takes place.

As noted earlier, TESSA's consortium of institutions has worked collaboratively to design and build a multilingual OER bank of materials which are modular in format and focus on classroom practice in literacy, numeracy, science, social studies, the arts and life skills. Its 75 study units are designed to improve teacher classroom practice and include activities for teachers to carry out with their pupils. Each study unit has been adapted and versioned for the nine country contexts of participating TESSA institutions, including translation to Arabic, English, French and Kiswahili. The design of the TESSA web environment is organised to enable each country/institution to have its own web presence and, because of current challenges in connectivity and access, the study units are provided in a range of formats. In addition, members of the TESSA community are encouraged to explore, share, adapt and add their own resources for teacher education. The website includes a forum platform for discussion.[291]

One of the institutions belonging to the consortium, the University of Fort Hare (UFH) in South Africa, has noted the positive benefits of participation in the TESSA consortium:

> *Participation in the TESSA consortium, including involvement in the development and integration of TESSA OERs, has afforded UFH academics and students (both pre-service and in-service) and relevant external stakeholders, such as the DoE, access to communities of practice within the institution, across institutions, and across countries and generated a new discourse of finding, adapting, and sharing educational resources.*[292]

[290] http://www.tessafrica.net
[291] http://www.irrodl.org/index.php/irrodl/article/view/705/1319
[292] Thakrar, J., Zinn, D., and Wolfendon, F. (2009). Harnessing Open Educational Resources to the Challenges of Teacher Education in Sub-Saharan Africa. *The International Review of Research in Open and Distance Learning*. (Vol 10, no.4). Retrieved from: http://www.irrodl.org/index.php/irrodl/article/view/705/1319

The work of TESSA offers a considerable contribution towards overcoming the problem of scarce resources in teacher education.

Another collaborative content development project is that of the African Virtual University (AVU), which launched the interactive Open Education Resources portal OER@AVU[293] in 2010. As noted earlier, this has completed the development of four Bachelors of Education programmes through the collaboration of 12 universities and over a hundred contributors in ten countries ranging across the continent's linguistic divisions. As well as developing 73 modules in maths, sciences and other disciplines, the AVU's portal enables academics throughout Africa and beyond to share, distribute, and disseminate resources globally and thereby contribute towards Africa's economic development through education.

Strengths of this approach include the following:

- Materials are sourced, created, and reviewed by educators who know their contexts and are able to judge and comment on what has worked and what has not.
- Competent educators develop learning materials (worksheets, tests, examination papers, assignment outlines, *etc.*) in the course of their teaching and as part of their professional role. Capturing and sharing what they already do with a wide community is a very cost-effective contribution to the system.
- Materials are reviewed for local context.
- Multilingual African educators can translate and adapt materials into languages other than English. Materials may be adapted for use in the medium of instruction and/or the language of the educators, thus stimulating a more diverse language offering. Incentives to encourage non-English language contributions may, however, be necessary to take advantage of this potential strength.
- Several educators are able to participate as collaborators in a network. In the case of TESSA, fora, workshops and advisory council meetings provide space for engagement in a network and for conversations with a focus on issues of practice.
- Resources are free for educators to use as they require them. Educators can review, rate and recommend materials in ways to which their colleagues can relate.

Weaknesses include the following:

- The ICT skills level of educators needs to be relatively high for them to be able to select and adapt resources as they require them.
- In the African context, this may result in certain types of educators (for example, those in better resourced schools or where English is prevalent) tending to dominate professional development communities. As such, incentives may be necessary to ensure that there is a diverse group of contributing educators and to encourage language diversity.
- Materials development is a complex process that requires the combination of subject matter knowledge with pedagogical creativity and knowledge of digital media environments. This is a rare combination of skills to find in one person. Educators tend to be able to provide the subject matter knowledge and may have some suggestions for

[293] http://oer.avu.org

instructional design, but many do not have the necessary creative production expertise. While educators are essential to the materials development process, they are typically not the only people involved.

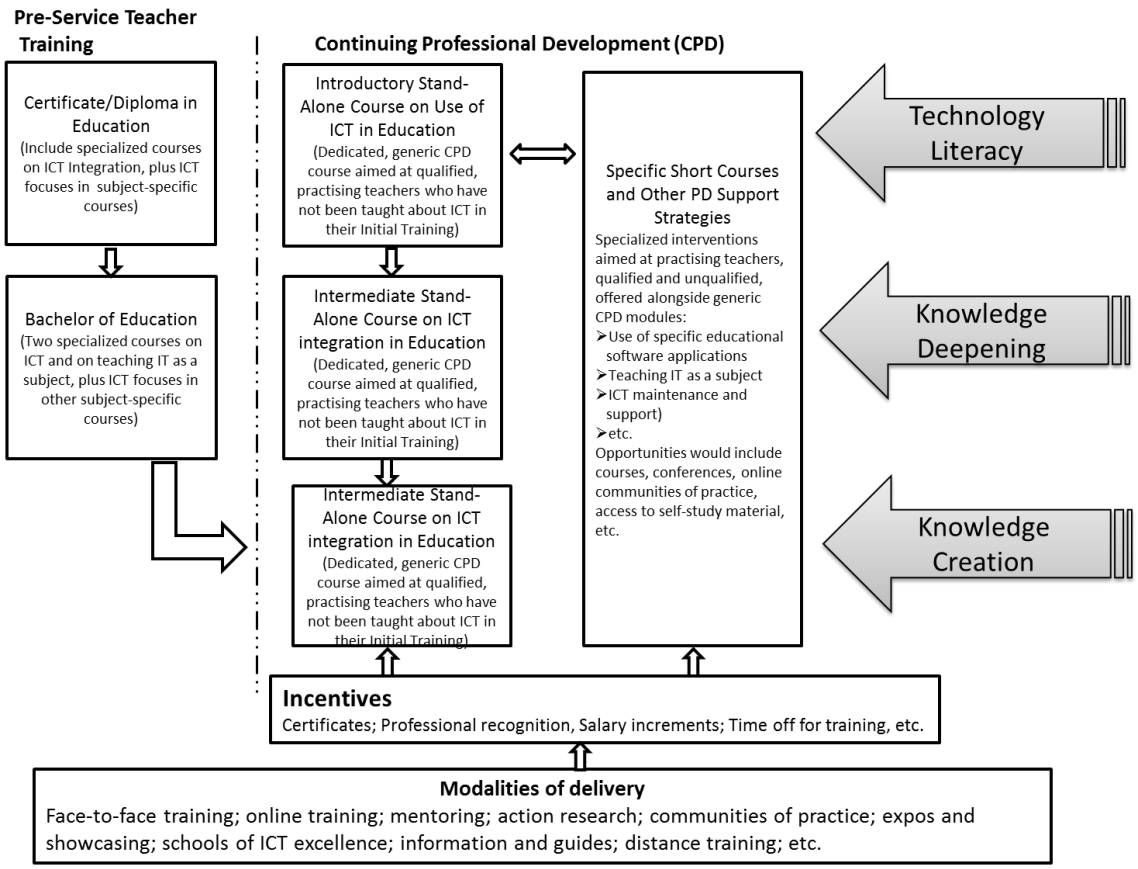
2.5 Building human capacity

2.5.1 A national framework and strategy for ICT professional development

As discussed above, ICT in education policy should include an implementation framework which should incorporate holistic approaches to teacher professional development on ICT integration, pathways to achieving universal access to training, and methods of motivating teachers to take up training as well as to integrate ICTs into teaching and learning.

Figure 3.1 proposes a model for how such a framework might look, based on the approach that the government of Guyana has used to develop a strategy that builds on the UNESCO ICT Competency Framework for Teachers (CFT). This model also incorporates what the literature cites as enablers to professional development for ICT integration. A framework such as this can help to ensure that teacher skills are developed within an holistic approach to educational reform where teachers develop competencies needed for technology literacy, knowledge deepening and knowledge creation. Detailed mapping will need to accompany this strategy, with resourcing built in for the cost of training as well as for incentives. Guyana's framework is based on a five-year plan of implementation.

Figure 3.1 - Illustrative Model of National Framework for ICT professional development



Countries that have developed a national strategy for professional development generally seem to achieve scale in the training of their teachers and in financing this professional development. For example, the Digital Strategy for Teachers in Australia has led to the government committing AU$40 million over two years for teacher training on ICT integration. The Egyptian Education Initiative's Learning and Technology Policy Framework focuses on teacher training as well as the development of infrastructure and provision of connectivity. Namibia's TECH/NA! strategy maps out training of the entire education workforce from ministry to school level, with training of teachers focused on pre-service and in-service work by teacher training colleges. Chile's Enlaces strategy has also achieved scale in the training of teachers and equipment of schools, and has introduced an incentive-based online training programme that teachers can take on their own, receiving pay incentives when they gain a certificate.[294]

2.5.2 Harnessing worldwide programmes

Worldwide and regional programmes, highlighted in Chapter 2, have achieved significant reach in terms of professional development for ICT integration. iEARN operates in 29 countries on the African continent, and has been working with Ministries of Education in Botswana, Egypt, Kenya, Tunisia, and Senegal and with SchoolNets in Namibia, Ghana, Mali, South Africa, and Uganda to train teachers in how to integrate collaborative project work into their teaching.[295] World Links, which provides capacity on ICT integration, is active in thirteen African countries – Botswana, Burkina Faso, Ghana, Mauritania, Mozambique, Nigeria, Rwanda, Senegal, South Africa, The Gambia, Uganda and Zimbabwe –training both principals and teachers.[296] Intel Teach and Microsoft PiL courses are used by SchoolNets in many African countries, while their networks reach many more teachers who do not attend the courses, providing opportunities for sharing resources and practice. These worldwide and regional programmes are quite entrenched and have outlived many donor-funded professional development programmes that have proved unsustainable because of funding challenges. These programmes have also ensured that willing and able schools participate in the digital global environment and integrate ICT even without dedicated government support or funding.

2.5.3 Incorporating a focus on pre-service teacher training

Research suggests that one-off training on ICT integration has had limited success in changing classroom practice to enable teachers to integrate ICTs into teaching and learning. The focus has therefore been shifting towards ICT integration training in pre-service teacher education. As the UNESCO ICT CFT specifies, new economies demand new skills from teachers, and pre-service teacher education – as an entry point to the profession – can provide adequate training for ICT integration, treating it as a necessary skill for teachers to acquire. Even when conditions in schools do not allow teachers to use ICT, perhaps because of infrastructure and connectivity deprivation, training new entrants to teaching with ICT integration skills alerts them to the possibilities of ICT integration and prepares them with the knowledge and skills should they require these later in their careers. Dedicated efforts

[294] Microsoft Partners in Learning. (2009). An Innovative Teachers' Network transforms Chile's schools. Chile: Microsoft.
[295] iEARN Africa: http://www.iearn.org/regions/africa?page=2
[296] http://www.world-links.org/regions/africa

at ICT integration training at national level could ensure universal access to this training by new teachers, by incorporating compulsory courses on the programme.

Guyana's and Namibia's ICT strategies require training of all pre-service teachers in ICT integration. In Senegal, all pre-service students are taught ICT integration.[297] The Ugandan Connect-Ed project, although unsustainable, also focused on pre-service teacher training, building the capacity of trainee teachers to integrate ICT into their teaching and create materials using computers.[298]

2.5.4 Parameters of good practice for professional development

In developing a framework and strategy for professional development for ICT integration, parameters for good practice can prove valuable. Some parameters are already available, having been developed for the NEPAD e-School Initiative. These advocate an holistic, multistakeholder, multi-modal delivery approach to professional development. They specify that:

> *All educational role-players – including government officials, school principals and management teams, administrators, teacher educators, teachers at all levels, learners, and community opinion-leaders – possess the skills and competence required to use ICT effectively in their daily lives. In addition, ongoing educational opportunities – formal, non-formal, and informal – are made available to, and are used by, all of these groups of people to further develop their educational ICT competence.*[299]

The NEPAD professional development guidelines are backed by criteria specifying that:

- Professional development of school managers and administrators should emphasise how ICT can enhance work functions.
- Technicians' programmes should empower them to procure, secure, maintain and repair computers and other technologies, and to assist teachers with ICT integration.
- For government officials, professional development should focus on empowering officials to support ICT integration effectively, and on developing an understanding of how ICT can streamline education management, for example through EMIS. Government officials also need to understand their responsibilities for leading ICT integration endeavours through negotiating package deals to facilitate ICT integration, investing in professional development of education stakeholders, negotiating partnerships for professional development, *etc*.

