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

DRAFT
Education Sector Study

Date: August 9, 2011

(While this is still work in progress, feedback is appreciated)
# Contents

LIST OF FIGURES ........................................................................................................... v  
LIST OF TABLES .............................................................................................................. v  
LIST OF ABBREVIATIONS ............................................................................................ vi  
EXECUTIVE SUMMARY ................................................................................................. 1  
  Introduction .................................................................................................................. 1  
  Methodology ............................................................................................................... 2  
The Education Sector in Africa: Current Status ............................................................. 3  
Introducing the Thematic Areas .................................................................................... 4  
Challenges/Barriers ....................................................................................................... 5  
Opportunities ................................................................................................................ 10  
Recommendations to Policy Makers, Regulators, and other Stakeholder ..................... 12  
  Policy and Strategy: .................................................................................................... 12  
  Open Educational Resources ....................................................................................... 12  
  Capacity Building ...................................................................................................... 13  
  Connectivity and Access ............................................................................................ 13  
  Sustainability .............................................................................................................. 14  
  Theme-specific recommendations .............................................................................. 14  
Recommendations to Development Partners ................................................................ 17  
  Initiatives that fall under government direction ......................................................... 17  
  Initiatives that can be handled by institutions or organizations of institutions .......... 18  

1. INTRODUCTION ...................................................................................................... 20  
  1.1 Background to the Study ...................................................................................... 20  
  1.2 Methodology ........................................................................................................ 21  
  1.3 Setting the Context .............................................................................................. 22  
    1.3.1 General Considerations .................................................................................... 22  
    1.3.2 The Education Sector in African Countries .................................................... 24  
  1.4 Introducing the Thematic Areas .......................................................................... 26  
    1.4.1 Teacher Professional Development ............................................................... 26  
    1.4.2 Digital Learning Resources .......................................................................... 28  
    1.4.3 Affordable Technologies .............................................................................. 30  
    1.4.4 Education Management Information Systems .............................................. 32  
    1.4.5 National Research and Education Networks .............................................. 33  
  1.5 The Inter-relationship among the themes ............................................................ 35  
  1.6 Report Outline ..................................................................................................... 36  

2. LANDSCAPE ANALYSIS ....................................................................................... 38  
  2.1 Introduction .......................................................................................................... 38  
  2.2 Teacher Professional Development ...................................................................... 38
2.2.1 Introduction .................................................................................................................. 38
2.2.2 Approaches to Teacher Professional Development for ICT-enabled environments .... 38

2.3 Digital Learning Resources ........................................................................................... 42
  2.3.1 Introduction .................................................................................................................. 42
  2.3.2 Digital Content Creation Tools .................................................................................... 42
  2.3.3 Open Source Software Applications in Education ....................................................... 44
  2.3.4 Examples of Education Content Models .................................................................... 49
  2.3.5 Strategies to procure and develop Digital Content .................................................... 49
  2.3.6 Potential content development agencies ................................................................. 53
  2.3.7 Distribution Options for Digital Learning Resources ................................................ 55

2.4 Affordable Technologies ............................................................................................... 56
  2.4.1 Introduction .................................................................................................................. 56
  2.4.2 Low-Cost Computing Devices (LCCD) ..................................................................... 57
  2.4.3 Mobile phones ............................................................................................................. 58
  2.4.4 Tablet PCs, iPads and eReaders .................................................................................. 64
  2.4.5 Cross-cutting Opportunities and Challenges ............................................................ 66
  2.4.6 Critical Success Factors ............................................................................................. 69

2.5 Education Management Information Systems .................................................................. 69
  2.5.1 Introduction .................................................................................................................. 69
  2.5.2 EMIS Experience in Africa and the Rest of the World ............................................. 70
  2.5.3 EMIS Development Process ...................................................................................... 72
  2.5.4 Technical Implementation: ICT Application Trends .................................................. 76
  2.5.5 The Application of Mobile Technologies and Social Networking in Managing Educational Information ................................................................. 79
  2.5.6 Challenges Facing EMIS Deployment in Africa ......................................................... 80

2.6 National Research and Education Networks ................................................................... 81
  2.6.1 Introduction .................................................................................................................. 81
  2.6.2 The Structure of NRENS .......................................................................................... 82
  2.6.3 NREN Growth in Africa ............................................................................................ 84
  2.6.4 Examples of NRENS from Africa and Around the World ........................................ 86
  2.6.5 Opportunities .............................................................................................................. 92
  2.6.6 Challenges .................................................................................................................. 94

3. OPPORTUNITIES AND CHALLENGES ............................................................................. 96
  3.1 Introduction ...................................................................................................................... 96
  3.2 Challenges/barriers that can be addressed by specific interventions ......................... 96
    3.2.1 Absence of comprehensive policy and strategy ..................................................... 97
    3.2.2 Lack of awareness and ownership of initiatives ...................................................... 97
    3.2.3 Funding constraints ................................................................................................. 98
    3.2.4 Lack of competent human resource ........................................................................ 99
    3.2.5 Lack of incentives .................................................................................................... 100
    3.2.6 Wide range of stakeholders .................................................................................... 100
3.2.7 Technology-led initiatives ................................................................. 101
3.2.8 High cost of technology ................................................................. 101
3.2.9 Limited access to the Internet .......................................................... 102
3.2.10 Limited access to power ................................................................. 102
3.2.11 Underdeveloped private sector ....................................................... 103
3.2.12 Limited impact research ................................................................. 103
3.2.13 Social, economic and cultural issues ............................................. 103
3.2.14 Sustainability ................................................................................. 104
3.3 Theme Specific Challenges .................................................................. 104
3.4 Cross-Cutting Opportunities ................................................................ 106
3.4.1 Interest of development partners in supporting ICT in education ........ 107
3.4.2 Communities of Practice ................................................................... 107
3.4.3 Increasing rollout of competitive fibre to Africa and within African countries 107
3.4.4 Increasing penetration of wireless and mobile platforms .................... 108
3.4.5 Increasing affordability and choice among devices that link through mobile and wireless platforms ......................................................... 108
3.5 Theme Specific Opportunities ............................................................. 108
3.6 Conclusion ........................................................................................... 110
4. CASE STUDIES ...................................................................................... 111
4.1 Introduction .......................................................................................... 111
4.2 South Africa ........................................................................................ 111
4.2.1 Introduction ....................................................................................... 111
4.2.2 South Africa’s Education Context ..................................................... 111
4.2.3 Curriculum ....................................................................................... 112
4.2.4 Implementation of ICT in education in South Africa ......................... 113
4.2.5 Infrastructure and connectivity ......................................................... 116
4.2.6 Teacher professional development ................................................. 117
4.2.7 Integrated management information systems .................................. 118
4.2.8 Digital education content and open educational resources .............. 118
4.2.9 Multiple modalities of dissemination of content .............................. 119
4.2.10 Mobile learning .............................................................................. 119
4.2.11 Private sector investment in ICT in education ............................... 120
4.2.12 Research and evaluation ................................................................. 121
4.2.13 Demand and supply of ICT in the higher education sector ............ 122
4.2.14 Challenges to implementation of ICT in education ....................... 124
4.2.15 Conclusions: Lessons from SA ICT implementation ..................... 126
4.3 Uganda ................................................................................................ 127
4.3.1 Introduction ....................................................................................... 127
4.3.2 Uganda’s Education Context ............................................................. 127
4.3.3 Implementation of ICT in education in Uganda ............................... 127
4.3.4 Challenges to implementation of ICT in education ....................... 128
4.3.5 Opportunities for implementing ICTs in education ........................................ 129
4.3.6 Conclusions: Lessons from Ugandan ICT implementation .................................... 130

5. RECOMMENDATIONS TO POLICY MAKERS, REGULATORS AND OTHER STAKEHOLDERS ...... 132
5.1 Introduction ...................................................................................................................... 132
5.2 Recommendations ........................................................................................................... 132
  5.2.1 Policy and Strategy: .................................................................................................... 132
  5.2.2 Open Educational Resources .................................................................................... 132
  5.2.3 Capacity Building ...................................................................................................... 133
  5.2.4 Connectivity and Access .......................................................................................... 133
  5.2.5 Sustainability ............................................................................................................ 134
5.3 Theme-specific recommendations .................................................................................. 134
  5.3.1 Teacher Professional Development ........................................................................... 134
  5.3.2 Digital Learning Resources ...................................................................................... 136
  5.3.3 Affordable Technologies ........................................................................................... 137
  5.3.4 Education Management Information Systems (EMIS) ............................................. 137
  5.3.5 National Research and Education Networks ............................................................. 138
5.4 Critical Success Factors .................................................................................................. 138

6. RECOMMENDATIONS TO DEVELOPMENT PARTNERS ................................................. 139
6.1 Introduction ...................................................................................................................... 139
6.2 Initiatives that fall under government direction ................................................................. 139
6.3 Initiatives that can be handled by institutions or organizations of institutions ............... 140
LIST OF FIGURES

Figure 1: Interplay among the thematic areas ................................................................. 35
Figure 2: EMIS Development Process .............................................................................. 73
Figure 3: The EMIS Data Supply Chain ........................................................................... 76
Figure 4: Progress with ICT Applications in EMIS ............................................................ 77
Figure 5: Layered Model of the Global Research and Education Community ..................... 82
Figure 6: Growth of NRENs in Africa ............................................................................. 86
Figure 7: Operational Status of NRENs in Eastern and Southern Africa ....................... 86
Figure 8: UbuntuNet Alliance Stakeholders Map showing the Value Addition Layer of the
Alliance ............................................................................................................................... 89
Figure 9: Map of evolving intra-African and external fibre to Africa .................................. 94
Figure 10: ICT professional development strategy formulation prototype ......................... 135