These parameters have been used by sixteen countries on the African continent (Algeria, Angola, Benin, Burkina Faso, Cameroon, Congo, Egypt, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Mali, Mauritius, Mozambique, Nigeria, Rwanda, Senegal, South Africa and Uganda) to support mapping of country strategies in relation to the NEPAD e-Schools project.[300]

[297] Salimata Sene Mbodji. (June 2011). Senegal Country Report prepared for etransform Africa.
[298] http://learnlink.aed.org/ConnectED/
[299] Ernst & Young. (2006). Chapter 5: NEPAD e-Schools guidelines for Good practice. Unpublished report.
[300] Ernst & Young. (2006). Chapter 5: NEPAD e-Schools guidelines for Good practice. Unpublished report.

2.5.5 The role of communities of practice

Because of their reliance on teachers themselves to contribute and sustain them, communities of practice (CoP) offer a cost-effective model of professional development. Teachers who engage in communities of practice are more confident of their work, and are less afraid to display it for scrutiny and critique by others. As a result, there is a considerably stronger likelihood that what is made available is of a good standard, and that it can be further enhanced through input from other teachers' comments. The fact that tried-and-tested practices and resources are being shared means that no additional funds are needed to develop new materials, while quite a large amount of material can be made available over a short period of time if it is shared openly through a CoP. The practices and materials that are shared amongst teachers are localised, and this should help to make them more applicable to the conditions in their contexts. If there is cross-context collaboration, ways to make materials appropriate for different contexts will form part of the engagement of the CoP.

CoPs are already a strong feature of professional development in Africa, with examples including the Partners in Learning Network (PILN), Siyavula and the Teacher Education in Sub-Saharan Africa (TESSA) Forum.[301]

- PILN connects teachers and education leaders in Africa and the wider world who wish to share challenges, solutions and teaching resources. Currently, PILN has over four million registered teachers from 107 countries.
- Siyavula, a South African project, helps teachers to work collaboratively to develop and share curriculum-aligned resources under a Creative Commons copyright licence. Siyavula has partnered with the OER pioneer, Connexions, to extend its education portal to serve as the foundation for Siyavula's community of educators. Siyavula has over 4500 Grade R to 12 OER in English and Afrikaans, with some materials translated into Xhosa, available through the Connexions portal.[302]
- TESSA fora are informed by exchange of ideas and opinions and by sharing of advice and resources. Participation is available in a choice of four languages: English, Arabic, Kiswahili and French. At the time of writing this chapter, in mid-2011, there were 4172 registered users on TESSA fora.

3 General challenges

Within each of the opportunities identified above, a number of specific challenges to implementation have also been identified. In addition to these specific challenges, a number of wider challenges and barriers affecting ICT in education more generally have emerged from the research undertaken for this report. These are summarised in the following paragraphs. The problems and constraints which are described here are not insurmountable but they are significant and widespread. They represent important factors that must be taken fully into account when ICT integration initiatives in education are designed and implemented in African countries. Initiatives which do not take them fully

[301] http://africa.partnersinlearningnetwork.com; http://siyavula.org.za; http://www.tessafrica.net/index.php?option=com_fireboard&catid=0&Itemid=255.
[302] http://cnx.org/lenses/siyavula

into account are likely to run into substantial management and implementation problems and to fail to achieve desired outcomes.

3.1 Absence of comprehensive policy and strategy

The establishment of an enabling policy environment has already been identified as an important opportunity for supporting the effective integration of ICT in education. However, the lack of comprehensive policies covering the integration of ICT in education remains a major barrier in many African countries. The potential for ICT in education is often mentioned in national ICT policies in general terms, but there is frequently little policy development beyond this. Policies that cover all aspects of ICT in education are needed, and these in turn need to be associated with time-specific implementation strategies, appropriate institutional arrangements, the allocation of resources and the implementation of monitoring plans to ensure that implementation can and will take place.

Lack of supportive policies in other sectors also remains a challenge. For example, poor policy and regulation within the ICT sector result in significant barriers to access. Tax policies and laws impact on the cost of technology, while the provision of tax breaks can enable a greater private sector role within the education sector. Policy and laws defining the intellectual property environment are needed to enable different approaches to OER, technology transfer and adaptation.

3.2 Lack of awareness and ownership of initiatives

Awareness, in this context, refers to an appreciation of the potential of ICT as an enabler for the learning process and the consequent positive effect of ICT-skilled graduates on national development. Lack of awareness of the potential of ICT at decision-making and project formulation levels has been a critical constraint in many African countries, alongside an inadequate flow of knowledge and over-reliance on external advice. These are compounded by the dynamics of the ICT sector which presents multiple choices, alternatives and challenges to be considered when making decisions.

Lack of awareness also leads to lack of ownership, and if this occurs at those government levels where priorities and funds are allocated, it is likely to lead in turn to lack of funding. If educators and principals lack awareness and a sense of ownership, implementation failure is likely to result, irrespective of the level of resources. Ownership stems from involvement in formulation, planning and implementation processes. Lack of awareness is a threat to sustainability: a policy, strategy or initiative is likely to collapse as soon as its external drive and funding support are withdrawn.

The limited involvement of policy makers and users in the design of EMIS provides an example of these problems. This has been compounded by a lack of political will and sustained support from decision makers in some African countries. Lack of coordination and shared vision amongst the various stakeholders (horizontally between ministries and agencies, and vertically between schools, districts, regions, and the ministry) means that EMIS development has often been *ad hoc* and/or left to the Ministry of Education and

school principals who gather and send data on an annual basis. EMIS data are often incomplete and inaccurate due to lack of full participation of all stakeholders. There is, in addition, often a lack of clarity between the mandates of Ministries of Education and statistical offices for the collection, management and dissemination of EMIS data, as well as a tendency by some educators and principals to view EMIS as a threat, leading to low levels of enthusiasm for its implementation.

3.3 Funding constraints

As noted in Chapter 1, African countries are already spending a very high proportion of their budgets on education, augmented by direct household expenditure on education as well as by development aid. In Uganda, one of the case study countries, education expenditure is about 16% in the current (2011/12) budget.[303] South Africa, at 20%, ranks among the highest in the world in this regard.[304] The reality, however, is that, for most countries, the base figure is already low, and so the high proportion spent on education does not imply sufficiency of funding. Low real funding levels are compounded by sometimes severe deficits in classroom space, numbers and standards of teaching staff, requisite skills to enable the mainstreaming of ICT in education, learning materials, the absence of campus networks and the high cost of access devices.

3.4 Lack of competent human resources

NEPAD's professional development guidelines outline the need for teachers, administrators, education managers and technical staff to develop the skills and competencies required for enabling ICT in education. However, lack of capacity across these stakeholder groups remains a challenge for an ICT-enabled education sector. The shortage of capacity is largely due to the failure of curricula in training institutions to develop the necessary skills, not least because lecturers in such institutions do not yet understand the real needs of the sector. The absence of high managerial and technical skills is a significant challenge facing implementation of ICT projects aimed at school computerisation, the deployment of EMIS, and National Research and Education Networks.

3.5 Lack of incentives

The Integration of ICT in learning will require retraining and impose new time demands on educators at all levels of education. The absence of incentive schemes, especially in environments where salaries and benefits are low, is both a challenge and a major risk to success. The need for incentives extends to innovators who can develop or scale up products and approaches that have demonstrated benefit and potential for sustainability.

[303] Uganda Case Study, Annex Eight.
[304] South Africa Case Study, Annex Seven.

3.6 Technology-led initiatives

There has been a common tendency to use technology specialists to lead the implementation of ICT in education projects, with a resultant focus on engineering or software skills. People who are trained in and understand education have often played a secondary or even peripheral role. Technology-led initiatives may appear successful at the technical level, but will not achieve the expected outcomes and impact in educational terms. They are consequently not sustainable.

An example of this occurs when technically-oriented personnel who have no knowledge of pedagogy are used to train teachers (pre-service or in-service) in the integration of ICT in learning. The training that is then delivered is de-contextualised from educators' work, being treated as a standalone subject. When educators do not develop a clear correlation between what they are learning and their work the training is likely to be ineffective, as they will fail to recognise its value and to transfer skills learned to their classrooms.

Within the field of information, it has been recognised that it is critical to permit those who understand the business processes of an organisation to be the drivers of information systems. This ensures that those information systems are responsive to actual needs. A challenge for the field of ICT in education is to inculcate the same level of awareness that it is those who understand pedagogy – particularly teachers – who should define needs, identify strategies, and drive integration of ICT in education. Technology specialists should provide a supporting rather than a determining role in this process.

3.7 High cost of technology

As outlined in Chapter 2, the cost of technology remains a critical challenge for both educational institutions and learners. Devices that are being produced for low-cost access by the end user, where the biggest challenge lies, are not low-cost for typical schools.

There is also almost total reliance in African schools on technology imports that, more often than not, are designed for developed country markets and environments rather than tailored to the African context. While there has been some progress on the software side of technology, a lot of critical applications are still imported. Open source software offers potential solutions, but there is still a lack of skills (in terms of both depth and numbers of people) for African educators to engage confidently with open source software.

3.8 Limited access to the Internet

Fewer than 12% of Africans were Internet users in March 2011.[305] Bandwidth costs for broadband in sub-Saharan Africa are still thirty to forty times those in the USA.[306] Research ICT Africa reported, in its 2009/2010 sector review, that sub-Saharan Africa trails North Africa, with Internet penetration rates below 3% on average and a broadband penetration

[305] 'Internet usage statistics for Africa', March 2011, http://www.internetworldstats.com/stats1.htm
[306] IEMP, https://confluence.slac.stanford.edu/display/IEPM/New+E.+Coast+of+Africa+Fibre

rate below 2%.[307] It cites low bandwidth and high prices as major challenges, with many countries still relying on satellite communications for bandwidth due to the limited reach of traditional fixed-line networks and lack of access to undersea cables.

Limited access to the Internet results from:

- limited coverage up to and including the last mile (fibre, microwave links, wired and wireless distribution within the campus);
- limited availability of access devices (PCs, laptops, mobile phones, tablets, *etc.*); and
- high recurrent costs for local and international bandwidth.

If effective use of ICT in education is to become the norm, the challenge of access at different levels of educational institutions needs to be resolved.

3.9 Limited access to electrical power

The inadequacy of electric power supply in Africa continues to be a major challenge, which has a huge impact on access to devices and on their running costs. Nearly 600 million people in Africa – about 60% of the continent's population – lack domestic access to electricity. Africa's rural poor are particularly energy-starved, accounting for 88% of those without electricity.[308]

Distribution networks, especially in rural areas, tend to be very limited and, where available, actual supply is intermittent. Wireless and mobile technologies that are very promising in terms of achieving mass access need to have independent access to power.

3.10 Disposing of e-waste

Discarded electronic devices, or e-waste, are a growing problem as ICT becomes more affordable and access grows. The increased consumption of electronic devices, compounded by their short life-cycle, has led to significant increases in e-waste levels. In addition, second-hand electronic goods are imported into Africa and other developing countries, where there is a strong electronic re-use market.[309] Estimates from Greenpeace in 2008 indicated that between 25% and 75% of second-hand electronics imported into Africa arrived in an unusable condition, beyond repair,[310] and environmental groups have claimed that developed countries are using developing countries as 'dumping grounds' for e-waste.[311]

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[307] Research ICT Africa (RIA), Comparative Sector Performance Review 2009/2010', http://www.researchictafrica.net/publications/Policy_Paper_Series_Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_2/Vol_2_Paper_5_-_Comparative_Sector_Performance_Review_2009_2010.pdf

[308] http://www.lightingafrica.org/component/k2/item/22.html?layout=item

[309] Sarah Marriott, 'e-waste: a growing environmental problem for Africa', August 2011, http://www.consultancyafrica.com/index.php?option=com_content&view=article&id=829:e-waste-a-growing-environmental-problem-for-africa-&catid=92:enviro-africa&Itemid=297

[310] Ibid

[311] APC and Hivos (2010), 'Global Information Society Watch 2010: Focus on ICTs and environmental sustainability', http://www.apc.org/en/system/files/gisw2010_en.pdf

The growing volume of e-waste in Africa and methods used for disposing of it present serious environmental and health challenges since these devices contain hazardous or toxic substances. In many countries, for example, e-waste is being disposed in general dump sites where it is liable to be incinerated alongside other solid waste materials.

Several African countries are in the process of drawing up policies regarding electronic equipment. Uganda, for instance, has introduced a controversial ban on the import of second-hand electronic goods.[312] A recent report on the growing environmental problem of e-waste in Africa reviews African responses and points out that that there is an absence of 'effective multi-faceted e-waste policies to respond to this growing problem.'[313]

3.11 Underdeveloped private sector

Private sector stakeholders can participate in teacher training and general capacity development, in the generation and distribution of digital learning resources, in the generation and supply of technology, and in providing backhaul and outsourced technical services to NRENs. However, the private sector in many African countries was suppressed for a long time due to a high degree of dependence on monopoly parastatals and to the lack of government policies to promote the growth of local industry. Technology-based industries also need environments where there are advanced training institutions to support them with both research and a supply of skilled personnel. One consequence is that, while there are now many start-ups, very few countries in Africa have the kind of developed private sector that would effectively support the integration of ICT in education. In sub-Saharan Africa, South Africa stands out as an exception to this – though even that country has its limitations.

3.12 Limited research into impact assessment

There are gaps in research in the use of ICT in education, particularly in the area of impact assessment. Much of what is written has positive biases and is written by members of implementing organisations. There is an ongoing need for rigorous impact evaluation studies on educational technology initiatives in developing countries. Ongoing monitoring and evaluation are required to build the evidence base concerning what works in the long term and what does not. This requires funding and remains a problem when considering the integration of ICT in education.

3.13 Social, Economic and Cultural Issues

Technology tends to reinforce existing social and cultural inequities. As governments move to full integration of ICT in education at all levels, the groups that normally suffer from

[312] See http://www.itnewsafrica.com/2010/04/uganda-effects-ban-on-used-electronics-imports-controversy-continues/ and http://www.balancingact-africa.com/news/en/issue-no-559/computing/ban-on-used-computer/en

[313] Sarah Marriott, 'e-waste: a growing environmental problem for Africa', August 2011, http://www.consultancyafrica.com/index.php?option=com_content&view=article&id=829:e-waste-a-growing-environmental-problem-for-africa-&catid=92:enviro-africa&Itemid=297

technology marginalisation (urban-rural; rich-poor; male-female) are likely to be disadvantaged even more. There is a need to understand and seek proactively to address these challenges.

3.14 Sustainability

As noted in many of the examples provided in this report, sustainability remains a critical challenge. Major government initiatives are sustainable only if they are conceived within the framework of a comprehensive policy and strategy, are owned by political leaders and other stakeholders, have sufficient allocation of resources, are supported by a competent human resource base, take into account all environmental factors, and are well-defined. This is not the case for many ICT initiatives in the education sector.

The failure to look at total cost of ownership has been cited as a major challenge in the evaluation of initiatives and technology acquisitions. Donor-led projects have unfortunately also often failed to consider sustainability.

4 Conclusion

This chapter has drawn out – from the landscape analysis in Chapter 2, the annexes to this report and other sources – specific opportunities that the consultant team believes are worth attention in an African context, while also highlighting critical challenges that need to be taken into account in taking advantage of these opportunities. Conclusions from this analysis can be found in the guidelines and recommendations that are set out in Chapters 5 and 6. Before proceeding to these, Chapter 4 summarises the experience of three African countries which formed the subjects of case studies commissioned for this report: Senegal, Uganda and South Africa.

Chapter 4: Country Case Studies

1 Introduction

Chapter 3 has reviewed the most important opportunities that African countries should consider as part of their strategies for the effective integration of ICT into education. These were grouped under the following five headings:

1) Establishing an enabling policy environment
2) Widening access to ICT infrastructure and connectivity
3) Harnessing ICT to improve management and administration
4) Harnessing digital learning resources
5) Building human capacity

This chapter presents the findings from three country case studies - of South Africa, Uganda, and Senegal – which were undertaken with the aim of clarifying understanding of factors for success and barriers to wider adoption, expressed as lessons that can be drawn from the evidence. Experience in each of these case study countries is reviewed under the same headings as the opportunities presented in Chapter 3, as a basis for affirming good practice and identifying gaps that need to be addressed. This chapter uses only selected illustrations from the case studies which are described in greater detail in Annexes 7 to 9.

2 The case study countries

This first section of the chapter briefly describes the background of the case study countries using the UNDP education indicators and the UNDP Human development Index (HDI). Table 4.1 presents indicators based on the UNDP Human Development Report for 2010[314].

***Table 4.1 : Key Education Indicators for the Case Study Countries*[315]**

Indicator	South Africa	Uganda	Senegal
Adult literacy rate (both sexes) (% aged 15 and above)	89.3	76.4	41.9
Combined gross enrolment ration in education (both sexes) (%)	76.8	62.3	41.2
Expenditure on education (% of GDP) (%)	5.1	3.8	5.1
Internet users (per 100 people)	8.6	7.9	8.4
Mean years of schooling (of adults) (years)	8.2	4.7	3.5
Expected years of schooling (of chidren) (years)	13.4	10.4	7.5

[314] UNDP Human Development Report 2010: http://hdr.undp.org/en/reports/global/hdr2010/;
[315] Country statistics at http://hdrstats.undp.org/en/countries/profiles/ZAF.html; http://hdrstats.undp.org/en/countries/profiles/UGA.html; and http://hdrstats.undp.org/en/countries/profiles/SEN.html

South Africa has a 2010 Human Development Index (HDI) of 0.597[316] and is ranked among countries with medium human development. Both Uganda and Senegal are ranked as countries with low human development, with 2010 indices of 0.422 and 0.411 respectively.

2.1 South Africa

As well as being the most advanced economy in sub-Saharan Africa, South Africa is known to invest heavily in education in a structured and focused manner, and is therefore a country whose experience is relatively likely to provide useful lessons for the rest of Africa. South Africa is highly developed in the use of distance education, and has a strong emerging culture of mobile learning. It is beginning to use its NREN to reach out to schools. For the purpose of this study, South Africa draws out issues in a country which is at a comparatively advanced stage of implementing ICT in education.

2.2 Uganda

Uganda has multiple ICT in education initiatives, but still has a long way to go in terms of effective coordinated implementation. This is not a result of lack of interest: the government of Uganda considers education among its top priorities, and the country was one of the pioneers of Universal Primary Education despite, at the time, objections from major funding agencies. As can be seen from Table 4.1, the level of literacy is quite high, as are the expected years of schooling for children. Uganda was selected as a case study country in expectation that it would draw out lessons for those countries where there has been some effort to introduce ICT in education but where there is no coordinated framework.

2.3 Senegal

Senegal has been one of the early pioneers of ICT in education, whose first efforts in this field (the LOGO Project which started to introduce computing to elementary schools) date back to 1982. Senegal, according to all indications in the literature, has a vibrant education sector. It also seems to have adopted a more holistic approach to education (and ICT in education). However, Table 4.1 shows that actual performance remains low in terms of literacy, gross enrolment ratio, mean years of schooling for adults, and number of years at school for children. It therefore seems that there has been limited real progress in the country.

3 Establishing an enabling policy environment

Successful integration of ICT in education requires cross-sectoral collaboration and detailed sets of policies. The approaches taken in each of the case study countries are examined below.

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South Africa

While responsibility for the management of schools is shared between national and provincial government in South Africa, all priorities and programmes are in line with national policy determined by the national Department.[317] Since 1994, the school curriculum has undergone comprehensive changes to make it responsive to the education of a diverse range of learners and to the needs of the 21st century labour market.

The *e-Education White Paper* of 2004 stressed the benefits of ICT for teachers, learners, managers and school administrators, especially with respect to the use of ICT in enhancing the quality of the teaching and learning process. This was also emphasised in the National Education Policy Act of 1996, which promoted enhancements in the quality of education and educational innovation,[318] and in the Further Education and Training (FET) Colleges Act of 2006, which stipulated that FET institutions should strive to provide education that meets the skills needs of the country.[319] Alongside these, the *White Paper on Science and Technology* (1996)[320] postulated benefits in terms of national innovation, while the *Public Service IT Policy Framework* (2001)[321] highlighted the benefits of ICTs for government administration and access to government services by citizens.

The skills shortage in ICT has been raised as a concern by the Accelerated Shared Growth Initiative for South Africa (ASGISA).[322] ASGISA has located this skills shortage within the whole education context, from primary to tertiary education and emphasised that, to alleviate skills shortages in ICT, schools and FET colleges will have to play a critical role in building the skills of learners and in motivating them to pursue ICT-related careers. The importance of ICT in the workplace is reflected in policies like the *Public Service IT Policy Framework* of 2001, whose vision of modernised government is one that enables citizens to access government services 24 hours a day using various ICT tools.[323]

To address content issues, the South African government has approved a policy and strategy for Free and Open Source Software (FOSS). FOSS has been proposed as a means to enable South Africa to develop content and programmes in education using local languages.

The importance of connectivity is recognised by the *e-Education White Paper*, which also specified that the Department of Basic Education (DBE) should support refurbished facilities for second-hand computers and set minimum specifications for refurbishments.[324] The cost of connectivity is addressed by the e-rate, which was formalised in the Electronic

[317] GCIS. (2011). South Africa Yearbook 2010/11, Education, Chapter 7, pp150 – 169: http://www.gcis.gov.za/resource_centre/sa_info/yearbook/2010-11.htm
[318] DoE. National Education Policy Act, No 27 of 1996. Retrieved 18 July 2006 from http://www.info.gov.za/acts/1996/a27-96.pdf, Section 4l
[319] FET Act. Retrieved 20 July 2007 from: http://www.info.gov.za/gazette/acts/1998/a98-98.pdf, Preamble
[320] This can be found at http://chet.org.za/manual/media/files/chet_hernana_docs/South%20Africa/National/Science_Technology_White_Paper%20SA.pdf
[321] *Electronic Government – the Digital Future*, at http://www.info.gov.za/otherdocs/2001/it.pdf
[322] http://www.info.gov.za/asgisa/
[323] Public Service IT Policy Framework. Available from: http://www.info.gov.za/otherdocs/2001/it.pdf, p.4
[324] DoE. 2004. White Paper on e-Education – Transforming learning and teaching through Information and Communication technology. Government Gazette, Vol. 470, No. 26734. Pretoria: DoE, p.30

Communications Act of 2005[325] to alleviate connectivity costs for schools. In addition to this, through the State Information Technology Agency (SITA) Act, 88 of 1998, SITA is mandated to help the DBE to access technologies in a manner that 'leverage economies of scale to provide cost-effective procurement.'[326] Power is also a requirement, and the *e-Education White Paper* stipulates that the Department of Education should work closely with the Department of Minerals and Energy to prioritise electrification of General Education and Training (GET) and Further Education and Training (FET) institutions.