LIST OF TABLES

Table 1: Examples of Commonly used Open Source Software in Education ...................... 45
Table 2: Technology Trends for access and computing devices ......................................... 56
Table 3: Major challenges facing EMIS in African countries ............................................. 70
Table 4: Data Required for Monitoring EFA ....................................................................... 74
Table 5: Availability of computer centres in public schools, 2009 ...................................... 124
Table 6: Access to telecommunications and internet ......................................................... 125
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAU</td>
<td>Association of African Universities</td>
</tr>
<tr>
<td>ACE</td>
<td>Advanced Certificate in Education</td>
</tr>
<tr>
<td>ADEA</td>
<td>Association for Education Development in Africa</td>
</tr>
<tr>
<td>AED</td>
<td>Academy for Educational Development</td>
</tr>
<tr>
<td>ALICE</td>
<td>America Latina Interconectada Con Europa</td>
</tr>
<tr>
<td>ASGISA</td>
<td>Accelerated Shared Growth Initiative for South Africa</td>
</tr>
<tr>
<td>AUBC</td>
<td>African Universities Bandwidth Consortium</td>
</tr>
<tr>
<td>AUP</td>
<td>Acceptable Use Policy</td>
</tr>
<tr>
<td>BECTA</td>
<td>British Educational Communications and Technology Agency</td>
</tr>
<tr>
<td>CAI</td>
<td>Community Anchor Institutions</td>
</tr>
<tr>
<td>CAT</td>
<td>Computer Applications Technology</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disc</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>CET</td>
<td>Center for Educational Technology</td>
</tr>
<tr>
<td>CLARA</td>
<td>Cooperación Latino Americana de Redes Avanzadas</td>
</tr>
<tr>
<td>CPD</td>
<td>Continuing Professional Development</td>
</tr>
<tr>
<td>CPTD</td>
<td>Continuous Professional Training Development</td>
</tr>
<tr>
<td>CSI</td>
<td>Corporate Social Investment Continuous Professional Training Development</td>
</tr>
<tr>
<td>CSI</td>
<td>Corporate Social Investment</td>
</tr>
<tr>
<td>CSIR</td>
<td>Council for Scientific and Industrial Research</td>
</tr>
<tr>
<td>DANTE</td>
<td>Delivering Advanced Networking to Europe</td>
</tr>
<tr>
<td>DFID</td>
<td>Department for International Development</td>
</tr>
<tr>
<td>DLR</td>
<td>Digital Learning Resources</td>
</tr>
<tr>
<td>DLRs</td>
<td>Digital Learning Resources</td>
</tr>
<tr>
<td>DRM</td>
<td>Digital Rights Management</td>
</tr>
<tr>
<td>DStv</td>
<td>Digital Satellite Television</td>
</tr>
<tr>
<td>EFA</td>
<td>Education for All</td>
</tr>
<tr>
<td>ELRC</td>
<td>Education Labour Relations Council</td>
</tr>
<tr>
<td>EMIS</td>
<td>Education Management Information Systems</td>
</tr>
<tr>
<td>EthERNet</td>
<td>Ethiopia Education and Research Network</td>
</tr>
<tr>
<td>EUC</td>
<td>European Union Commission</td>
</tr>
<tr>
<td>FETMIS</td>
<td>Further Education and Training MIS</td>
</tr>
<tr>
<td>FOSS</td>
<td>Free and Open Source Software</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>GNP</td>
<td>Gross National Product</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Position System</td>
</tr>
<tr>
<td>HEIs</td>
<td>Higher Education Institutions</td>
</tr>
<tr>
<td>HEMIS</td>
<td>Higher Education Management Information System</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>IBM</td>
<td>International Business Machines</td>
</tr>
<tr>
<td>ICTs</td>
<td>Information and Communication Technologies</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>IDRC</td>
<td>International Development Research Centre</td>
</tr>
<tr>
<td>IEEAF</td>
<td>Internet Educational Equal Access Foundation</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>IPR</td>
<td>Intellectual Property Rights</td>
</tr>
<tr>
<td>IRUs</td>
<td>Indefeasible Rights of Use</td>
</tr>
<tr>
<td>IT</td>
<td>Information technology</td>
</tr>
<tr>
<td>IVR</td>
<td>Interactive Voice Response</td>
</tr>
<tr>
<td>JANET</td>
<td>Joint Academic Network</td>
</tr>
<tr>
<td>KENET</td>
<td>Kenya Education Network Trust</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LCCD</td>
<td>Low-Cost Computing Devices</td>
</tr>
<tr>
<td>LMSs</td>
<td>Learning Management Systems</td>
</tr>
<tr>
<td>LPC</td>
<td>One Laptop per Child</td>
</tr>
<tr>
<td>LTSM</td>
<td>Learner Teacher Support Material</td>
</tr>
<tr>
<td>M4Lit</td>
<td>mobiles for literacy</td>
</tr>
<tr>
<td>Mbps</td>
<td>Megabits per Second</td>
</tr>
<tr>
<td>MCIT</td>
<td>Ministry of Communications and Information Technology</td>
</tr>
<tr>
<td>MDGs</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>M4Lit</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>MIS</td>
<td>Management Information Systems</td>
</tr>
<tr>
<td>MoE</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>MoEV</td>
<td>Ministry of Education and Vocational Training of Tanzania</td>
</tr>
<tr>
<td>MTN</td>
<td>Mobile Telephone Network</td>
</tr>
<tr>
<td>NCERD</td>
<td>National Centre for Educational Resource Development</td>
</tr>
<tr>
<td>NECTEC</td>
<td>National Electronics and Computer Technology Centre</td>
</tr>
<tr>
<td>NEPAD</td>
<td>New Partnerships for Africa’s Development</td>
</tr>
<tr>
<td>NESIS</td>
<td>National Education Statistical Information Systems</td>
</tr>
<tr>
<td>NFPTED</td>
<td>National Framework for Professional Teacher Education and Development</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non Governmental Organizations</td>
</tr>
<tr>
<td>NKC</td>
<td>National Knowledge Commission</td>
</tr>
<tr>
<td>NLR</td>
<td>National Lambda Rail</td>
</tr>
<tr>
<td>NRENs</td>
<td>National Research and Education Networks</td>
</tr>
<tr>
<td>NTN</td>
<td>National Knowledge Network</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OER</td>
<td>Open Education Resources</td>
</tr>
<tr>
<td>OLPC</td>
<td>One Laptop per Child</td>
</tr>
<tr>
<td>OSS</td>
<td>Open Source Software</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
</tr>
<tr>
<td>PiL</td>
<td>Microsoft Partners in Learning</td>
</tr>
<tr>
<td>PNC on ISAD</td>
<td>Presidential National Commission on Information Society and Development</td>
</tr>
<tr>
<td>POP</td>
<td>Point of Presence</td>
</tr>
<tr>
<td>PPPs</td>
<td>Private and Public Sector Partnerships</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>REN</td>
<td>Research and Education Network</td>
</tr>
<tr>
<td>RENU</td>
<td>Research and Education Network of Uganda</td>
</tr>
<tr>
<td>RIA</td>
<td>Research ICT Africa</td>
</tr>
<tr>
<td>RRENs</td>
<td>Regional Research and Education Network</td>
</tr>
<tr>
<td>SA</td>
<td>South Africa</td>
</tr>
<tr>
<td>SADC</td>
<td>Southern African Development Community</td>
</tr>
<tr>
<td>Saide</td>
<td>South African Institute for Distance Education</td>
</tr>
<tr>
<td>SANREN</td>
<td>South Africa Research and Education Network</td>
</tr>
<tr>
<td>SA-SAMS</td>
<td>South African Schools Administration and Management System</td>
</tr>
<tr>
<td>SCORM</td>
<td>Sharable Content Object Reference Model</td>
</tr>
<tr>
<td>SIDA</td>
<td>The Swedish Agency for International Development</td>
</tr>
<tr>
<td>SITA</td>
<td>The State Information Technology Agency</td>
</tr>
<tr>
<td>SITFE</td>
<td>Sugar Industry Trust for Education</td>
</tr>
<tr>
<td>SME</td>
<td>Small an Medium Enterprises</td>
</tr>
<tr>
<td>SMMEs</td>
<td>Small, Micro and Medium Enterprises</td>
</tr>
<tr>
<td>SMS</td>
<td>Short Message Service</td>
</tr>
<tr>
<td>SNSA</td>
<td>SchoolNet South Africa</td>
</tr>
<tr>
<td>SRS</td>
<td>Student Record System</td>
</tr>
<tr>
<td>SUIN</td>
<td>Sudan Universities Information Network</td>
</tr>
<tr>
<td>TCO</td>
<td>Total Cost of Ownership</td>
</tr>
<tr>
<td>TENET</td>
<td>Tertiary Education Network</td>
</tr>
<tr>
<td>TESSA</td>
<td>Teacher Education in Sub-Saharan Africa</td>
</tr>
<tr>
<td>TLI</td>
<td>Teacher Laptop Initiative</td>
</tr>
<tr>
<td>TORs</td>
<td>Terms of Reference</td>
</tr>
<tr>
<td>TPD</td>
<td>Teacher Professional Development</td>
</tr>
<tr>
<td>TTC</td>
<td>Text to Change</td>
</tr>
<tr>
<td>TV</td>
<td>Television</td>
</tr>
<tr>
<td>UCT</td>
<td>University of Cape Town</td>
</tr>
<tr>
<td>UJ</td>
<td>University of Johannesburg</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNICEF</td>
<td>The United Nations Children’s Fund</td>
</tr>
<tr>
<td>UNIDO</td>
<td>United Nations Industrial Development Organization</td>
</tr>
<tr>
<td>UNISA</td>
<td>University of South Africa</td>
</tr>
<tr>
<td>UP</td>
<td>University of Pretoria</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>USAASA</td>
<td>Universal Service Access Agency of South Africa</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
</tr>
<tr>
<td>WGES</td>
<td>Working Group on Education Statistics</td>
</tr>
<tr>
<td>YAL</td>
<td>Young Africa Live</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Introduction

This study is part of a cross-sector study conducted by the World Bank Group and the African Development Bank, with the support of the African Union, intended to produce a report on how information and communication technologies (ICTs), especially mobile phones, have the potential to transform the education sector in Africa. This is in recognition of the reality that the future development of Africa will be heavily influenced by how Africa manages to deliver quality education to its citizens.

The study examines the potential for exploiting information and communication technologies (ICT) to support the transformation of the education sector in Africa. A key objective is to raise awareness and stimulate action, especially among African governments and development practitioners, in using ICTs to contribute to the improvement and transformation of education. The study identifies specific opportunities and challenges, and recommends areas of intervention for governments, educational institutions, the private and NGOs, and development partners.

While ICT is seen as a way to promote educational change, improve the skills of teachers and learners, and prepare them for the global economy and the information society, technology of itself should not be seen as the heart of change, because this leads to failure. Technology integration is only successful if it is introduced within a holistic framework to support well thought out business processes in particular educational reform and planning at all levels. Specifically, for education sector, pedagogy must be placed at the center, and also be the main driver of transformation with technology as an enabling tool where appropriate.

The following five thematic areas were examined:

**Teacher Professional Development**: with an emphasis on the contextualization and implementation of a teacher competency framework that also addresses ICT in education.

**Digital Learning Resources**: with an emphasis on the experience and challenges for development of open educational resources that are responsive to development needs.

**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.

**Education Management Information Systems (EMIS)**: with an emphasis on the opportunities and challenges for mobile data collection and dissemination.

**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, and how these can reach out to all levels of education.
It should be noted that while these five thematic areas are strongly interrelated, the competence of teachers, and the availability of learning resources, both digital and traditional, sit at the heart of any successful programme. The other three (Affordable Technologies, EMIS, NRENs) simply create the environment in which good pedagogy can thrive.

The figure below shows the mutual dependence among the thematic areas examined, and also shows the cross-cutting role policy, strategy, and funding play.

Methodology

The global environment was sampled for examples that relate to the study, leading to the identification of lessons and best practices as well as opportunities and challenges relating to African countries within each of the five thematic areas. Opportunities and challenges enable the definition of recommended areas of intervention by the different stakeholders.

Three country case studies were conducted: South Africa was a desk research case study because of the rich selection of published literature, while Uganda and Senegal were deep
dive case studies, involving field and desk research as well as country workshops bringing together key stakeholders in the education sector.

Wide stakeholder input involved: questionnaires to more than fifty experts and stakeholders, followed by interviews with a cross-section of the same group; invitation of experts to write blog essays, resulting in a total of 24 essays; and posting the blog essays on the Educational Technology Debate website and the interim reports on the eTransform Africa website to create open opportunity input.