While the discussion here does not detail all of the policies described in Annex 7, it demonstrates that South Africa has a number of cross-sectoral and mutually supportive policies that create a strong environment for the integration of ICT in education.

Successful implementation of policy requires enabling institutional arrangements. South Africa has a number of public entities and agencies concerned with ICT, and a national commission to advise on ICT development in the country. There are also agencies that support ICT in education as part of their mandate. The Universal Service Access Agency of South Africa (USAASA), established under section 58 of the Telecommunications Act (1996), manages the Universal Service and Access Fund, which is dedicated, *inter alia*, to equipping school computer laboratories including access to the Internet.[327] The Presidential National Commission on Information Society and Development (PNC on ISAD), constituted in 2001,[328] has a mandate to focus on policy and development of ICT in priority areas of e-government including: e-health; e-education; small, micro and medium enterprises (SMMEs); and content development.

Uganda

Uganda, by contrast with South Africa, has a fragmented approach to ICT in education. Uganda first developed a National ICT Policy framework in 2003,[329] which recognised the potential of ICT in supporting development across different sectors. The development of an education sector-specific ICT policy in 2005[330] was another outcome, although, at the time of this study, the draft document is still with Cabinet and has yet to be ratified. The draft policy document aims to coordinate the disparate ICT projects which are taking place within the sector, leveraging the potential role of the private sector to deliver much needed investment in light of limited investments from government. It touches on a range of issues that need to be addressed in providing a supportive environment for integrating ICT in education. These include legal and security aspects, infrastructure, curriculum revision, and ICT skills training for teachers at different levels.

The issue of Uganda's ICT in education policy was a matter of debate during the national workshop held as part of this study. Many participants thought that Uganda lacked a

[325] http://www.info.gov.za/view/DownloadFileAction?id=67890
[326] State Information Technology Agency (SITA) Act, 88 of 1998. 2005. Government Gazette No 28021, p.16
[327] The DOC. Public agencies and entities. Available at: http://www.doc.gov.za/index.php?option=com_content&view=article&id=427&Itemid=509
[328] IST Africa. Regional impact of information society technologies in Africa: http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=3574
[329] http://www.ucc.co.ug/nationalIctPolicyFramework.doc
[330] http://www.education.go.ug/ICT/ICT%20policy%20July%2005.pdf

unified national direction with which to deal with ICT in education. One participant, Paul Muyinda, aptly summarised this as 'Government needs to be switched on.'[331] Another attributed it to the fact that most of those currently making decisions today were trained at a time when ICT was not used in education and so do not appreciate the need. While Ministry (MoES) officials pointed out that a policy document had been prepared, the workshop agreed that this has been pending approval by Cabinet for a rather long time. Uganda is therefore still at the starting stage with respect to integration of ICT in education.

Senegal

Senegal is ahead of Uganda in terms of setting up the necessary policy environment. The Ten Year Education and Training Programme (PDEF) (2003) of the Ministry of Education[332] includes objectives for the connection of schools to the Internet, development of computer education, use of ICT in education to improve teaching and learning, use of ICT for school management, and development and implementation of a blueprint for an information system for the sector.

Senegal has now developed a policy for the education sector (2009),[333] along with a master plan.[334] It would appear that the critical policies that Senegal would use as a basis for integrating ICT in education are recent (2009) and just moving to the implementation stage, which would explain the fact that important indicators do not yet identify Senegal as an example to emulate. Outside this, a comparison with the wide range of policies to enable ICT in education which South Africa has in place points to likely implementation failures: a policy that only covers ICT in education cannot of itself create the environment required to support success.

4 Widening access to ICT infrastructure and connectivity

The critical elements of access include user devices, a connectivity platform (mobile or wired, the latter including optical fibre) and power.

South Africa

Alongside a vibrant private sector, the government of South Africa has invested a lot of money to develop South Africa's telecommunications sector. SANReN, TENET, and the new approach of reaching out to schools by TENET have been discussed in Chapter 2. ICT roll-out is also dependent on power supply, and South Africa has made great strides in the electrification of schools: in 2009, of the 24,460 public schools in the country, 20,857 had electricity.[335]

[331] Uganda Case Study, Annex 8.
[332] http://www.gouv.sn/IMG/pdf/pdef-ept.pdf
[333] http://www.education.gouv.sn/politique/Fichiers/PDI.pdf
[334] http://www.education.gouv.sn/politique/sdi.html
[335] DBE. (2009). National Education Infrastructure Management System Report, 2009. Available at: http://www.education.gov.za/LinkClick.aspx?fileticket=p8%2F3b6jxko0%3D&tabid=358&mid=1263

Several initiatives have supported ICT access for schools. In 2009, there were 5,714 public schools with a computer centre, constituting 23% of all public schools. This means that these schools had computers that they could use for administration and preparation of teaching and learning resources. However, of these schools, only 2,449 (10% of public schools) had computer centres that were adequately equipped, *i.e.* with an adequate number of computers and other technologies for classroom teaching and learning.[336]

A national project of note, with provincial input for implementation, is the Dinaledi Schools project. This was launched in schools through the 2001 Mathematics, Science, and Technology strategy, aimed at improving learner achievement in these subjects in high schools. To achieve this objective, Dinaledi schools are well resourced with teaching and learning materials, including computer laboratories. Currently, there are 500 Dinaledi schools nationwide.[337]

In all, 3,161 South African Schools had Internet connectivity in 2009.[338] 1,700 of these schools were linked to the e-Schools network. This offers an email service, SchoolMail, which creates a mailbox for all the learners and teachers in a school for an annual fee of R1,050.[339]

Because of the high penetration of mobile technology in the country, especially among the young, South Africa is piloting projects that make use of mobile technology for learning. South African universities are also making use of mobile technologies to support academic administration and community work. At the University of Cape Town, in a project run by CET, mobile phones are used to enable students to text questions that they would otherwise not ask in a face-to-face session. These questions serve as feedback on learning to the practitioner. This project is designed with a Web and mobile interface, where practitioners post announcements on a virtual notice board and which students can acces by SMS. Academics also use SMS to send notifications about online resources and lecture scheduling.[340]

Based on the numbers cited above (such as the percentage of schools with access to electricity and having computer labs), South Africa has now gone beyond the pilot stage of initiatives to national rollout.

Uganda

Uganda, by contrast, has not seen any government effort to date that seeks to extend Internet connectivity to schools. The initiatives identified, with the exception of those of the Uganda Communications Commission, are all donor driven. Fibre backbones in Uganda are still far from achieving full national reach, leaving wireless access either via VSAT or the

[336] DBE. (2009). National Education Infrastructure Management System Report, 2009. Available at: http://www.education.gov.za/LinkClick.aspx?fileticket=p8%2F3b6jxko0%3D&tabid=358&mid=1263

[337] Sibiya, S. (2009). Dinaledi school project performance report for the 2008 national senior certificate Mathematics and physical science. Available at: http://www.thutong.doe.gov.za/Default.aspx?alias=www.thutong.doe.gov.za/dinaledischools

[338] ibid

[339] e-Schools network. About the e-Schools Network: http://www.esn.org.za/

[340] http://www.cet.uct.ac.za/projects

mobile network operators as the most common options for Internet access. In addition to this challenge, the overwhelming majority of schools at all levels, both primary and secondary, lack access to both the Internet and power. Rural schools are especially marginalised with respect to connectivity and access.

Uganda's main connectivity device is the mobile phone. The Uganda Communications Commission (UCC) estimates that 100% of the population is now within reach of a mobile network.[341] Wherever the mobile network goes, data services of varying capacity and quality are offered, the most advanced being within the major urban centres. Not surprisingly, the mobile platform is the most commonly used means of accessing the Internet. It should however be noted that mobile phones are banned in schools.

Access to power remains a limiting factor: the power grid has only 400,000 registered customers nationwide. Even with these, the grid can only provide about 60% of normal demand, leading to extensive load-shedding.[342] In the national workshop for this study, participants were vehement about the lack of reliable power. One participant, Daniel Kakinda from SchoolNet Uganda, noted during the workshop that, 'in urban areas where the grid is, load-shedding is unpredictable.'

Connectivity and access initiatives in Uganda include Connectivity for Educator Development (Connect-ED),[343] a project that was funded by USAID as part of the Education for Democracy and Development Initiative (EDDI). This project ran from 2000 to 2003 (with a no-cost extension into 2004), with the aims of integrating computers into the teaching methods of Primary Teacher Colleges (PTCs) and of building staff capacity to create materials and use them in teaching activities. Connect-ED created multimedia and computer laboratory facilities at the Institute of Teacher Education, Kyambogo (then ITEK, now Kyambogo University) and eight other Primary Teachers Colleges (PTCs) across the country. Each laboratory was equipped with a 64kbps Internet connection. The project developed a computer literacy course that was offered at each of the PTCs and trained some support staff. The intervention was really nominal: on average each PTC had about 300 students to about 10 PCs, limiting individual access to a level that negated effectiveness.

The Research and Education Network of Uganda (RENU) has plans to reach out to all levels of education, by providing backbone connectivity derived from capacity on the national fibre backbone. The Rural Communication Development Fund (RCDF), which is managed by the Uganda Communications Commission, has sought to introduce ICT laboratories within schools in line with the National ICT Policy. One such project is the School-based Telecentres Project that was implemented from 2004 to 2009 by SchoolNet Uganda.[344] Schools were provided with ICT laboratories, but with a requirement that the surrounding community could use the laboratory after school hours and over the weekend. Since the target areas were all rural, connectivity was provided via VSAT to five rural schools.

[341] Uganda Communications Commission, End of year performance review 2010: http://www.ucc.co.ug/endOfFYReview2011.pdf
[342] Data from the Electricity Regulatory Authority, Uganda
[343] http://pdf.usaid.gov/pdf_docs/PNADC164.pdf
[344] http://schoolnetuganda.sc.ug/projects/on-going-projects/school-based-telecentre-project.htm

The Uganda Connectivity (UConnect) Project, an initiative of Mission Mobile Education in Europe started in 1995, started out as a computer literacy project targeting schools in rural areas.[345] The project set up computer laboratories using donated computers and solar panels in rural schools in northern Uganda. Later, UConnect launched a mobile component – an old Swiss Army truck loaded with PCs that could connect to the Internet via dial-up modem – which became its enduring image. The truck could drive anywhere, set up shop and tutor local residents on how to use PCs and connect to the Internet.

What emerges from the Ugandan experience is a series of pilot projects that have not moved to the stage of large-scale roll-out. There is also a lack of information about whether or not project objectives were achieved in each case.

Senegal

In Senegal, expanding access to computers and connectivity is an important element of ICT integration in the education sector, with government and private sector operators playing a joint role. Telephone companies are the main players in the extension of Internet connectivity to schools in Senegal, rolling out broadband GSM and CDMA networks. There are over 3,000 kilometres of optic fibre cable across the country. Some illustrative examples of initiatives that have led to the introduction of computers and connectivity are highlighted below.

World Links,[346] launched in 1997 by the World Bank in partnership with the Ministry of Education, provided (mainly) second-hand computers to more than 45 middle, high and elementary schools. The World Links project comprised computer literacy, maintenance of computers and capacity building for over 500 teachers.

Another project, which targeted the pre-primary age group, was Case des tout-petits[347] (Hut of Toddlers), launched in 2000 in partnership with the Waterford Institute. This project focused on providing early learning to four- and five-year-old children. The initiative supplied 427 schools with multimedia tools (computers, microphone, video-projector, DVD reader, and headphones).

The TEAM-9 project was initiated in 2004 and was aimed at promoting educational connectivity between nine countries – eight in Africa (Burkina Faso, Chad, Cote d'Ivoire, Guinea Bissau, Mali, Senegal) as well as India.[348] It provided equipment to 99 schools in Senegal, each school typically being equipped with 20 computers connected to the Internet, allowing online learning led by Indian teachers, in addition to the five regional university centres.