The Education Sector in Africa: Current Status

The potential of using ICT to tackle some of the challenges facing education and other sectors, and thereby impact on development, has led to efforts in many African countries to invest in ICT in order to support their development strategies. However, many African countries face challenges in terms of capacity, capability, and resources (human and financial) to harness the potential of ICT successfully and effectively. More often than not, they also face the challenge of not knowing how to approach the integration of ICT in the different facets of development, unfortunately often implementing technology-led interventions that do not yield the expected results. The following comments can be applied in a general nature to most African countries, with caution that Africa is too large and too diverse in human development to be characterized by single statements. Indeed, each country’s unique aspects have to be taken into account in formulating any initiative.

i. The education sector involves on a full time basis, directly or indirectly, a very large portion of a national population: students at all levels of education; teachers; education managers; regulators; policy makers; and a significant portion of the private sector that offer services, support, facilities, or learning materials to schools. There is also a large population attending non-informal education. Transformation in the sector is therefore a major exercise that requires involvement of all stakeholders within a carefully synthesised policy and strategy framework.

ii. For a long time, especially during the eighties and nineties, most developing countries in Africa, driven by structural adjustment requirements and conditions, removed public investment in education from the priorities: this slow down has led to a current massive deficit in most African countries in terms of classroom space, trained teachers, and educational resources of all description.

iii. The challenge of massification (used in Africa in the context to refer to rapidly increasing enrolment) has meant that the systems cannot cope.

iv. The combined challenge of accumulated national debt (despite some major write-offs) combined with low GDP and multiple demands on the public purse has led to expenditure levels on education well below the UNESCO recommended percentage
for developing countries. This makes it very difficult to address both the current demands as well as the resources deficit accumulated over the years.

v. The challenge of low salaries and poor benefits for teachers has impacted severely on motivation and the overall quality of education.

vi. The challenge of corruption undermines development initiatives in the sector as major portions of the funds allocated by government or development partners are siphoned out.

Policy makers are also increasingly focusing on decentralized approaches to education to facilitate decisions at local levels. This has significant implications to the way ICTs are applied to teaching, learning and management.

Computerisation remains extremely low in the overwhelming majority of schools in Africa and, for all intents and purposes, non-existent. This is compounded by the challenge of getting teachers and technical human resource who can handle ICT integration in education.

It is clear from the above that any transformation undertaking will have to address more than the central issues to increase likelihood of success, and will be resource intensive. The current situation however provides, for most countries in Africa a green field environment in which etransformation can be constructed without the challenges caused by legacy systems. This creates flexibility in terms of selecting solutions that would best address the key thematic areas looked at in this study. Additionally, Africa is the new technology frontier, and is now a recognised hub of innovation especially with respect to mobile applications driven by near ubiquitous mobile signal coverage.

**Introducing the Thematic Areas**

i. **Teacher Professional Development**

Teacher skills and knowledge in ICT integration are imperative if schools are to produce students with adequate digital and numeracy skills to enable them to function effectively in 21st century economies. Current approaches to teacher’s professional development are largely ad hoc. The introduction of ICTs to teachers have limited focus on its transformative role in teaching and learning processes. The attention is often on increasing teacher’s computer and web search literacy.

In order for teachers to integrate technology into teaching and learning more effectively, the focus of training should embody effective pedagogy for teaching and learning for any classroom situation, be it technology enabled or not. Further, teacher training in ICT integration should not only be focused on their use of ICT for teaching learners, but should show them how ICT can be used to enhance other job and social functions, for example administration and communication.

ii. **Digital Learning Resources**
In this discussion, digital learning resources (DLRs) include educational content (materials that are designed to support teaching and learning directly); software tools (applications developed for a wide range of functions – operating systems, management information systems, authoring, learning management systems, etc); and implementation resources such as copyright licenses. There has been a significant growth of digital learning resources world wide that can be tapped into and adapted to the local settings. The main challenges facing digital learning resource is lack of integration and adaptation to meet local settings.

iii. Affordable Technologies

End user access is the point where cost scales up rapidly per user added because of the cost of end user devices. End user devices need to be affordable relative to the incomes of users. The focus in this study is on the opportunities and challenges for use of mobile devices and smart phones for access to learning materials and collaboration platforms.

iv. Education Management Information Systems (EMIS)

EMIS provide support to decision making, policy analysis and formulation, planning, monitoring and management at all levels of an education system through enabling the quick access to, and easy correlation and analysis of data relating to the educational sector. The biggest challenge in African countries is having accurate, comprehensive, up to date data. The use of data for meaningful planning and resource allocation is another chronic challenge that rendered efforts that focused on collecting data worthless.

v. National Research and Education Networks (NRENs)

NRENs provide dedicated data networks serving the data communication needs of principally non-profit universities and research institutions. They enable access to online resources, provide a platform for collaboration, meet the “on demand” bandwidth needs of the education and research community that cannot be served by the commercial sector, enable the sharing of resources, and support advanced applications, elearning, and ehealth. They also create social value by including communities outside their primary research university constituencies, like primary and secondary schools, libraries, museums, scientific and cultural institutions.

Challenges/Barriers

The following key challenges that also identify areas where intervention is required were identified:

i. Absence of comprehensive policy and strategy

A well thought out policy and strategy for the integration of ICT in the entire education system can be a major tool for mobilizing approaches, consensus and resources. The lack of comprehensive policies addressing the integration of ICT in education remains one of the major barriers in Africa. To be effective, the national ICT in Education policy must be complete with a time bound implementation strategy and the necessary institutional
arrangements, resource allocations, and monitoring plan to ensure that implementation can and will take place.

Policies in the telecommunications and ICT sector also have a significant bearing on the way ICTs are used in the education sector. The absence of open competition in the telecommunication sector, caused by poor policy and regulation, is the greatest causatory factor for high bandwidth costs in the majority of Africa countries. Tax policies and laws also impact on the cost of technology, impacting end user access. Policy and laws defining the intellectual property environment are necessary for enabling different approaches to OER, and to technology transfer and adaption. All these have to be addressed at the policy level.

**ii. Lack of awareness and ownership of initiatives**

Awareness here refers to an appreciation of the potential of ICT as an enabler for the learning process and the consequent impact of ICT enabled graduates on national development. Awareness of the potential of ICTs at decision making and project formulation levels has been the key constraint in Africa due to inadequate flow of knowledge, over reliance on external advice and more importantly the dynamics of the ICT sector which presents choice, alternatives and challenges. Lack of awareness also leads to lack of ownership. Ownership stems from involvement in the formulation, planning, and implementation processes. Lack of awareness is a threat to sustainability: the policy, strategy, or initiative will collapse as soon as the external drive and funding support are withdrawn.

**iii. Funding constraints**

Many governments do not allocate resources that are necessary and sufficient for the education sector to achieve the MDGs, partly because of overall insufficiency of resources and partly because of priority setting challenges. Low funding levels are compounded by sometimes severe deficits in classroom space, teachers, requisite skills to enable the mainstreaming of ICT in education and learning materials; absence of campus networks; high cost of access devices; and massification (rapidly increasing enrollment). This is aggravated, again in many countries, by corruption.

**iv. Lack of competent human resource**

Human resource required for an ICT-enabled education sector is wide-ranging, including:

a) Suitably trained teachers able to use available tools and resources to develop digital content and engage students effectively in an ICT-enabled learning environment.

b) Teacher trainers and tutors who are able to support trainee and in-service teachers in acquiring the requisite skills for the environment;
c) Administrators, education managers, and policy makers who fully understand the environment, its challenges, and its opportunities in order to create and sustain the necessary policy strategy and ensure ongoing availability of the required resources;

d) Technical human resource that enables the technical back-end processes and also offers technical support at all levels;

e) Programmers and software engineers who are able to engage in the open source communities and support institutions in Africa;

f) Managers and implementers of the large scale ICT for education programmes,

h) The legislators who approve government policies and expenditure allocations.

The shortage is largely due to curricula in training institutions that supply human resource not matched to needs, taught by lecturers who do not yet understand the real needs of the sector. The absence of high managerial and technical skills is one of the chronic challenges facing the implementation of ICT projects aimed at school computerization, the deployment of EMIS and National Research and Education Networks.

v. **Lack of incentives**

The integration of ICT in learning will require retraining and call for new time demands on teachers 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.

vi. **Wide range of stakeholders**

The wide-range of stakeholders means that any consultations related to policy and strategy need to be well thought out, starting with the identification of all stakeholders and defining roles. It also takes longer to create common positions and to get to the stage of implementation. If the consultation process is well managed, the wide range of stakeholders brings on board multiple perspectives and multiple players and creates the kind of vibrant environment where users can get choices say in digital learning resources, access technologies, and capacity building opportunities.

vii. **Technology-led initiatives**

There has been a common tendency to use technology people (engineering and/or software skills) to lead the implementation of ICT in education projects. People who are trained in and understand education play a secondary and often peripheral role. Technology-led initiatives may appear successful at the technical level but will not achieve the expected outcomes and impact. They are consequently not sustainable.

viii. **High cost of technology**
There are hardly any technology companies in most African countries, with almost total reliance on imports that, more often than not, are designed for developed country markets and environments rather than tailored to the African context. There is therefore a near total dependence on imports. Considering the wide range and the massive numbers the African countries have to deal with to make ICT-enabled education the norm rather than the exception, the cost is not sustainable.

ix. Limited access to the Internet

Limited access to the internet results from:

a) Limited coverage up to and including then last mile (fibre, microwave links, wired and wireless distribution within the campus)

b) Limited availability of access devices (PCs, laptops, mobile phones, tablets, etc)

c) High recurrent cost of local and international bandwidth

x. Limited access to power

Electricity in Africa continues to be a major challenge that has a huge impact on access to the devices, and power-back up will only increase the running cost of these devices. Wireless and mobile technologies that are very promising in terms of achieving mass access need to have independent access to power.

xi. Underdeveloped private sector

The private sector 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. The private sector in many African countries was unfortunately suppressed for a long time due to a high dependence on monopoly parastatals and lack of government policies that 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 supply of human resource. While there is an increasing number of start ups, very few countries in Africa have the kind of developed private sector that would effectively support the integration of ICT in education.

xii. Limited impact research

There are gaps in research in the use of ICT in education in so far as it relates to its impact. Much of what is written has positive biases, being often written by members of implementing organizations. There is an ongoing need for rigorous impact evaluation studies on educational technology initiatives in developing countries. Ongoing monitoring and evaluation is required to build up the evidence base of what works in the long term and what does not.
xiii. **Social, economic and cultural issues**

Technology tends to reinforce existing social and cultural inequities. As governments move to the full integration of ICT in education at all levels, the groups that normally suffer from technology marginalization (urban-rural; rich-poor; male-female) are likely to be disadvantaged even more. There is a need to understand and pro-actively seek to address these challenges.

xiv. **Sustainability**

Major government initiative are sustainable if they are conceived within the framework of a comprehensive policy and strategy; are owned by the leadership and stakeholders; have sufficient allocation of resources; are supported by a competent human resource; take into account all environmental factors; and are well-defined. The failure to look at total cost of ownership has been a major challenge in the evaluation of initiatives and technology acquisitions. Donor-led projects have unfortunately often also not looked at sustainability.

 xv. **Absence of ICT in learning in pre-service training curricula**

Often, colleges of education do not address ICT integration because the faculty members themselves have not been prepared to use technologies effectively and cannot support students in integration. In some cases where student teachers are taught about ICT, this is taught as a separate subject, and not as part of curriculum integration. Colleges that teach it as part of curriculum integration may have the challenge that students do not get a chance to model lessons using technology, as their practice teaching schools may be technologically deprived, or the supervising teachers may lack ICT integration skills to support the student teacher meaningfully.

xvi. **Making the right choice about teacher training programmes**

There are many programmes on ICT integration for teachers, making decisions about which programme to choose harder. As a result, some governments are being coerced into subscribing to specific courses by some private sector ICT companies, based on negotiated deals that include discounts, without governments necessarily evaluating the quality of the programmes. These deals often expose the disadvantages of lack of training of a leadership in the Ministry of Education to make informed and valuable choices for schools and teachers.

xvii. **Lack of locally contextually relevant digital learning content**

There is little digital education content that is locally contextually relevant or based on local curriculum frameworks. Content currently available online often does not cover the specific requirements of African curricula, so tends to be supplementary in nature. The absence of educational content directly linked to curricula is one of the key inhibitors of ICT use by teachers and learners.

xviii. **Rapid technology evolution**
The changing nature of technology literally means that before one generation is evaluated, the next generation is on the market. Technology can therefore be evaluated only from general principles, not specifics. Much of the technology covered in this document is new and so its impact in education is not fully understood.