[345] www.uconnect.org
[346] http://www.world-links.org/regions/africa/senegal
[347] Hut of Toddlers similar to a Kinder garden for the little ones from the age 18 months to 6 years; see also http://www.case-toupetit.sn/etat_des_lieux.html#Accès
[348] http://www.eximbankindia.com/press040707.asp

The USAID Basic Education project (USAID/EDB)[349] is a five year initiative launched in 2008. The project aims to support the Ministry of Education to improve the quality of education in middle schools within the framework of the PDEF. The project has multiple components, one of which is the provision of computer laboratories and WiFi Internet access to 408 middle schools within ten of the fourteen regions of Senegal. It is the largest ICT project implemented in schools in partnership with the Ministry of Education. The intention is to enable all of the schools in the southern regions to have computer laboratories connected to the Internet.

The Sankore project, which started in 2009 with the support of France, will implement 350 digital classes by installing whiteboards and projectors into schools.[350] The project began in elementary schools and the first training activities took place in June 2011.

Like Uganda, Senegal has seen implementation of a number of externally funded and standalone projects, despite the existence (in the case of Senegal) of an ICT in education policy. This is not surprising: externally funded projects tend to follow the agendas of the funding agencies.

5 Harnessing ICT to improve management and administration

South Africa

South Africa has management information systems for the various educational sectors. The Department of Basic Education (DBE) has an Education Management Information System (EMIS) which is used for the acquisition, processing, dissemination and reporting of education data.[351] The EMIS collects data from ordinary schools, adult education and training, inclusive education, early childhood development, and further education and training institutions at provincial level. These data are analysed and consolidated at national level.

The Department of Higher Education and Training (DHET) has a Higher Education Management Information System (HEMIS). HEMIS provides data on higher education enrolment, graduation and staffing. The FET College Management Information System (FETMIS) is used by FET colleges to capture survey information electronically. The South African Schools Administration and Management System (SA-SAMS) is a 'robust computer application designed to meet the management, administrative and governance needs of public schools in South Africa.'[352] Information input into SA-SAMS by schools enables the provincial and national departments to access quick and up-to-date data for snap and annual surveys that enable appropriate educational planning.

Uganda

[349] United States Agency for International Development
[350] http://sankore.org/actualites/reception-et-installation-de-350-classes-numeriques-sankore-au-senegal
[351] DBE. EMIS. Available at: http://www.education.gov.za/EMIS/tabid/57/Default.aspx
[352] Government IT. (2009). ICT in Education, December 2009. Available at: http://www.it-online.co.za/content/view/1771114/76/1/4/

Since 1999, the Ministry of Education and Sports in Uganda has had a number of projects aimed at improving EMIS, all funded by different development partners. Data are collected through an annual census carried out across schools. After analysis, the resulting information is used to plan and monitor various activities across the education sector.[353]

The World Bank funded the project during 1999-2001, with an emphasis on creating EMIS at MoES headquarters. DFID support from 2001 to 2003 emphasised decentralising EMIS to the districts. With support from USAID between 2004 and 2005, attention was given to creating a strategic plan and building GIS capability into the existing EMIS. More recently, MoES has received a new USAID grant to further enhance the current EMIS. Unfortunately the implementing partner, the Academy for Educational Development (AED), was suspended by USAID and the project is currently on hold.[354]

EMIS in Uganda has faced several challenges, including unreliability of data, challenges in decentralisation relating to human capacity in EMIS and equipment maintenance, and challenges in sustainability relating especially to connectivity costs. Additionally, all data are only used at the centre – they are not used to support decision-making by schools or districts.

Senegal

Compared with Uganda, Senegal has achieved considerable progress in the deployment of EMIS. The Computer Unit of the Ministry of Education (CIME) is responsible both for the development of ICT in education and for the adoption of applications for managing educational resources. There are systems in place for collecting all education-related data. These data are integrated with spatial data on pre-schools, elementary, secondary middle and high schools using GIS tools. To do this, cartographical coordinates of these entities are collected through GPS and transferred to the computer through the application GPS Utility.

EMIS systems deployed in Senegal include StatEDuc, an educational statistics project comprising input, data editing and processing interfaces. The input interface provides data integration from multiple sources and years, carries out consistency checks and school-level data entry while the editing interface provides data-cleaning and consolidation. StatEDuc is also used to provide information on demand, and to develop a national educational statistics and projects database, by the National Agency of Statistics and Demography (ANSD). Another application is Finpronet, a software package for financial management and accounting developed within the Microsoft.Net platform. It consists of modules for general accounting, cost accounting, costing, budget preparation, budget monitoring, monitoring of agreements, asset management, financial statements, contract management, and disbursement. Human resource management is handled using *Fichier unique du personnel* (FUP).[355] The application was made available through the Human Resources Directorate of the Ministry of Education and shared with all stakeholders at regional level. It was developed internally using Microsoft Access and SQL server.

[353] http://www.education.go.ug/EMIS.htm
[354] http://www.usaid.gov/press/releases/2010/pr101208.html
[355] Staff unique file

Other internally developed applications include those aimed at managing examinations. For example, the Best Grade application is widely used at school level to enter student data and produce documents such as transcripts, school attendance certificates and ID cards. Another application that is widely used by private schools is MS Dara, which allows schools to track student attendance, student performance, schedules, class size and other data related to students' needs.

6 Harnessing digital learning resources

South Africa

In South Africa, as mentioned in discussion of the enabling policy environment, the government has approved a policy and strategy for Free and Open Source Software (FOSS). Open Source Software is also proposed to enable South Africa to develop content and programmes in education using local languages. By September 2009, more than half of government departments had FOSS implementation plans, about 25% of the departments used FOSS servers, 40% used FOSS at the back end, and 12% on desktops. [356]

Several initiatives provide free educational resources. Through this, South Africa is witnessing a growth in the open educational resources (OER) movement, where educational resources are made available under open licences. While not all materials being freely and openly made available are labelled as OER or have open licences, many are effectively OER because they are available for re-use by others free of charge. The Thutong portal, the Mindset Network, and the Siyavula project are highlighted here as examples.

The Thutong portal has resources on curriculum and examinations, teacher development, school administration and management. In 2010, the Thutong Portal provided over 14,000 digital content resources, had 10,000 registered users and averaged 80,000 hits a month. There are 84 learning spaces on the portal, including a dedicated space for Matric support.[357]

Mindset Network, an NGO founded in 2002, has been distributing high-quality materials for the schooling and health sectors openly and freely. Mindset Network has three primary projects specifically targeting the education sector, addressing different subjects and target groups.[358]

The Siyavula project,[359] founded in 2008, is a Shuttleworth Foundation project focused on working with teachers to develop teaching and learning materials collaboratively and share them through an open licence agreement. Siyavula has partnered with Connexions,[360] a

[356] Webb, A. (2009). Where is FOSS today? Presentation at the WITS FOSS awareness event, September 2009. Available at: http://presentations.wits.ac.za/usrfiles/webpresent/gen13Srv42Nme14_5006_1251975494/gen13Srv42Nme14_5006_1251975494.pdf

[357] Mosuwe, E. Progress on the implementation of ICT in education in South Africa. Presentation at SITA GovTECH 2010. Durban International Convention Centre, 5-8 September 2010.

[358] Mindset Network – programmes, available at: http://www.mindset.co.za/about

[359] http://siyavula.org.za/

[360] http://cnx.org

pioneer in OER, to extend its education portal to serve as the foundation for the Siyavula community of teachers. Siyavula has over 4,500 Grade R to 12 OER in English and Afrikaans, with some materials translated into Xhosa, aligned to the South African curriculum, accessible from the Connexions portal.[361]

Some universities are also actively producing open educational resources. CET is running the OER UCT project with support from the Shuttleworth Foundation, to showcase the teaching of UCT academics by encouraging them to publish their teaching resources as open educational resources.[362] UCT's Faculty of Health Sciences and UWC's School of Public Health have, in the past two years, been actively involved in the production of Health OER in a project driven by the OER Africa initiative of the South African Institute for Distance Education (Saide) and the University of Michigan.[363] Saide has also spearheaded the production of open source teacher education materials through the AceMaths project, which was a collaboration between Saide and several universities to develop materials that could be openly used and adapted for reuse in universities. Uptake of the AceMaths materials has been very good. There were 266 users of the materials in 2003, and, in 2009, uptake had risen to 2,233.[364]

Uganda

In Uganda, MoES has improved the quality and relevance of local materials by stimulating the local publishing industry, defining curricula, creating standards for educational materials, and procuring them locally. However, this and other initiatives are standalone, not being driven by an overall policy and strategy direction. The only noteworthy example is CurriculumNet.

CurriculumNet was a pilot project of the National Curriculum Development Centre (NCDC)[365] to explore an ICT-based curriculum delivery strategy for primary and secondary schools. The goal was to develop, test, and implement online resources that are directly linked to curricula at both primary and secondary school levels, and thereby explore how an ICT-based curriculum could support the growing number of students brought into Ugandan schools by the Universal Primary Education (UPE) policy. IDRC and the Open Learning and Information Network, both from Canada, funded the project which ran from 2001 to 2005. Critical challenges included the low level of ICT literacy among staff in different schools, lack of connectivity and computers (one computer for 40 students), and irregular power supply. Resources to maintain the computers that were critical for classes had also not been provided for in budgets. The project nevertheless produced content in a variety of formats, including CDs, websites and print, at the school level.

Senegal

[361] http://cnx.org/lenses/siyavula
[362] CET. OER UCT: http://www.cet.uct.ac.za/oer
[363] Harley, K. (2011). 2010 – 2011 African Health OER Network, Phase 2 Evaluation: Consolidation and Sustainability. Research Report. Available at: http://www.oerafrica.org/healthproject/HealthProjectHome/tabid/956/Default.aspx
[364] Welch, T. (2011). What are we learning about OER in teacher education? Presentation at the OER convening Meeting, 16 -18 May 2011, Safari Park Hotel, Nairobi, Kenya.
[365] http://www.ncdc.go.ug

Senegal, while still much less advanced than South Africa, has progressed further in digital learning resources than Uganda. At the national level, the Ministry of Education has collaborated in the development of an education portal through which teachers can download learning resources and adapt them to local needs. The portal also provides a training space that allows teachers to take courses, participate in collaborative work and engage with peers and experts.

The Association for the Promotion of Open Educational Resources Africa (APRELI@)[366] is active in Senegal, its main objective being to support the development of OER competence. This association aims to build the capacity of teachers in the development of Open Educational Resources and related pedagogical innovation, and to promote dialogue and exchange of information on digital resources. APRELI@ provides, through a portal, a forum for information and digital content sharing, dialogue and mutual support.

7 Building human capacity

South Africa

One of the critical features of teacher education in South Africa is the National Framework for Professional Teacher Education and Development (NFPTED), which specifies how ICT can be used to widen access to teacher education, improve teacher learners' motivation, speed up communication, and provide an enriched environment for learning.[367] In keeping with current thinking, ICT professional development has been integrated into pre-service teacher education by some universities, and there are also many opportunities for in-service teacher professional development in ICT. For example, the University of Johannesburg (UJ) and the University of Pretoria (UP) offer pre-service and postgraduate courses in ICT integration as part of their teacher training programmes. UJ has three qualifications focusing on ICT integration:[368] the Bachelor of Education Honours degree (B.Ed. Hons), a postgraduate degree completed over a period of two years on a part-time basis, and the Advanced Certificate in Education (ACE). Educational Computing, delivered on selected Saturdays, and contact sessions are compulsory.[369] The ACE is mainly for in-service training.