**Scalability**

Many of the projects are pilots and implemented on a small scale and still need to be assessed for adaptability and scalability.

**Data gaps**

With regards to EMIS, there are sometimes data gaps especially relating to the private education sector; the informal education sector; and pre-primary school sectors. All these play a very significant role in the sector, and lack of data, or inaccurate data, will result in policy initiatives and decisions that are based on the wrong premises.

**Lack of authorizations for NRENs to operate, and cross-border barriers**

An NREN needs authorizations from regulators that enable it to deliver services to members. They need licensing to own and operate a network for a closed user group that is national in scope; connect with NRENs across the national borders; and transit traffic for other NRENs. This has been a major hurdle in most African countries. Even when that is achieved, cross border physical connections run into other challenges that often force them to work through expensive incumbent service providers.

**Weak financial base of start-up NRENs**

Where there are no tangible services being offered, it is difficult for member institutions that are themselves cash-strapped to contribute to a start-up organisation. This has been a major barrier to the organizational and operational development of African NRENs.

**Opportunities**

The major cross-cutting opportunities identified include:

1. **Interest of development partners in supporting ICT in education**

There is a wide range of development partners including bilateral, multilateral, and private sector that are interested in supporting the implementation of ICT-enable education in African countries. While, due to sustainability concerns, development partners should not support recurrent funding except for pre-defined timelines, they can help in addressing the start-up capital (which can be very high for some initiatives) as well as innovation, research, and evaluation.

2. **Communities of Practice**
Communities of practice, bringing together groups of people facing the same challenges and likely to benefit from common approaches, are an opportunity that can be exploited across all sectors. This applies to all the themes discussed.

**iii. Increasing rollout of competitive fibre to Africa and within African countries**

Over the last five years, many governments have moved to establish extensive national data backbones, supplementing private sector initiatives that were observed to move very slowly. Access for the education and research sector is been made a priority in most cases. At the same, better regulation has allowed fibre from utility companies (especially power, railways, and oil pipelines) to come on to the market. Increased competition has led to reduced prices.

During the same period, there has been a sharp rise in actual fiber construction projects targeting Africa and creating real competition within the international bandwidth market

**iv. Increasing penetration of wireless and mobile platforms**

The new wave of opening up telecommunication markets and the growth of regional operators has lifted competition in the mobile sector to a new high. This has led to rapid rollout, very competitive price offerings, and fast improvement in capability with all providers offering 3G services that enable much faster internet access than before. In addition to the mobile platforms, WiFi and WIMAX penetration is increasing rapidly, creating the opportunity for wide scale deployment of wireless access devices.

**v. Increasing affordability and choice among devices that link through mobile and wireless platforms**

The proliferation of mobile phones has meant that more learners have access to ICT devices than has been the case previously. This offers opportunities to look at how access to these devices can be used to support learning.

**vi. Availability of online content**

The ready availability of multimedia resources is making it easier for students to become more interested in their own learning as they explore the Web to locate information to supplement their own understanding of various topics. Online content can be greatly beneficial for rural and poorer institutions that have inadequate access to traditional resources such as printed materials. If online content resources are good, this can increase the demand for access to the Internet

**vii. Open Educational Resources**

Digital content can become more effective and efficient if it is built upon the prior work of others. OER offer greater scope for new work to be built upon existing works and for people to share in the development and use of such new works. OER has potential to build capacity by providing institutions and teaching staff access, at relatively low cost, to the means of production of educational materials. This can help to develop their competence in
producing such materials and carrying out the necessary instructional design to integrate such materials into high quality programmes of learning.

viii. Social networking

Social networking is on the rise in Africa; it can therefore be exploited to facilitate real time reporting on school data and other related aspects such as resource usage.

Recommendations to Policy Makers, Regulators, and other Stakeholder

Policy and Strategy:

Governments should take the following major steps (steps that have already been addressed by particular governments can be omitted or revisited to ensure that there are no gaps):

i. Carry out a comprehensive baseline survey of the education sector to inform both the policy and strategy processes. This includes a comprehensive map of stakeholders along with their roles.

ii. Formulate a national ICT in Education policy through a consultative process that will also create awareness and ownership. This should have as a component a comprehensive implementation plan along with a budget and tools for monitoring and evaluation; should assign responsibilities to defined institutions; and should include methods of funding, indicating what will be available from government and what needs to be sourced from elsewhere.

iii. Define the education standards against which progress will be measured and assign responsibility to the appropriate agency for monitoring and compliance enforcement.

iv. As a pre-condition or concurrent requirement, elaborate and implement the national ICT Policy and e-government to provide a comprehensive environment for the implementation of ICT in Education.

Open Educational Resources

Governments need to:

i. Develop and implement policy and laws that protect intellectual property, along with the necessary institutions for enforcement.

ii. Develop and implement policies and strategies that will promote the growth of OER that are tailored to the curriculum, language, and context of the country. Such policies and strategies should include engagement of the relevant organisations in the private and NGO sectors.

Institutions need to:

i. Have clear internal policies that relate to copyright ownership among the different participants in the development of digital learning content, with emphasis as
licensing as much of the output as possible under the Creative Commons Licensing provisions.

**Capacity Building**

Governments need to:

i. Develop and implement ICT in education capacity building programmes for all those involved in the implementation of ICT education, starting with the political leadership and policy makers through teacher trainers and school heads and administrators. Such programmes should be conducted as much as possible through digital learning environments. Where appropriate, governments could source the necessary external expertise, including from development partners, NGOs, and the private sector, to do this.

Institutions need to:

i. Review their curricula where they relate to professionals within the education sector (for example teachers), or who support the sector (for example ICT professionals) with input from the private sector, the NGO sector, and ICT in education experts to ensure that graduate match the needs of the sector.

ii. Put in place the necessary internal policies and infrastructure to ensure that ICT-enabled learning is implemented in the institutions.

iii. Develop and implement programmes that will ensure that in-service training for ICT integration in education can be availed on a continuing basis.

The private sector and NGOs need to:

i. Engage the government and institutions to identify capacity gaps that they can address in a supporting role to government and institution capacity building programmes.

**Connectivity and Access**

To address connectivity and access challenges, governments need to:

i. Place broadband access for educational institutions on the national development agenda as part of the social services sector. This should include access to national or commercial data backbones as well as access to international bandwidth.

ii. Establish education rates (e-rates) for the education sector

iii. Work with ICT regulators to permit full competition in the telecommunications sector.

iv. Work with regulators to ensure that NRENs, as dedicated carriers of education and research traffic have the necessary permissions, licenses, or authorisation to own and operate independent national networks for their closed user group; own and
operate international gateways (including fibre); and transit traffic for NRENs in neighbouring countries.

v. Work with the private sector, NRENs, and regulators to ensure that schools have access to the internet through wired or wireless access, based on context specific evaluation of what approach is best. This could be part of the national universal access targets.

vi. Implement programmes that will ensure that teachers increasingly get more computer time until individual full time access is achieved; and that students get increasing online time through shared or individual access, according to level, so that they can engage effectively in a digital online learning environment. This could be made part of the national universal access targets.

vii. Remove barriers (where they exist) to the use of mobile phones by students for learning. This includes implementing number portability so that the individual has the choice to use any mobile network without operator imposed barriers.

viii. Remove tax barriers to access – extending from active backbone devices, servers and related equipment for NRENs, to tax barriers to recurrent use.

ix. Engage the private sector in PPP arrangements that will promote access to more bandwidth at lower cost for the education sector; and technology development and transfer to reduce on imported technology.

**Sustainability**

Government and education institutions need to:

i. Integrate Total Cost of Ownership in sustainability planning, which should be an integral part of policy, implementation plans, and initiatives.

ii. Plan and provide incentives to teachers who undergo training and use ICT-enabled learning approaches in their work.

iii. Work with the private sector in developing and implementing PPP initiatives to ensure that the current total dependence on importation (for most African countries) of all the technology required for both access and content is reduced over time.

iv. Carry out ongoing impact evaluation and subsequent strategy iteration to ensure continuing improvement.

**Theme-specific recommendations**

**Teacher Professional Development**

Governments and institutions need to:

i. Adopt a suitable global professional development framework to guide national implementation of ICT professional development. We recommend use of the
UNESCO ICT Competence Standards for Teachers and Teacher Training, as a useful starting point for planning professional development strategies at national level.

ii. Make ICT integration a mandatory aspect of pre-service teacher training

iii. Build into professional development strategies incentives for teachers linked to enhancing their knowledge of ICT integration. These incentives should not only be based on acquiring a qualification, but also on demonstration of successful integration of ICTs to enhance educational outcomes.

iv. Provide teachers access to post-training support structures, for example technicians for troubleshooting, and mentors and coaches for sharing ideas and resources and encouraging teachers.

v. Implement schemes that enable growing numbers of teachers to gain access to their own computers (with a possible emphasis on mobile devices such as laptops or netbooks).

vi. Ensure that the national system gives teachers a choice of which training they can take, to enable them to select needs-based courses. Careful selection of available training is needed, so that programmes that are selected are useful for the work of teaching and are able to help teachers improve learning outcomes. Teachers will only adopt technology if it serves their purposes, that is, help them perform their teaching duties effectively.

Digital Learning Resources

Governments and institutions need to:

i. Review and adjust as appropriate existing national/institutional policies and staff incentives schemes to ensure that they encourage educators to invest time in ongoing curriculum design, creation of effective teaching and learning environments within courses and programmes, and development of high quality teaching and learning materials.

ii. Ensure that budgets for purchasing educational materials allow for procurement of materials across a wide range of media types and formats. Given current bandwidth and connectivity challenges, a balanced mix between digital and printed resources is required. It will be beneficial for education curriculum experts to evaluate freely available digital content in the same way that is done for physical texts so that schools/colleges can make appropriate and informed choices between different products.

iii. Consider judicious investments in content creation to ensure compliance with African curricula, or local language demands, motivating usage by teachers and learners. In the first instance, priority content could be sourced from open content. If
this is not available, it will be useful to identify and invest in priority content development focus areas that might not be covered through an open market.

iv. It may be worth investing in a centralized, national content development process (run through competitive tenders) which will lead to the generation of content. Additionally, it is recommended that incentive mechanisms 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, but with proper recognition, by the public.

v. Ensure that the country and individual institutions have in place robust, enforceable IPR, copyright, and privacy policies (addressing possible full-time, part-time and contract staff as well as students any and all of whom might become involved in a team-based curriculum and materials development process). As part of this policy process, consider the relative merits of creating flexible copyright policies that automatically apply open licences to content unless there are compelling reasons to retain all-rights reserved copyright over those materials.

vi. Invest in ongoing awareness-raising, capacity-building, and networking/sharing activities to develop the full range of competences required to facilitate more effective use of educational resources in education delivery.

vii. Adopt and support the use of content management and authoring tools (web content editing tools, content management systems), templates, and toolkits that facilitate the creation of adaptable, inclusively designed educational resources.

viii. Invest in knowledge management systems and strategies to store, curate, and share educational content. Ideally, to ensure cost-effectiveness, this would be done as part of a coordinated national strategy or in partnership with emerging global OER networks and repositories. This should ideally be accompanied by ongoing investments to ensure that teaching staff have access to the necessary ICT infrastructure and connectivity to access the Internet and develop or adapt educational materials of different kinds.

**Affordable Technologies**

Governments and institutions need to:

i. Address affordable technologies as just a tool and approach it within the context of the entire eco-system (e.g. access to electricity; access to technical support)

ii. Use PPP to get technologies as close to affordable as possible.

iii. Support experimentation with technologies in education, to effectively learn from these experiences and share the lessons learnt.

iv. Carry out evaluation and research to determine the impact of a particular technology or approach as well as for understanding how, when and why something does or
does not work. It is also important that the lessons learnt are documented and shared with stakeholders to enable continuous learning.

**Education Management Information Systems (EMIS)**

Governments and institutions need to:

i. Build capacity at all levels in using EMIS for decision support.

ii. Design EMIS with decentralization, scalability and cost in mind while exploiting the opportunities provided by open source, wireless technologies, broadband, GIS and other emerging tools such as Web services and Web 2.0.

iii. Promote common and open systems that can be supported through the sharing of scarce human resource (this can be required for institutions under direct government direction and encouraged for others).

**National Research and Education Networks**

Governments need to:

i. Support start-up on a decreasing basis NRENs through direct funding and inkind support to enable them to get to an operational level where they can cover recurrent costs through user-charges.

ii. Support schools and campuses in the development of wired or wireless networks; provision of access devices; and ongoing technical support.

iii. Requirement regular industry input into university curricula, involvement of people from industry as occasional lecturers, and internship requirement for students.

iv. Implement industrial training levies as well as obligatory absorption of students for internship – supported with suitable incentives like tax breaks.

v. Support the development and growth of content networks

**Recommendations to Development Partners**

Development partners have two entry points: direct support to governments for specific initiatives, or direct support to institutions or organizations of institutions that are addressing any of the main thematic interventions.

**Initiatives that fall under government direction**

i. Support governments in the development of a cross-cutting policy and strategy for ICT in Education.

ii. Develop reference guidelines as well as model policy frameworks for ICT in education for countries at different stages of inception or implementation.

iii. Develop graduated interactive on-line learning materials along with equivalent printed formats for various stakeholders, through which they can fully understand and appreciate the role, importance, and issues around ICT in education. This could
include the stages and content in developing policy frameworks and implementation strategies for ICT in education.

iv. Support governments in defining and establishing policy and legal environments as well as initiatives that promote the development and use of OER.

v. Support governments in defining approaches and frameworks for PPP arrangements that will support the growth of locally produced hard and soft resources for ICT in education, with some focus on affordable technologies.

vi. Address, through incentives, innovations (technology or strategy) that address the needs of the ICT in education undertakings, including scaling up. This applies for example to support for the production of low technology devices that can be used for charging the growing multitude of portable of handheld devices, including laptops.

vii. Support research aimed at rigorous impact evaluation studies on educational technology initiatives in developing countries.

viii. Support governments in conducting curriculum reviews especially where external to government expertise is needed.

ix. Support the adaption of learning materials imported from different settings to local contexts.

x. Support acquisition and implementation of EMIS with a focus on open source platforms which focus on data collection and use at school and college levels with integration at district and national levels.

xi. Support the revamping of the EMIS Units to play a key integration role using modern web, GIS and distributed database tools. In addition there is a need to build the capacity of Ministries of education in developing EMIS policy and standards and using the web for dissemination of educational information.

**Initiatives that can be handled by institutions or organizations of institutions**

i. Support EMIS development at school level, possibly through piloting with a selection of core schools with a programme of rollout to other schools as capacity grows. Development Partner investment should target supporting standardised EMIS that are developed using open standards and capable of interfacing with, GIS, social networks and mobile and low cost computing; and building the capacity of data providers and users in schools.

ii. Support districts to enhance the decentralisation of EMIS and increase the capacity to use multiple channels to carryout decentralised planning at that level. Donor support to districts needs to encompass the installation of web-based distributed databases and information systems using open standards capable of integrating school information resources. Capacity is also needed to improve data verification and usage at the district levels.
iii. At the higher levels of education, support:
   
a) Content networks: Library; e-learning; grid-computing; agriculture; medicine and e-health are some of the sectors where there already exist established or emerging content networks.

b) National Research and Education Networks

c) Regional Research and Education Networks

d) Support NRENs in extending connectivity through long term (IRU) leases, backbone connectivity and last mile access to educational institutions
1. INTRODUCTION

1.1 Background to the Study

This study is part of a cross-sector study conducted by the World Bank Group and the African Development Bank, with the support of the African Union, intended to produce a report on how information and communication technologies (ICTs), especially mobile phones, have the potential to transform the education sector in Africa. This is in recognition of the reality that the future development of Africa will be heavily influenced by how Africa manages to deliver quality education to its citizens.

Increasingly, countries across the globe are embracing a vision for the development of knowledge societies and adopting policies and strategies to encourage this development. Education is a critical requirement in the knowledge society, being a source of basic skills, a foundation for development of new knowledge and innovation, and an engine for socio-economic development. The African Union specifically recognises this in its Second Decade of Education for Africa (2006-2015) Draft 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”

While ICT is seen as a way to promote educational change, improve the skills of teachers and learners, and prepare them for the global economy and the information society, it is important to make a precautionary statement at the outset: technology of itself should not be seen as the heart of change, because this leads to failure. Technology integration is only successful if it is introduced within a holistic framework to support well thought out business processes in particular educational reform and planning at all levels. Specifically, for education sector, pedagogy must be placed at the center, and also be the main driver of transformation with technology as an enabling tool where appropriate—this is the route to successful technology integration.

The potential of using ICT to tackle some of the challenges facing education, and thereby impact on development, has led to efforts in many African countries to invest in ICT in order support their development strategies. However, African countries face challenges in terms of capacity, capability, and resources (human and financial) to harness the potential of ICT successfully and effectively. More often than not, they also face the challenge of not knowing how to approach the integration of ICT in the different facets of development, unfortunately often implementing technology-led interventions that do not yield the expected results. Policymakers therefore face major hurdles in trying to create conditions that support these developments in their countries, whilst also creating policies and programmes that harness their effects to support economic growth and the public good.

It is against this backdrop that this study was formulated. This study examines the potential for exploiting information and communication technologies (ICT) to support the transformation of
the education sector in Africa. A key objective is to raise awareness and stimulate action, especially among African governments and development practitioners, in using ICTs to contribute to the improvement and transformation of education. The study identifies specific opportunities and challenges, and recommends possible approaches to scaling up the successful application of ICTs and to further operationalising their use within the education sector, while taking into account associated constraints and risks.

The following five thematic areas were examined:

**Teacher Professional Development**: with an emphasis on the contextualization and implementation of a teacher competency framework that also addresses ICT in education.

**Digital Learning Resources**: with an emphasis on the experience and challenges for development of open educational resources that are responsive to development needs.

**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.

**Education Management Information Systems (EMIS)**: with an emphasis on the opportunities and challenges for mobile data collection and dissemination.

**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, and how these can reach out to all levels of education.

It should be noted that while these five thematic areas are strongly interrelated, the competence of teachers, and the availability of learning resources, both digital and traditional, sit at the heart of any successful programme. The other three (Affordable Technologies, EMIS, NRENs) simply create the environment in which good pedagogy can thrive.

### 1.2 Methodology

The methodology was based on a combination of desk research, questionnaires and interviews with selected experts and stakeholders, country cases studies, and online engagement using the Educational Technology Debate\(^1\) and eTransform Africa\(^2\) websites.

During the Desk Research, we sampled the African and global environments for examples that relate to the study, and identified lessons and best practices as well as opportunities and challenges within each of the five thematic areas. This was followed by engagement using questionnaire with more than fifty experts and stakeholders, followed by interviews with a cross-section of the same group. The respondents provided insights, examples, and specific experiences that contributed to information and insights gathered through the desk research.

Three Country Case Studies were conducted: South Africa was a desk research case study because of the rich selection of published literature. Uganda and Senegal were deep dive case studies,

---

1. [www.edutechdebate.org](http://www.edutechdebate.org)
2. [www.etransformafrica.org](http://www.etransformafrica.org)
involving field and desk research as well as a country workshop bringing together key 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, five covering each thematic area, that were posted on the Educational Technology Debate website, providing opportunity for wider input. Progressive preliminary outputs were also posted on the web, permitting comment and input from various stakeholders, and ensuring that the final report and recommendations take into account the views of a diverse audience. The Methodology is fully detailed in Annex 1.

1.3 Setting the Context

1.3.1 General Considerations

The past ten years have seen an unprecedented explosion of innovation in ICT, leading to a sometimes bewildering array of new technological options that can be harnessed to support education, in its managerial and administrative operations, in teaching and learning, and in research. A significant proportion of these developments have emerged as a consequence of the growing availability of high quality, stable broadband Internet connections. Indeed, perhaps the defining feature of the development of the Internet in recent time has been the rapid growth of Web 2.0 platforms. This growth is predominantly driven by assumptions that participants (not users) are able to be online, in a broadband environment, 24 hours a day. The problems associated with this for people living in countries or areas where such Internet access does not exist or is not affordable are significant.

In places where technology is readily accessible, “digital natives” (i.e., people who have grown up with ubiquitous access to ICT) will continue to demand that more learning be delivered asynchronously, via whatever electronic telecommunications device they have available, including – increasingly – low-cost laptop computers, mobile telephones, Personal Digital Assistants (PDAs), and MP3 players. Consequently, mobile and personal technology is increasingly seen as a delivery platform for services of all kinds, although the value of educational benefits is as yet unproven.

Critically, the emergence of these, and other related technological innovations has tremendous potential to accentuate the digital divide within education, conferring benefit on those with access to ICTs and further marginalizing those without such access. However, while provision of hardware has been an essential focus of debates on the digital divide, it is now seen as only one of a range of factors that must be tackled to increase participation in the information economy: the digital divide is multi-faceted challenge. It includes access to hardware and affordable/reliable broadband Internet connections, information literacy, extent of integration of ICT into the social fabric of everyday life, provision of technical and training support, and access to compelling applications and content. While the growing opportunities are recognized, it is important to note that throughout sub-Saharan Africa, there are other dimensions, totally outside the usual realm of ICT, that

---

3 Part of the discussion in this section is based on the thematic paper, “ICT, Education, Development and the Knowledge Society”, prepared for GeSCI by Neil Butcher Associates
accentuate the divide: food-security; poor governance, evidenced by instability and fragility; environmental degradation and its consequences; poverty; disease – all these can determine the success or failure of any initiative, including those that are ICT-based. This calls for pragmatic approaches that work within these realities to achieve incremental improvement.