Training by universities in ICT teacher professional development has been complemented by the efforts of SchoolNet South Africa (SNSA), which has played a leading role in the development and facilitation of innovative professional development programmes in ICT integration and school ICT leadership. What differentiates SNSA from university training is that SNSA trains most teachers at their sites of practice, and that there is a very strong evaluative element to its training, to judge its effectiveness. SNSA manages three large

[366] http://www.aprelia.org/
[367] DoE. 2007. The National Policy Framework for Teacher Education and Development in South Africa. Pretoria: DoE, Section 43
[368] University of Johannesburg. Faculty of Education. B Ed Degree: http://www.uj.ac.za/LinkClick.aspx?fileticket=hKI8qrrPOxY%3d&tabid=2896
[369] University of Johannesburg. Faculty of Education. Advanced Certificate in Education (ACE), Educational Computing: http://www.uj.ac.za/LinkClick.aspx?fileticket=vz02wxqkngg%3d&tabid=10532

teacher development programmes:[370] Intel Teach, which is based on face-to-face or distance delivery; Microsoft PiL, based on a range of selected courses designed for teachers, school management, district officials and technical support champions; and the Commonwealth Certificate for ICT Integration, which is an ACE-level distance learning qualification for teachers and school leaders to achieve integration of ICT into school management, teaching and learning.

Possibilities for informal learning and acquisition of ICT skills that could ultimately influence ICT integration are being created through the Teacher Laptop Initiative (TLI), implementation of which is now underway.[371] The TLI is open to all permanently employed teachers under the Employment of Educators Act. The minimum purchase price for specified laptops, over 60 months, is R11,750. The government provides teachers on this scheme with a monthly allowance of R130 (about US$20) to assist with repayment for their laptops, based on the cost of R195.83 a month for repayments.[372] Owning their own laptops is likely to lead teachers to engage in informal learning at their own pace, in their own time, using these laptops, thereby improving their ICT skills in ways that will benefit their learners.

Other informal professional development activities are available through communities of practice. The Thutong portal, for example, which was described earlier in this chapter, has a strong focus on online communities of practice through discussion fora and blogs, where teachers can share ideas on 'best practice' and resources.

Uganda and Senegal

While both Uganda and Senegal have initiatives aimed at building the capacity of teachers, both countries appear to focus on computer literacy among teachers rather than the pedagogic issues around ICT in learning.

Uganda has remained at the small-scale pilot level, without any visible plan or strategy for national level expansion. It has participated in projects including Connectivity for Educator Development (Connect-ED), CurriculumNet, and Uganda Connectivity (UConnect).

Senegal, in addition to participating in international programmes like Microsoft PiL and iEARN, has some national level initiatives that address both pre-service and in-service training. The Senegal case study author observes that:

> *It is still difficult for teachers to integrate ICTs in teaching and learning processes and contribute to the digital content. Most of new teachers who need to be trained are in rural areas and, they do not have enough funds to go to the training centres in the urban areas in addition to the electricity, and Internet connection problems.*[373]

[370] SchoolNet South Africa. (2010). Empowering teachers through ICT integration. Available at: http://www.schoolnet.org.za/
[371] http://www.teacher-laptop.co.za/
[372] Department of Education. (2009). *Teacher Laptop Initiative Policy*. Government Gazette No 32007, 8 May 2009.
[373] See Annex 9.

8 Lessons from the case study countries

The case study countries – with their mixture of successful and less successful initiatives – bring out the following lessons. Not surprisingly, these echo some of those drawn in earlier chapters.

1) A robust policy environment that supports the e-education policy is an enabling, but not sufficient, condition for ICT roll-out in education. In addition to this, policies in other sectors are required to create the necessary environment. A comparison between South Africa's and Senegal's ICT in education policy environments illustrates this clearly. While it is true that Senegal is much poorer than South Africa, this alone does not explain the widely different levels of success and progress.

2) Policy requires supportive institutional arrangements that may necessitate coordination at the centre. Universal access to ICT, for example, should be linked to universal access to power, but these fall under different agencies reporting to different ministries.

3) ICT integration in education requires national budget support as well as nationally driven partnerships with the private sector. Total reliance on donor-funded projects, which are necessarily driven by differing donor agendas, will lead to standalone projects that are not sustainable.

4) National ownership and sustainability planning are critical in all initiatives if they are to go beyond the novelty pilot level to nationwide projects that have real impact.

5) The successful integration of ICT in education requires a change of focus from computer literacy for teachers to understanding ICT integration in education from the pedagogic perspective.

9 Conclusion

This chapter has used three case studies, which have considered countries at different stages of development, to tease out lessons in good practice, reinforcing earlier findings based on the landscape analysis. The next chapter presents a methodology and guidelines for the integration of ICT in education that draws on these and lessons discussed elsewhere in this study.

Chapter 5: Suggested guidelines for integration of ICT into education

1 Introduction

Chapter 3 identified a number of significant opportunities in the use of ICT in education in Africa. This chapter follows on from that discussion by presenting some generic guidelines for the integration of ICT into education, taking into account the realities a) that different African countries have their own unique needs and b) that they have already taken what are often very different approaches to ICT investments in education. These guidelines should be read in conjunction with the Guidelines for Good Practice developed by the New Partnership for African Development's (NEPAD's) e-Schools Initiative, which have already defined a set of generic guidelines through a wide-ranging consultative process. For ease of reference, these NEPAD Guidelines are re-printed in Annex 11 to this report.

The opportunities presented in Chapter 3 and the country case studies described in Chapter 4 have illustrated a number of ways in which effective deployment of ICT has potential to address critical barriers which impede the improvement of education in African countries:

1) **The Internet can connect Ministries of Education with educational institutions (including schools, colleges, and universities)**. It can also interconnect institutions nationally, regionally, and globally – both to enable the sharing of resources (content and infrastructure) and for collaboration (in education and research). Thanks to the spread of mobile cellular networks, more and more institutions lie within reach of at least low-speed Internet connectivity which enables email, messaging and downloads of limited size. As a result of this, and of the proliferation of access devices described in Chapter 3, connecting all schools is becoming an increasingly viable proposition for all African countries. Combined with the kind of dedicated high speed backbones operated by NRENs, such connectivity enables administration and management, resource sharing and other types of collaboration.

2) **Increased communication and information sharing can help improve low-performing schools.** The review of strategies to harness ICT to improve management and administration which is summarised in Chapter 3 and detailed in Annex 5 demonstrates how widespread 'ICT infrastructure' can help to strengthen Ministry of Education management, while supporting school management and monitoring to increase educational institutions' accountability. Good information about the education system helps to identify strong performers in specific areas, while flagging weaknesses in others. Data on schools' internal efficiency – such as dropout rates, test performance and benchmarks – is useful to guide local actions to improve performance. Widespread ICT infrastructure can also support the sharing of content and good practice, as well as the delivery of teacher training and institutional capacity building.

3) **Increased use of ICT can enhance the management and administration of educational institutions.** Improved use of the Internet, computers and mobile and wireless

technologies can also enhance data gathering, analysis and use at the level of schools, colleges and universities. It can facilitate better planning, monitoring, and resource allocation by district, regional and federal education administrators.

4) **Digital curriculum resources can help educators and learners.** Annex 4 describes a range of examples of ways in which digital curriculum resources, particularly those released under open licences, are creating opportunities to improve the quality of educational delivery across all education sectors.

Investing in ICT in African education systems can therefore help to address challenges of high inequality, low institutional capacity, lack of capacity of educators and lack of access to curriculum materials and learning resources, as well as low levels of reporting of (even basic) school management and financial information.

2 Common needs in African education systems

Drawing on the analysis presented in previous chapters, it is possible to define generic underlying needs of education systems in Africa, which provide a useful starting point for guiding ICT in education initiatives. It is important to recognise that these are not concerned with ICT *per se*, but rather with defining systemic priorities, where investments in ICT can contribute to meeting diverse countries' varied educational needs. Identifying these needs should help to ensure that investment in ICT does not become an end in itself, but is focused on solving real social challenges. It is essential that thorough analysis is undertaken within individual countries as part of the planning process. However, the following generic needs are likely to be common across most – if not all – countries on the continent:

1) Providing all learners with access to quality education, regardless of their geographical location or income level:

    a) Learners need to be provided with access to the resources (harnessing all media as appropriate) and learning opportunities needed to meet the requirements of the national curriculum successfully.
    b) Learners need to leave education systems as ethical, discerning and responsible users of information, as well as being capable of making use of ICT.
    c) Learners with special requirements (such as those with barriers to learning or those in remote or rural schools) and their educators need to have access to specialised resources and to networks of specialist support.
    d) Education should make a measurable contribution to the growth and development of the national society and economy through skills and capacity building.
    e) African countries should participate as vibrant members in global intellectual discourse and the ongoing development of knowledge about education and its role in socio-economic development.

2) Building educators' capacity to teach effectively:

a) Educators need to be provided with or have access to the necessary resources (harnessing all media as appropriate), tools, and information for teaching to create effective learning opportunities for learners successfully to meet the requirements of the national curriculum;
b) Educators need to enhance their skills for curriculum delivery. A large majority of them need to strengthen their subject knowledge base, pedagogical content knowledge, and teaching skills. A sizable proportion of them need to develop specialist skills in areas such as health and physical education, diversity management, classroom management and discipline. Many need to renew their enthusiasm and commitment to their calling.
c) Non-core teaching responsibilities of educators need to be reduced and the workload of educators needs to be streamlined to enable them to discharge their core function as educational professionals.
d) Effective communities of practice need to be created amongst educators and sustained to enable them to benefit from exposure to quality teaching and learning methodologies, professional dialogue with peers, and ongoing sharing of information, ideas, and resources.

3) Enhancing Logistics and Operations:

a) Streamlined, rapid, and reliable communication and flow of information are essential – both up and down the information chain – between national, provincial, district and institutional levels[374] in order to ensure the effective operation of the education system.
b) Institutional administrations should adhere to agreed minimum standards. They should use labour-saving tools that both reduce the time required for administration and improve administrative performance.
c) Reliable, accurate and timely management information is needed to facilitate effective management and decision-making within the education system and to improve the transparency of operations. To achieve this, it must be possible to convert data into information in ways that enable improved decision-making.
d) Flexible access to:
   i) human resource information;
   ii) financial information; and
   iii) management and administrative information
   is needed at institutional, district, provincial, and national levels to allow efficient reporting, operational management, and decision-making.

2.1 Considering strategic objectives

Using the NEPAD Guidelines for Good Practice as a Guide, it is possible to identify eight key areas in which it is important to define strategic objectives, as follows:

1) Legal, regulatory, and policy framework;

[374] Although countries use different terms to organize themselves, for the sake of convenience, we use the following generic terms to describe four levels of organization: national, provincial, district, institution. Although different terms are used in different countries, these four levels usually exist in some form in most countries.

2) Bandwidth and connectivity;
3) Infrastructure and technology;
4) ICT applications and e-learning content;
5) Professional development;
6) Governance and operations;
7) Monitoring evaluation and research;
8) Change management and advocacy.

Broad strategic objective can be defined for each area, against which all planning and spending on ICT at national, provincial, and district level should be tested. Taken together, these strategic objectives represent a comprehensive future vision for ICT in African education.