The emergence of national research and education networks (NRENs) across Africa especially over the last five years – initially driven by access to sufficient and affordable bandwidth, and now increasingly by the recognition of the development potential of local and international research and education collaboration – is a major opportunity for Education in Africa. NRENs create the opportunity to reach out to all levels of educational institutions as well as libraries and hospitals. They create the physical network that enables collaboration and resource sharing, and also provide affordable backhauls to both concentrated and distributed knowledge repositories (local, regional, and global). The African NRENs will however continue to face the challenge of last mile connectivity for most institutions, as well as a final access challenge for the majority of end users. Wireless technologies therefore have a major role to play in completing the connection.

The potential impact of ICT on learning is the vision that it enables learning anywhere, anytime, and anyhow: knowledge is not constrained by geographic proximity, and offers more possibilities for sharing, archiving, and retrieving. In addition, the knowledge society and widespread use of ICT generates a need for new digital skills and competences for employment, education and training, self-development, and participation in society. Provided it is correctly approached and applied, ICT has the potential to widen access to educational resources, improve the quality of learning, and improve management efficiencies of the education system. Put another way: ICT can be a very useful tool, but it is neither the driver of, nor the determining factor in an improved learning environment.

ICT use in education and development to build a knowledge society is not simply about teaching ICT literacy, i.e., learning to operate the technology: it is more about building higher-order skills, such as knowing and understanding what it means to live in a digitized and networked society and to use digital technology in everyday life. This includes understanding how ICT applications and services function, as well as knowing where to search for certain information, how to process and evaluate information, and how to assess the reliability and trustworthiness of multiple sources of information (online and offline). It is especially important, when dealing with educational content, to be able to assess the quality and reliability of knowledge and to contextualize it effectively. In addition, there is a need for networking skills related to building, maintaining, and developing social interaction using ICT.

If African societies are to harness ICT effectively to build knowledge societies, the implications are that there will be changing skills requirements for students, as well as changing roles for educators. Schools and universities need to provide formal instruction in information, visual, and technological literacy, as well as in how to create meaningful digital content using modern tools. This requires education institutions to develop and establish methods for teaching and evaluating these skills at all levels of education. It also requires employers to continue to engage in training,
mentoring, and professional development practices that achieve similar objectives within the workplace.

It should be noted that at the back-end, there is also need to build the technical human resource that will ensure the availability of infrastructure, services, systems and applications: this must be addressed hand in hand with any initiative to exploit the increasing opportunities for IT-supported teaching and learning.

Seen within this context of social transitions towards a knowledge society, UNESCO outlines the following as broad reasons for growth in use of ICT within education systems:

i. Development of knowledge-society attributes in students, including higher order thinking skills, lifelong learning habits, and the ability to think critically, communicate, and collaborate, as well as to access, evaluate, and synthesize information.

ii. Development of ICT skills and competencies in students, as preparation for operating in an ICT-rich workplace and society.

iii. Resolution of structural problems and deficits in education systems. This can include using ICT to enhance administrative and teaching efficiency, alleviate under-resourcing in specific areas (for example, a lack of textbooks or learning support materials), address equity issues through enabling equality of access to knowledge, resources and expertise, or support teachers who may be under-equipped to deal with new teaching challenges.

1.3.2 The Education Sector in African Countries

In order to contextualise the environment that is being addressed, various key features of the education sector in Africa and its environment need to be highlighted.

First is the qualification of this statement itself – it is not possible to sum up such a large diverse continent that covers more than the combined areas of the USA, Europe, India, and China correctly either quantitatively or qualitatively because of the very wide diversity and variations in the quality of life. This must qualify any reference to Africa in this report, because no single description can be taken as truly representative. Each country, and each region in that country, can be very distinct in terms human development. The statements used below are generalisation: each country would have to be examined to see which of them apply and to which extent. This also means that any proposed adaptation of initiatives in any country needs to start with a careful examination of the national environment to assess what can and what cannot apply.

Second is the general truism that in any context, the education sector is the most extensive in terms of involving on a full time basis, directly or indirectly, the largest portion of a national population. This is especially so in sub-Saharan Africa where the life expectancy tends to be low, fertility rates high, and the population young. There is also a large population attending non-informal education. The population actively involved in the sector combines students at all levels of education, teachers, regulators, and policy makers. It also involves a significant portion of the

---

private sector that offer services, support, facilities, or learning materials to schools. Transformation in the sector is therefore a major exercise, requiring involvement of all stakeholders within a carefully synthesised policy and strategy framework.

Third is the fact that for a long time, especially during the eighties and nineties, most developing countries in Africa, driven by structural adjustment requirements and conditions, removed public investment in education from the priorities: this slowdown has led to a current massive deficit in most African countries in terms of classroom space, trained teachers, and educational resources of all description.

Fourth is the challenge of massification that has been compounded in Africa by the two factors above. While massification in the global context refers to total enrolment above 50% driven by, among other factors, globalisation and the knowledge economy, it is used to refer more to sustained high growth rates of enrolment in Africa. Even if actual enrolment is low, the systems cannot cope with rapid rise in the numbers demanding increasingly higher and better education as citizens position themselves for personal competitiveness in a globalised economy where individual competition comes from across the borders.

Five is the combined challenge of accumulated national debt (despite some major write-offs) combined with low GDP and multiple demands on the public purse. The macro-economic performance of many economies in Africa appears good in terms of growth, but the absolute levels remain very low. This makes it very difficult to address both the current demands as well as the resources (classrooms, teachers, learning materials) deficit accumulated over the years. It is true that this is partly caused by, in many cases, poor governance and lack of prioritisation, but that is just part of the challenge.

Sixth is the challenge of low salaries and benefits for teachers that have impacted severely on motivation and the overall quality of education. A symptom of this, using Uganda as an example, is that private schools, which used to have the worst performance twenty years ago, are now generally the best and most sought after by those who can afford it, while most public schools have dropped drastically in performance and are becoming the recourse of the poorer sections of the population.

Seventh in the challenge of corruption that undermines development initiatives in the sector as major portions of the funds allocated by government or development partners are siphoned out. As one stakeholder in the Uganda Case Study workshop put it, “Officers in the Ministry of Education see each new initiative as a deal”.

Eighth is the fact that computerisation is extremely low in the overwhelming majority of schools in Africa and, for all intents and purposes, non-existent. Any initiative to mainstream ICT in education

---

at all levels will demand prioritisation because tackling the entire spectrum at once is too demanding: even if funds were available for access and access devices, there would be a challenge of getting both teachers and technical human resource.

Policy makers are also increasingly focusing on a decentralized approaches to education to facilitate decisions at local levels. This has significant implications to the way ICTs are applied to teaching, learning and management.

When all this is pulled into the picture, it will be appreciated that any transformation undertaking will have to address more than the central issues to increase likelihood of success, and will be resource intensive.

There are however certain advantage in the current situation: it provides, for most countries in Africa, a blank page or green field environment in which etransformation can be constructed without reservations or hold-backs caused by legacy systems. This creates flexibility in terms of selecting solutions that would best address the key thematic areas looked at in this study.

The integration of ICT in education requires ownership, competence, and involvement of all educational role players. This includes students, parents, teachers, administrators, management, policy makers, NGOs in education, and the private sector. Integration will also require precondition and concurrent interventions to ensure that the ecosystem is right for success.

1.4 Introducing the Thematic Areas

Each of the five thematic areas examined in this study is introduced here with focus on the key principles, followed by a discussion of the interplay and mutual dependence among them.

1.4.1 Teacher Professional Development

Teacher skills and knowledge in ICT integration are imperative if schools are to produce students with adequate digital and numeracy skills to enable them to function effectively in 21st century economies. In order for teachers to integrate technology into teaching and learning more effectively, the focus of training should embody effective pedagogy for teaching and learning for any classroom situation, be it technology enabled or not. Further, teacher training in ICT integration should not only be focused on their use of ICT for teaching learners, but should show them how ICT can be used to enhance other job and social functions, for example administration and communication. In this regard, training programmes for teachers should consider the following principles:

i. Empower teachers to develop their knowledge and skills actively and experientially, in a variety of learning environments, both individual and collaborative;

ii. Include a variety of learning strategies, encompassing direct instruction, discussion, drill and practice, deduction, induction, and sharing;

iii. Aim at higher-order thinking skills;

iv. Provide an authentic learning environment so that teachers engage in concrete tasks within realistic scenarios;
v. Emphasise ways in which technology can facilitate and enhance teachers’ professional lives;
vi. Encourage teachers to be mentors, tutors and guides of the learners’ learning process (rather than simple presenters of knowledge and information);
vii. Develop teachers’ skills in learning how to learn (define learning objectives, plan and evaluate learning strategies, monitor progress, and adjust as needed);
viii. Promote co-operative and collaborative learning;
ix. Be sensitive to the culture and diversity of teachers as learners, using a multifaceted approach to respond to different learning styles, opportunities, environments and starting points; and
x. Enable learning independent of time and place.  

These principles suggest that technical mastery of ICT skills is not a sufficient precondition for successful integration of ICT into teaching, and that teacher training in ICT should also focus on effective curriculum delivery, which must therefore be modeled in the teacher training. *Technology integration which is based on poor pedagogy will not translate into improved learning outcomes.*

The professional development of teachers to integrate ICT into teaching and learning should ideally be located within a broader framework of teacher professional development, and not be seen as a separate or additional teacher training undertaking. This means that the training should be planned for as part of a national, provincial, district, and/or school’s strategy for professional development. Broadening the scope of all teacher professional development to include technology integration supports the view that professional development of teachers for ICT integration should be an ongoing, lifelong process. To this end, in many countries globally, traditional, once-off workshop training is gradually being replaced with lifelong professional development of teachers, which focuses on at least three dimensions:

i. Pre-service training – integrating technology into the teacher training course to model use of technology and enable student teachers to start thinking about, and if they get the chance during teaching practice, design lessons that make use of technology.

ii. In-service training – using structured workshops, seminars, short courses, and peer collaboration in communities of practice where exchange of ideas takes place and support is offered on how to integrate technology into teaching. In these structured activities and processes, teachers’ skills in the use of technology in the classroom are developed.

iii. Enduring formal and informal pedagogical and technical support for teachers as they engage with technology for teaching and learning can create opportunities to connect teachers to colleagues, mentors, curriculum experts, and the global teacher community, breaking the

---

traditional confinement of teachers within the four walls of their classroom. Ever-evolving technologies provide justification for professional development to be a process of on-going capacity-building activities aimed at assisting teachers to develop basic and advanced skills to use technologies comfortably, as well as integrate it successfully into their teaching.

Training is not a magical solution to technology integration. While teacher training is an integral aspect of teacher uptake of technology for teaching and learning, it should not be viewed simplistically as the solution to problems of uptake. There are several other barriers, at individual teacher level, and school level, which may impede on teacher uptake and use of technology. These barriers include lack of confidence and resistance to change, as well as negative attitudes. Research conducted in 2004 by the British Educational Communications and Technology Agency (BECTA) cited lack of confidence as the barrier identified by most teachers as preventing them from using technology for teaching. Other studies, for example Beggs (2000) and Balanskat et al (2006), attribute teachers’ lack of confidence to fear of failure and limitations in skills and knowledge to use technology effectively for teaching. In relation to resistance to change and attitudes towards technology, technology in education is likely to be a major change to some teachers, and for various reasons, change is often resisted. While some teachers’ resistance may be because they are comfortable with their set ways of teaching, for others, resistance may be only at the initial stages of the introduction to technology in schools. These teachers may adopt a wait-and-see attitude to see what the impact of technology is for early adopters, and then take up technology much later. Thus, change management becomes an important aspect of technology integration, and ongoing professional development makes sense for late adopters so that they can be supported in their uptake.

1.4.2 Digital Learning Resources

In this discussion, digital learning resources (DLRs) include educational content (materials that are designed to support teaching and learning directly); software tools (applications developed for a wide range of functions – operating systems, management information systems, authoring, learning management systems, etc); and implementation resources such as copyright licenses. DLRs are closely related to Teacher Professional Development: In addition to providing the content and environment for teachers to contribute to the learning process and which they must therefore fully understand, DLRs provide the learning content and environment for the teachers themselves. The increasing availability of improved, cheaper, and more user friendly information technology (IT) resources has made content cheaper and easier to produce and share, and has redefined the authoring and publishing domain for learning resources: content-rich materials are no longer either static, or the exclusive domain of publishing companies, opening participation space for teachers, students, and other stakeholders. New licensing schemes based in the open resource movements

---


have facilitated sharing and reuse of content. Social drivers that include increased willingness to participate in online activities and share self-made content\textsuperscript{12} are another factor.

The growth of digital learning resources however does not mean the death of printed materials: The important role of both is highlighted in the NEPAD e-Schools Guideline for Good Practice on Educational Content\textsuperscript{13}:

\begin{quote}
All African learners regularly use a wide variety of electronic and printed media that supports successful completion of their [educational] careers, whilst simultaneously developing their ability to participate actively in the global information society and knowledge economy. Printed and electronic media complement each other both in terms of supporting learning and teaching and in relation to spending on learning support materials.
\end{quote}

Educational content is categorized by various attributes: target audience; level of difficulty; content focus; duration; languages; coverage of curriculum; and type of learning resource or activity. While this shows the level of diversity that is possible, the focus in this discussion is not content and its attributes, but on process: how content is developed, distributed, and accessed.

The ICT explosion has led to a shift from content as a product to content as a service: Since content can be dynamically updated and is no longer the preserve of a single team, the value has changed from content itself, to services that package and rapidly publish content that is both current and tailored for a myriad of audiences and purposes.

Within the context of this discussion, the focus is necessarily on Open Education Resources (OER). OER refers to any educational resources that are openly available for use by educators and students, without an accompanying need to pay royalties or licence fees. Importantly, there is only one key differentiator between an OER and any other educational resource: its licence. An OER is simply an educational resource that incorporates a licence that facilitates reuse, and potentially adaptation, without first requesting permission from the copyright holder; whilst copyright allows the creator or author the exclusive right to control the publication, distribution and adaptation of their works for a certain period of time, an ‘open license’ 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 are licensed for use, the best known of which is the Creative Commons licensing framework (see \url{www.creativecommons.org}). It provides legal mechanisms to ensure that authors of materials can retain acknowledgement for their work while allowing it to be shared, can seek to restrict commercial activity if they wish, and can aim to prevent people from adapting it if appropriate.

While the educational value of OER lies in the idea of using resources as an integral method of communication of curriculum in educational courses (i.e. resource-based learning), its transformative power lies in the ease with which such resources, when digitized, can be shared via the Internet, revolving around three linked possibilities:

i. 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.

\textsuperscript{12} OECD (2007) Digital Learning Resources as Systemic Innovation – Project Outline and Definitions.
\textsuperscript{13} Insert ref
ii. The principle of allowing adaptation of materials provides one mechanism amongst many for constructing roles for students as active participants in educational processes, who learn best by doing and creating, not by passively reading and absorbing.

iii. OER has potential to build capacity by providing institutions and educators 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.

It must be noted though simply making content freely available for use and adaptation will not improve education delivery: Content is only one piece of the educational puzzle, and effective use of educational content demands, amongst other requirements, good educators to facilitate the process. Importantly, OER provides a structured opportunity to engage education institutions and academics in structured processes that build capacity to design and deliver high quality higher education programmes without increasing cost. Without this growing institutional capacity, OER will not be able to fulfill its transformative potential.

1.4.3 Affordable Technologies

A digital learning environment assumes a technology enabled environment with the three key activities of: backhaul and distribution; content and processes management and administration; and individual access for the final user. In this discussion, backhaul and distribution will be addressed under the National Research and Education Networks (NREN) theme; content and process management and administration under Education Management Information Systems; and individual access under Affordable Technologies. This sub-section addresses Affordable Technologies, easily the greatest barrier in creating a technology enabled environment.

Before the issue of technology is addressed, it is important to put into context what the loosely used term “affordable” really means. At a school level, budgets are very constrained and leave limited scope to invest in technology. For instance, according to UNESCO statistics, in 2009 Uganda spent $84.8 per primary student and $247.1 per secondary student and Senegal spent $388.1 per primary student and in 2008 an estimated $465 per secondary students\(^\text{14}\). Most of this would go to teacher salaries. At an individual level, the survey of ICT access and use conducted by Research ICT Africa in 2008 indicated that large numbers of Africans continue to be marginalized due to the high cost of access and that households were spending considerable portions of household income on communication\(^\text{15}\). For technology to be used in education it must be affordable and accessible but this remains a key barrier for schools, teachers and learners in Africa.

This sub-section focuses on the opportunities and challenges for use of mobile devices and smart phones for access to learning materials and collaboration platforms. However, this is not to suggest that older technologies should be ignored when considering ICTs in education. TV and radio, for

---


instance, remain important in terms of reach. Digital migration may also open opportunities for more channels and diversity of content (including educational content).

While it is recognized that technology has got a role to play in education transformation, it must be noted from the outset that first, technology is just a tool and is not a substitute for a good education system; second, technology should not be considered on its own but requires a broader ecosystem / enabling environment to ensure its effective use in supporting the achievement of a specific education objective; and third, while there are examples of where the use of technology has had a positive impact on specific educational outcomes there are also many failures – it is important to learn from both.

It is important to understand the limits of technology. Bas Hoefman\(^{16}\) writes in his essay in Annex 3 that the “future of ICT/Mobile deployment in mLearning is encouraging, however, this cannot be substituted for a weak education system – a good quality education sector is vital”.

While there are opportunities for the use of technology in education, there are also a range of factors, including the context and educational need, need to be looked at when determining if technology is the most appropriate intervention. Kentaro Toyama, for instance, argues that “technology at best only amplifies the pedagogical capacity of educational systems” and that “technology has a huge opportunity cost in the form of more effective non-technology interventions”\(^{17}\). He critiques the role of technology in education in an essay entitled “There are no technology shortcuts to good education”\(^{18}\) and outlines what he sees as the nine myths of technology in education.

There can often by a great deal of hype about the potential of different technologies. Toyama comments that both Larry Cuban\(^{19}\) and Todd Oppenheimer\(^{20}\), who have looked at the record of technology in schools, make the point “that there is a repetitive cycle of technology in education that goes through hype, investment, poor integration, and lack of educational outcomes”\(^{21}\). In a study of the use of low-cost laptops in schools in Mexican schools it was found that “more than the laptop, it was the support infrastructures that made an educational difference”\(^{22}\).

There is a need to understand where (and when) technology is successfully being used to achieve specific educational outcomes as well as to learn from those interventions which have not been successful. It is equally important to learn from the many failures that are often not reported.

The application of technology in education is also context specific. Its use must be grounded in a clear understanding of educational needs and the context in which it will be used. Yerushalmy and Weizman write in their essay in Annex 3 that “three decades of using technology in mathematics education provide clear evidence that the tools designed to support a well-defined educational

---

\(^{16}\) See Section 7.2, Annex 3 (Affordable Technologies) of this report.

\(^{17}\) Toyama, K (2011), “There are no technology shortcuts to good education”, https://edutechdebate.org/ict-in-schools/there-are-no-technology-shortcuts-to-good-education/

\(^{18}\) Ibid

\(^{19}\) Larry Cuban wrote “Teachers and Machines: The Classroom Use of Technology Since 1920”, 1986

\(^{20}\) Todd Oppenheimer wrote “The Flickering Mind: Saving Education from the False Promise of Technology”, 2004

\(^{21}\) There are no technology shortcuts to good education”, Kentaro Toyama, January 2011, https://edutechdebate.org/ict-in-schools/there-are-no-technology-shortcuts-to-good-education/

agenda were the most successful ones”. Other elements such as content and training are also required to be in place to ensure its effective use.

1.4.4 Education Management Information Systems

Tomas Cassidy defines an Education Management Information System (EMIS) as “[a] system for the collection, integration, processing, maintenance and dissemination of data and information to support decision making, policy-analysis and formulation, planning, monitoring and management at all levels of an education system. It is a system of people, technology, models, methods, processes, procedures, rules and regulations that function together to provide education leaders, decision makers and managers at all levels with a comprehensive, integrated set of relevant, reliable, unambiguous, and timely data and information to support them in completion of their responsibilities”.

Therefore, the typical Education Management Information Systems comprise three interrelated components:

i. Organizational unit, people, networks, hardware and software that are used to collect, organize, produce, manage and disseminate educational data in support of policy making, planning, resource allocation, research, monitoring and evaluation. Such a unit is often located within the Ministry of Education either as a standalone department or attached to a larger entity such as a planning department.

ii. A formalized and integrated operational process, procedure and partnership arrangement between key stakeholders that are involved in teaching, learning and administration of educational systems. EMIS is a process by which data and information about schools, learning, facilities, teachers and students is integrated from multiple sources and disseminated throughout the educational establishments.

iii. A culture and environment that facilitates data-driven decision making and that in turn promotes sustainable demand for information and knowledge sharing.

The setting up of formal structures and the collection of data (item i) has been the focus of both national and region-wide efforts in Africa over the last three decades, with initial attention to educational statistics. The scope of educational data has been widening ever since, covering qualitative, quantitative and geographic information. Comparable progress has not been made in putting processes and partnership in place (item ii) and developing the capacity for data-driven decision making in Africa.

A survey of EMIS development in Southern African Development Community (SADC) member States 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. The majority of the countries:

i. have had difficulty in pulling data from different sources together and recast it into meaningful information,

ii. suffer from capacity and integration problems where data is only available to a handful of analysts and statisticians in the ministries of education,

iii. hold data that are old, inaccurate and that make cumbersome to use.

On the other hand, there has been significant interest in building educational data collection in Africa in the recent years. The key drivers for Education Management Information Systems include:

i. Increasing need for disaggregated and integrated data to monitor progress towards international and regional commitments such as Education for All (EFA) and Millennium Development Goals (MDGs).

ii. Increasing call for managing and distributing scarce financial, human and other material resources in equitable manner including transparency and administrative accountability for resources invested in education.

iii. Increasing drive towards the concept of unit costing that demand for accurate student enrolment information, number and activities of teachers and total cost figures for all component of education including text books and facilities.