Table 5.1 - Strategic objectives for ICT in Education in African countries (adapted from NEPAD Guidelines)

Component	Strategic objective
1. *Legal, regulatory, and policy framework*	• Through appropriate consultative processes, the Ministry of Education has developed, published, and systematically advocated a clear and detailed set of policies, laws, and regulations that will most effectively support the integration of ICT into education systems. This is aligned with its national education policy, and takes account of the country context, as well as international trends in ICT in education.
2. *Bandwidth and connectivity*	• Affordable, broadband connectivity enables all education institutions (schools, universities, and government departments) to connect as many ICT devices as they require to the Internet, ensuring that any online activities (managerial, administrative, or educational) being undertaken by the educational institution can be done reliably and quickly.
3. *Infrastructure and technology*	• All educational institutions have access to the basic infrastructure required to integrate ICT into their operations: some form of transport access (of sufficiently good quality to guarantee safe and reliable delivery of sensitive ICT equipment); reliable and stable provision of electricity from a range of appropriate sources; and safe and secure building infrastructure. • All educational institutions are equipped with all of the technology solutions that they require in terms of their own technology plans.
4. *ICT applications and e-learning content*	• Available ICT applications provide educational institutions with a clear and compelling rationale to sustain ICT and connectivity investments, as well as to continue investing in developing the capacity of all members of the education community to be able to use these applications effectively. These applications are accessible to and affordable for all educational institutions. • All learners regularly use an appropriate variety of electronic and printed media that support successful completion of their educational careers, enhancing their ability to participate actively in the global information society and knowledge economy. Printed and electronic media complement one another, both in terms of supporting learning and teaching and in relation to spending on learning support materials.
5. *Professional development*	• All educational role-players – including government officials, principals and management teams, administrators, teacher educators, educators at all levels (including those in pre-service teacher training programmes), learners, and community opinion-leaders – possess the skills and competence required to use ICT effectively in their professional lives. Ongoing educational opportunities – formal, non-formal, and informal – are made available to, and are used by, all of these role-players to develop further their educational ICT competence.

Component	Strategic objective
6. *Governance and operations*	• Deployment of ICT throughout the education system significantly reduces the costs of governance and operations of both the system and individual educational institutions, while enhancing their productivity. Additional governance and operations structures and processes required for the integration of ICT into education systems integrate seamlessly with existing educational structures and processes, rather than adding layers of bureaucracy and expense to the education system.
7. *Change management and advocacy*	• ICT is embraced by all actors in the education sector and used to transform the way in which the system functions, so that it is better able to prepare learners for life and able to operate more cost-effectively. ICT is harnessed as a catalyst for change and innovation in the way the education system functions.
8. *Monitoring, evaluation and research*	• There is a culture of learning and reflection which allows for ongoing change and adaptation of strategies as contexts change and lessons are learnt about what works and what does not.

2.2 Some general guidelines

Having defined the needs in broad terms and defined a set of generic strategic objectives that should be largely relevant to most or all countries in Africa, the next section of this chapter sets out some general guidelines for approaching ICT in education on the continent. These guidelines preface the specific recommendations for action that have emerged from the study, which are set out in Chapter 6.

The research for this study has emphasised the need to acknowledge three important and fundamental realities:

1) The 'solution' required for each country and indeed each educational institution may be different according to its particular contextual profile and needs, the specific subjects and/or programmes it is offering, and the preferences/choices of its community/ies.
2) Different educational institutions in all countries are already at different stages of readiness for and maturity in the use of ICT.
3) Service delivery approaches and accompanying management structures need to provide for simultaneous implementation of a diverse range of linked solutions over an extended period.

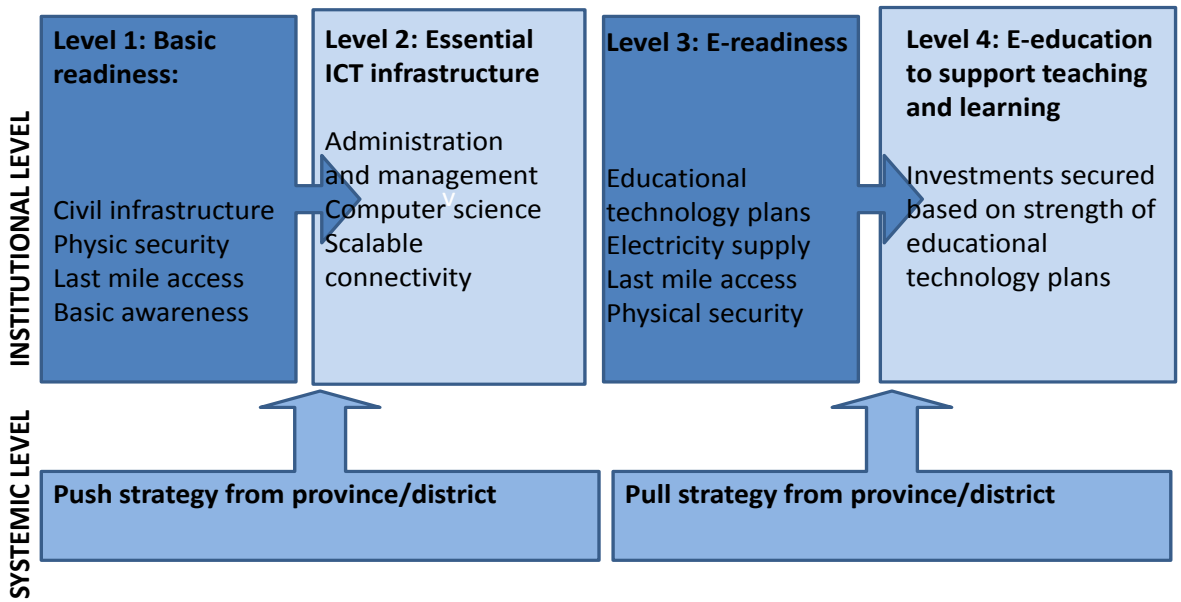
Not all educational institutions are in a position to integrate use of ICT immediately into their operations. An incremental approach will, therefore, generally be necessary. Furthermore, different institutions – depending on provincial or district interventions – are likely to be at different levels of maturity in the use of ICT. African educational institutions are not all starting from a zero base. In recognition of the variation across institutions, the following basic e-maturity levels can be used to guide planning for ICT in education initiatives:

- **Level 1 – Basic readiness**: institutions have the necessary infrastructure (for example, a reliable source of electricity, buildings to house the ICT equipment) and a level of awareness of the implications and benefits of the deployment of ICT infrastructure.

- **Level 2 – Essential ICT infrastructure**: institutions have the ICT hardware and applications, connectivity, and associated professional development, maintenance and support needed to use the equipment and applications that are available.
- **Level 3 – E-readiness**: institutions have a detailed technology plan which outlines how ICT will be used and maintained in order to support management and learning and are prepared for the roll-out of ICT to support teaching and learning.
- **Level 4 – Basic E-maturity**: ICT hardware and applications, connectivity, content, and associated professional development, maintenance and support have been provided to educational institutions and are being used predominantly to support teaching and learning.

For this to work successfully, institutional-level development needs to be underpinned and supported systemically, at both national and provincial/district levels. Without effective systemic support, large-scale roll-out of ICT and effective integration of ICT in education are unlikely to be possible. This can be represented diagrammatically as set out in Figure 5.1. In this diagram, 'Push' support is that which is driven from the top-down, such as requiring educational technology planning at school level or providing connectivity to schools. Conversely, 'Pull' support is that which is driven from the bottom-up, such as requests for professional development or budgets for ICT infrastructure procurement.

Figure 5.1 - Service Delivery Approach for ICT in Education



ICT rollout will not usually be uniform across every province, district, and educational institution in a country, because different institutions will usually be at different stages of e-maturity. However, so far as possible, it is preferable that national, provincial and district plans to invest in ICT in education should focus on moving all educational institutions systematically and sequentially through these levels towards a basic level of e-maturity. A detailed national baseline study will usually be required to determine which institutions are at which maturity levels. Following this, a monitoring system will be needed to keep track of progress made with implementation at each institution. In this way, ICT integration can be phased across provinces and districts as they become more ready.

In implementing such an approach, the following generic guidelines are worth considering:

1) It is important to establish a robust, scalable, affordable ICT connectivity network for the public education system in the country, to which every school, college, and university becomes connected. To work effectively and enable the creation of NRENs and national EMIS systems, there should be a focus on ensuring that all educational institutions can connect to this network as soon as is logistically possible.

2) With this in mind, a sustained political drive should be undertaken to provide connectivity throughout the education system to facilitate ongoing developments. There may also need to be changes in the telecommunications regulatory environment aimed at driving down the price of connectivity.

3) Change should be managed by enabling educational institutions, and district-level education offices where relevant, to take ownership of, and responsibility for, their choices about how they wish to use educational technology to support teaching and learning.

4) Negotiations with technology vendors should be concluded and framework agreements signed to ensure that the economies of scale of national roll-out drive down unit prices of hardware and software. Relevant bulk purchase contracts should be negotiated with technology vendors to ensure that infrastructure and technology purchased against institution-level technology plans are cheap, of the requisite quality, and capable of adaptation for future needs in a context of continuing rapid technological change.

5) Equipment supplied to educational institutions, educators and learners should contain relevant software applications which are needed by educators to perform their ongoing teaching, administrative and communications tasks.

6) National, provincial and district targets should be set to ensure that the pace of roll-out described above is broadly in line with national objectives. These should focus on critical indicators such as numbers of institutions that are e-ready or that have ICT infrastructure, computer-to-learner ratios, learner ICT access hours, and learner performance.

7) Clear policy guidelines need to be put in place for the collection, management, analysis and use of educational data at all levels, in order to leverage the management gains from EMIS that have been described in chapter 3.

8) A refined, decentralised, and streamlined national Educational Management Information System (EMIS) system should be operationalised. Such a system should take into account the different tools and technologies available, including open source software, smartphones, low-cost computers, and best practices in educational statistics and distributed database systems. An electronic school management system (and equivalent systems for other sectors of education) should be selected/developed, tested and finalised, so that it can be used by institutions to manage their day-to-day

operations. This should generate required EMIS data automatically, so that no additional work is required to meet district, provincial, and national reporting requirements.

9) Building on this, the software types/programmes needed for management and administrative functions of educators and administrators – including operating systems and basic office software (such as word processors, spreadsheets, e-mail applications, presentation software, and web browsers) – should be agreed at national level and licensing secured for educator use across the system. Use of education management software based on open standards should be promoted in order to achieve interoperability and facilitate seamless integration of data from different sources and levels.

10) It should be part of the vision of national education systems to ensure that every educator in the country has access to a relevant computing device and associated ICT peripherals.

11) Changes should be made to key performance indicators and performance incentives to encourage or, where appropriate, require use of ICT by relevant personnel. Without this, professional development investments are likely to have limited effect.

12) Educators and learners should be able to access a comprehensive range of teaching and learning materials at no cost through an appropriate national education portal, as well as becoming more able to access online content through broadband Internet connections as these are rolled out nationally.

13) A range of relevant ongoing professional development activities should be made available to all educators to enable them to acquire the skills and competencies necessary to use ICT to perform their jobs effectively and productively. Support in the use of ICT infrastructure, as well as relevant software applications, should be made available through online help facilities and perhaps through a call centre service.

14) All educators and learners should be able to join and participate in specialised online communities of practice that provide access to a range of support services, peer networking opportunities and additional resources to be used for teaching and learning purposes.

15) Implementation of ICT for teaching and learning purposes should be actively monitored by national, provincial and district education offices, and strategies to improve implementation. Rigorous impact assessment studies should be undertaken to build understanding of the impact that results from approaches taken at different levels (for example, school, district and national levels). The outcomes of this impact assessment should inform ongoing development and implementation.

This chapter of the report has presented a framework of generic guidelines concerned with ICT in education in Africa. Chapter 6 proceeds from these guidelines to identify specific

recommendations to policy-makers and donors concerning how they can take advantage of the opportunities described in the report.

Chapter 6: Recommendations

1 Introduction

This final chapter of the report presents both general and specific recommendations for policy makers and regulators in African countries, and for development partners. These are based on the analysis of the current landscape of ICT in education set out in Chapter 2, which focuses on the five thematic areas identified for exploration in the terms of reference for the study; the discussion of opportunities and challenges which can be found in Chapter 3; the country case studies described in Chapter 4; and the suggested guidelines which have been put forward in Chapter 5. Although there are many possible recommendations that might usefully be presented for governments, development partners and other stakeholders, this chapter focuses on recommendations which the consultants believe have strategic importance for ICT in education. The recommendations themselves should be considered alongside the discussion of opportunities identified in Chapter 3.

2 Recommendations for policy-makers and regulators

In implementing the following recommendations, it is almost certain that most sub-Saharan countries will need expertise that is not currently available within their governments. The generic guidelines in Chapter 5 provide a starting point in moving towards implementation, but governments should be prepared to engage the necessary expertise – through employment, sub-contracting/consultancy, or the secondment of experts from countries that have made significant progress – to help them in developing the detail of policy and implementation that is specific and appropriate to their national contexts.

2.1 Establishing an enabling policy environment

Ensure that all investments in ICT in education (including those made by governments, development partners, individual educational institutions and NGOs) are – to the greatest extent possible – directed by a single, integrated ICT-in-education strategy so that they are working towards common national strategic objectives. The importance of having an enabling policy and strategy environment is especially clear from the discussion in Section 2.1 of Chapter 3 where the success of South Africa and Egypt illustrate this need. This is reinforced by the comparative discussion of case study countries in Chapter 4.

An integrated strategy for ICT in education should be underpinned by a clearly defined systemic approach to the use of ICT (drawing on the suggested guidelines presented in Chapter 5) so that investments are focused on improving efficiencies within the system and on raising productivity levels. Such a strategy should, as a minimum, include:

a) A focus on all critical aspects of ICT integration – the legal, regulatory and policy framework; bandwidth and connectivity; infrastructure and technology; ICT applications and e-learning content; professional development; governance and operations;

management information systems; monitoring, evaluation, and research; and change management and advocacy.

b) Mechanisms to prioritise connectivity for the education sector (for example, use of universal access funds, e-rates, national broadband strategies, or private-public partnerships).
c) Strategies for ensuring sustainable availability and security of connectivity for schools and universities (for example support to NRENs and Schoolnets; ensuring that curricula, training, and internships are in place to produce a technically competent human resource base within the telecommunication and computer science disciplines).
d) Strategies to remove unnecessary barriers to access to ICT (for example, taxation on equipment) and to support competition in the telecommunications sector.
e) Analysis of the total cost of ownership of ICT investments, combined with assessment of options for reducing cost (for example, reviewing power consumption of all components, different power supply options, *etc.*).
f) Emphasis on the importance of ongoing planning and strong leadership at the institutional level as a basis for rolling out ICT in education.
g) A review of the scope for partnerships with the private sector (for example, network operators, technology manufacturers, publishers, application developments and social entrepreneurs).
h) Support for experimentation, as well as research and ongoing evaluation, to understand the effects of particular technologies or approaches – rather than embedding use of a single, specific technology or ICT access model into roll-out plans.

To be effective, strategies should be developed through appropriate processes of consultation within countries, in order to ensure that there is strong consensus on the proposed approaches by all major stakeholders, combined with buy-in to the strategic objectives defined. Strategies should also be based on a clear assessment of the current status of all of the critical aspects of ICT in education identified in Chapter 5.

2.2 Widening access to ICT infrastructure and connectivity:

Implement programmes that enable students, teachers, and administrators to gain access to, or own suitable computing devices, and that support the development of NRENs as a means to enable resource-sharing and collaboration. As discussed in Section 2.2 of Chapter 3, connectivity and access provide the physical route that enables the integration of ICT in education. The opportunities provided by mobile platforms for connectivity anywhere have also been discussed. The "Push" strategy illustrated in Figure 5.1 is aimed at ensuring the minimum connectivity and access that are essential for progress. In addition to supporting an enabling policy and regulatory environment, important strategies include:

a) Working with the private sector, through public-private partnerships (PPPs), to provide computing devices based on mass-market and concessionary pricing so that access, where there is connectivity, is not constrained.
b) Supporting the development of NRENs, including PPP collaboration, to create an environment in which the connectivity needs of schools at all levels can be met, including the intensive short term demands common in higher institutions of learning.

c) Engaging mobile service providers so that students and teachers can access online resources away from school campuses at educational rates.

2.3 Harnessing ICT to improve management and administration

***Promote data-driven decision-making at all levels*.** With the decentralisation that is taking place in many countries, information is required away from the centre to support sector management at all levels. The focus on data usage at all levels implies that investment in the future of EMIS development should focus on schools (public and private, formal and non-formal), colleges and universities that provide the data. Strategies to drive this will include:

a) The development of national EMIS policies and standards.
b) Support for standardised school-based management information systems and higher education management information systems that are developed using open standards and capable of interfacing with GIS, social networks, and mobile and low-cost computing.
c) Promotion of integrated educational management information systems at the level of tertiary education.
d) Building the capacity of data providers, in particular school leaders and university registrars as well as other data providers and users.
e) Support for the development of district-level EMIS data integration systems, as these provide an ideal platform for integration of school and college data and serve as a starting point for verification and application of EMIS.
f) Building the capacities of the EMIS unit and the Ministry of Education, which require the capability to integrate data from multiple sources, multiple years and multiple levels in order for decision-makers to see the whole picture and to make effective decisions at national level.

2.4 Harnessing digital learning resources

Consider judicious investments in content creation and aggregation to ensure compliance with African curricula and/or local language demands, motivating usage by educators and students. In the first instance, priority content could be derived from open content sources. If suitable content is not available, it will be useful to identify and invest in priority content development areas that are not covered by the open market. The latter may include:

a) Reviewing and adjusting existing national/institutional policies and staff incentive schemes to ensure that they encourage educators to invest time in ongoing curriculum design, the creation of effective teaching and learning environments within courses and programmes, and the development of high-quality teaching and learning materials.
b) Translating existing digital educational material into priority indigenous languages in priority content areas.
c) Procuring the copyright to high-quality existing materials so that resources can then be freely distributed without generating additional cost.

d) Building structured long-term partnerships with commercial organisations, corporate social investment (CSI) initiatives and NGOs that currently produce free materials, and supporting their efforts to raise funds to sustain their business models.
e) Investing in knowledge management systems and strategies to store, curate and share educational content, ideally in partnership with emerging global OER networks and repositories.

It may be worth investing in a centralised national content development process (selected through competitive tender) which will lead to the generation of content. Additionally, incentive mechanisms could be devised to encourage educators to contribute materials. Any new materials commissioned for development should be licensed under a suitable Creative Commons licence so that they can be freely copied and adapted by the public, while also acknowledging the work of those responsible for developing them.

2.5 Building human capacity

Adopt a suitable global professional development framework to guide national implementation of ICT in education professional development. The absence of the necessary capacity among those responsible for education has been identified in this report as one of the major barriers to the integration of ICT in education, making it a priority point of action. Based on discussion in Section 2.5 of Chapter 3, this report recommends use of the UNESCO ICT Competency Standards for Teachers and Teacher Training as a starting point for planning professional development strategies at national level. Adoption of this would lead to a generic national strategy along the lines in Figure 3.1.

Professional development strategies should take into account all educational actors and target groups – including government officials, principals and management teams, administrators, teacher educators, educators at all levels (including those in pre-service teacher training programmes), learners, community opinion-leaders, ICT coordinators (the staff members at a school or university who are responsible for implementing its ICT integration plan) and ICT maintenance and support personnel. Professional development strategies should:

a) Make professional development in ICT integration a mandatory aspect of pre-service training so that all educators become aware of the value of ICT for teaching and learning, and how they might use ICT for teaching and learning when they become practicing teachers;
b) Incorporate incentives for all target groups linked to enhancing their knowledge of ICT integration, which should be based not just on acquiring a qualification but also on demonstration of the successful application of skills and competencies acquired; and
c) Ensure that the national professional development system gives people a choice of which professional development activities they can participate in (not limited to formal training courses), to enable them to select needs-based activities.

3 Recommendations for development partners

Development partners have various roles to play in relation to the use of ICT in education. They are potential sources of funding for initiatives which cannot be readily financed from national budgets, as well as potential sources of policy guidance and expertise. Development partners are especially well positioned to stimulate and support initiatives that are based on cross-border collaboration. In this light, it is recommended that development partners:

1) **Ensure that funded projects contribute to implementing the initiatives outlined in the recommendations for policymakers and regulators**. Often, ICT in education projects initiated by development partners have not been clearly aligned to broader national policies and objectives. Where this has been the case, such projects tend – at best – to be unsustainable and – at worst – to impede progress in effective roll-out of ICT in education by creating conflicts of interest and unnecessary fragmentation. Should it not be clear what the national strategy is, initial investments might most usefully focus on supporting policy and strategy development at the national level.

2) **Consider investment in the enabling environment**. In particular, development partners should consider support for governments that want to move towards establishing enabling policy environments as discussed in Section 2.1 above, including expert support, financing and capacity building at both national and regional levels.

3) **Consider investments at a regional or continental level that build common capacity across countries**. There are many ways in which regional or continental initiatives can contribute to building capacity that would support policy makers in implementing the kinds of initiatives outlined in the previous set of recommendations. These might include:

    a) The development of common, openly licensed course and programme materials aligned to the UNESCO ICT CFT that can be adapted and used in national professional development initiatives.
    b) Support for the aggregation and release under open licences of digital learning resources produced in African countries in order to widen and deepen the pool of available educational content that is specifically designed with African educational contexts in mind. Where appropriate, this might usefully be done by supporting regional consortia of providers to produce materials in areas of common need, an important activity that often cannot be funded solely through government or other sources of national funding.
    c) The establishment of platforms for capacity building and knowledge exchange on EMIS deployment, building on the experience of ADEA, using this to support the development of district-level EMIS data integration systems and to build the capacities of EMIS units and the Ministries responsible for education.
    d) Support for the development of NRENs and deployment of associated data networks and applications (grid-computing, video-conferencing, e-learning, *etc.*).

e) Development of the capacity of policy makers and regulators to enable them to establish more effective ICT in education policies, strategies and regulatory frameworks.

4) **Continue to fund pilot projects that test the use of new and innovative technologies, ensuring that these experiments are well evaluated and the results widely shared**. As this report has illustrated, development of technology is still occurring rapidly and bringing with it new educational opportunities. As a result, it is important that there are controlled 'experiments' taking place on a regular basis in order to test the potential educational applicability of these new technologies and approaches, examine their total cost of ownership and establish their strengths and weaknesses. Often, it is difficult for governments to fund such experimentation, but it remains an essential part of building a knowledge base of best practice. Development partners have a critical role to play in supporting such activities.

5) **Ensure that the intellectual capital generated by funded projects is shared under a suitable open licence and made accessible via an appropriate web platform**. Over the years, development partners have invested large sums of money in innovative initiatives which have produced important and high-quality products, either in the form of software applications, research outputs, educational resources, or other similar forms of intellectual capital. In a small minority of instances, there has been a good reason to allow the project grantee to retain full copyright of this intellectual capital in order to establish a viable long-term business model. More often than not, however, over time, this intellectual capital has simply been lost due to restrictions in its re-use and subsequent poor curation of the intellectual capital in a suitable repository. While some donors have started to impose requirements that funded projects release their intellectual capital under an open licence and have developed websites to store the products of such projects, the majority still do not do this, with the result that, in the long term, the full value of these investments is lost to education in Africa. Adopting policies that lead to release of intellectual capital under open licences (unless there are valid reasons not to do so) and ensuring that this is stored in a sustainable online repository would help significantly to reduce wastage and duplication of investment.

6) **Undertake an evaluation and impact assessment of regional initiatives at different stages of development and implementation.** This report has highlighted regional initiatives in a number of thematic areas, ranging from those focused on digital learning resources and teacher education, such as the Education in Sub-Saharan Africa (TESSA) initiative and AVU's ICT-Integrated Teacher Education programme, to those focused on connectivity and access such as the UbuntuNet Alliance. Some of these have achieved gains which are discussed in this report, but the impact of many is uncertain. Investments by donors– and indeed by national governments – in this crucial field will be much more productive if they are rooted in independent critical evaluation of these regional initiatives. This will provide a better understanding of which initiatives to support and how these can be best supported, reinforced or expanded where appropriate. Approaches resulting from independent evaluation could potentially include support for collaboration between regional initiatives so that they reinforce one another.