The availability of different tools and knowledge in handling educational data, along with opportunities for using computers at school levels has also been the other driver of ICT-led education management at all levels.

1.4.5 National Research and Education Networks

National Research and Education Networks (NRENs) have multiple roles in the research and education community even if what is commonly known is the provision, at the infrastructure level, of dedicated data networks serving the data communication needs of principally non-profit universities and research institutions. In his blog essay, Louis Fox says:

“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”.

---

Other perspectives are given by the following three quotations addressing the some of the varying aspects and importance of NRENs:

“By definition, the research community pushes at the boundaries of our knowledge. Researchers and students use the most advanced tools, techniques and applications to exchange and process often very high volumes of time-critical data quickly and efficiently. They rely on the network to provide greater speeds, timely delivery and a very high level of resilience. Connections must be reliable and delivery defined.”

“To improve the way we deal with disease, disasters and other natural challenges, we need to understand more about our world - how it works and how it’s changing. If we’re going to make life better for people, we have to learn to share our knowledge and our skills. The answer lies in working together effectively. R&E networking is important because it provides a platform that enables better cooperation, collaboration and integration within and between geographically dispersed research and education communities.”

“...R&E networking is not just about helping ‘big science’. At a local level, students in physically remote parts of North Africa and Asia gain access to a better quality education experience over their new connections. By overcoming the barriers to education, e-learning can provide new and life-changing opportunities for students. For example, thanks to stable videoconferencing, students in Palestinian universities can now enroll on courses and participate remotely and interactively in lectures held anywhere in the world…”

A major driver of NRENs is 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 totally independent of the commercial cloud. In many countries, they actually extend this to other non-profit public institutions that are associated with academic and research work, including libraries, hospitals, and museums. Many countries also use them as a vehicle to provide connectivity and other support to lower level education institutions. These come with their own set of needs and challenges that need to be addressed.

A defining aspect of the operation of NRENs, put in place to ensure that they do not compete with commercial service provider, is the Acceptable Use Policy (AUP) which spells out the dos and don’ts of NRENs. A key one is that one end of any transmission (i.e., originating or receiving) handled by NRENs must be someone within the education and research community.

NRENs enable the sharing of content that includes digital learning content; sharing applications and resources (expert human resource; e-learning platforms; management information systems; i-labs; video-conference platforms; computers; etc); and implementation of, as well as access to advanced applications and high capacity on demand that the private sector cannot handle.

Working together has also positioned universities and research institutions to have higher negotiating power when dealing with governments, regulators, the private sector, and development partners. It actually creates a win-win situation for all, enabling the achievement of

---

27 http://www.eumedconnect2.net/server/show/ConWebDoc.3304#1
both development and commercial objectives with much lower operating overheads. This is enhanced by the fact that NRENs are non-profits and are bound by a code (the acceptable use policies) that ensure that grant funding and other privileges are not used to disadvantage the private sector.

1.5 The Inter-relationship among the themes

Figure 1 is a conceptual illustration of the interplay among the five thematic areas, showing how they support and benefit each other, and also illustrating the output of the education system.
NRENs, if the connectivity component of their role is extended to all levels of education, could provide the main data transport and distribution to all users. Not shown in the illustration are the opportunities for technical and content support that comes from the technical and content groups normally found among NRENs. While it is true that NRENs also rely on affordable transport and distribution technologies, many of which have been researched and indeed deployed in some parts of Africa, they are not categorized as depending on affordable technologies because some of the mission critical applications they support necessarily demand the best that is available.

Access is enabled for the users through affordable technologies, ranging from thin clients for universities to ultra low cost devices for primary schools.

The combination of NRENs and affordable technologies provide the layer through which all users interface with digital learning resources and educational management information systems. This, as shown by the bi-directional arrows, is for purposes of both use (one direction) and contribution (the other direction. The positioning of the policy/regulatory/budgetary framework should especially be noted.

The core foci of the entire system within the context of this study are the two semi-oval boxes:

i. Teachers capable of integrating ICT into curricula and supporting learning in the knowledge environment;

ii. Graduates capable of participating effectively in the knowledge society and enabling national development.

While the thematic areas have been isolated from the totality of the concept for ease of analysis and discussion, it is important to always bear in mind this interplay because initiatives within each theme will have an impact on the other themes.

1.6 Report Outline

Chapter 1 gives an introduction to the study and introduces five thematic areas, outlining the key principles of each and the cross-linkages among the different themes. It also introduces and discusses the context, including specific focus on the education sector in Africa. The Landscape Analysis in Chapter 2 presents a discussion of trends and current practice around the world and within Africa, providing a take-off for Chapter 3 that identifies opportunities and challenges. This Chapter also covers the scope for targeted interventions, identifying success factors and barriers to wider dissemination and take-up. In Chapter 4, three country case studies are presented: South Africa, Uganda, and Senegal, providing examples of both successes and failures that can be learning points for other countries. The key outputs of this study are the recommendations: those to policy-makers, regulators and other stakeholders, which are given in Chapter 5; and those to the donor community, especially World Bank, African Development Bank, and the African Union, which are given in Chapter 6. These identify possible interventions that might benefit from donor investment, and guidelines for evaluation. The report has the following annexes that have been used as source documents for the main report. While the report has been made entire, these annexes can be
cross-references for an in-depth discussion of each of the thematic areas, including examples of cases and practices from around the world:

- Annex 1: Detailed Methodology
- Annex 2: Teacher Professional Development
- Annex 3: Digital Learning Resources
- Annex 4: Affordable Technologies
- Annex 5: Educational Management Information Systems
- Annex 6: National Research and Education Networks
- Annex 7: Case Study – South Africa
- Annex 8: Case Study – Uganda
- Annex 9: Case Study – Senegal
2. LANDSCAPE ANALYSIS

2.1 Introduction

This Chapter gives a review of the landscape, both generally, drawing on examples from around the world, and specifically, drawing on examples from within Africa. While each of the thematic areas is necessarily addressed independently in the analysis, the interplay and mutual dependence discussed in Chapter 1 is a key feature that comes up in many of the examples.

2.2 Teacher Professional Development

2.2.1 Introduction

This section examines some of the key frameworks and issues around developing teacher competence for an ICT-enabled learning environment. It also discusses current research, practice and trends, as well as examples approaches to teacher professional internationally and within Africa. All these provide valuable learning points for African governments.

2.2.2 Approaches to Teacher Professional Development for ICT-enabled environments

There are three main types of implementation of ICT professional development suggested by Dzidonu (no date) and substantiated by the types emerging from the literature. In addition to these three, a fourth type has emerged. These types are intricately tied to and can be used to describe ICT integration in education. Annex 2 gives comprehensive discussion of some of the examples of approaches to teacher professional development for ICT-enabled learning environments. A few of these are highlighted here as illustrations.

Category 1: Worldwide (programmes)

These are programmes that are based on specific teacher training curricula or models, like cascading, communities of practice, and networks, which are replicated in many countries globally. They are usually driven by ICT corporations or donor agencies.

iEARN (http://www.iearn.org/about) is a non-profit organization working with over 30,000 schools and youth organizations in more than 130 countries. iEARN empowers teachers and the youth to work collaboratively online, using the Internet and other new communications technologies, offering both face-to-face workshops and online professional development courses for teachers to equip them with skills to integrate online global project work into their classrooms. iEARN is reported to be working in 29 countries on the African Continent, partnering with in-country institutions to facilitate its work and model of professional development, for example the Ministries of Education in Botswana, Egypt, Kenya, Tunisia, and Senegal; and with SchoolNets in Namibia, Ghana, Mali, South Africa, and Uganda.  

---

30 iEARN Africa: http://www.iearn.org/regions/africa?page=2
World Links works with Ministries of Education in focus countries to provide programs that support teachers on how to integrate technology into their lessons, to enhance the quality of education provision. World Links has trained over 25,000 teachers in developing countries, building local capacity to use technology. World Links is actively operating in 13 African countries, Botswana, Burkina Faso, Ghana, Mauritania, Mozambique, Nigeria, Rwanda, Senegal, South Africa, The Gambia, Uganda and Zimbabwe. World Links has managed to reach quite a few schools in Africa as reflected in Table 1.\(^{31}\)

Since 2003, Microsoft Partners in Learning (PiL)\(^{32}\) have partnered with more than 8 million teachers, and reached more than 190 million students in 114 countries. Microsoft PiL Africa offers opportunities for teachers and school leaders to connect, collaborate, create, and share to improve learning outcomes. Regarding training, Microsoft PiL offers a comprehensive suite of courses for education leadership, teachers, and technicians to enable them to acquire knowledge and skills to integrate ICTs into management, teaching and learning. The PiL courses are being used in several African countries including Angola, Madagascar, South Africa, Ghana, Kenya, Rwanda, Mozambique and Egypt.\(^{33}\)

The Intel® Teach Program improves teacher effectiveness through professional development, helping teachers integrate technology into their lessons and promoting students' problem-solving, critical thinking, and collaboration skills. The Intel® Teach Program has trained 9 million teachers in over 60 countries.\(^{34}\) The Intel® Teach programme is being used in Africa for teacher training in Egypt, Kenya, Morocco, Nigeria, Libya and South Africa.\(^{35}\)

Teacher Education in Sub-Saharan Africa (TESSA) (http://www.tessaafrica.net/) is a research and development initiative creating open educational resources (OERs) and course design guidance for teachers and teacher educators working in Sub-Saharan African countries. TESSA brings together teachers and teacher educators from across Africa. It offers a range of materials (Open Educational Resources) in four languages to support school based teacher education and training. TESSA uses a community of practice approach for discussion forums where teachers can share ideas. There are four language based forums in French, English, Arabic and Kiswahili.\(^{36}\)

**Category 2: The full house model**

These are large-scale, national projects guided by a national strategy and implementation plans and usually driven by the Ministry of Education, where government provides a large proportion of the funding required, or raises these funds to support rollout. 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 management information systems (MIS).

---

31 World Links, Africa. Available at: http://www.world-links.org/regions/africa
32 (http://www.microsoft.com/education/ww/leadership/partnerships/pil/Pages/index.aspx
34 http://www.intel.com/about/corporateresponsibility/education/programs/intelteach_ww/index.htm
Government-driven programmes on ICT typically include provision of digital content and radio broadcasting among others.\(^{37}\)

Australia has made great strides in preparing education to meet the requirements of a digitally enabled citizenry. Projects such as the Digital Education Revolution, with government funding of AU$2.4 billion, support secondary schools by providing funding of up to AU$1 million during the funding cycle for new ICT infrastructure and upgrading of existing infrastructure to achieve a 1:1 learner/computer ratio. The Digital Revolution Education fund has dedicated AU$100 million for installation of high speed broadband to schools, through collaboration with the Department of Broadband, Communications and Digital Economy and schools, to ensure that at least 90% of schools have fibre optic coverage and the rest have satellite and wireless connection.\(^{38}\) In 2008, the Australian Government committed AU$28.6 million for the *Online Curriculum Resources and Digital Architecture Initiative*, aimed at supporting the development of high-quality digital tools, resources and infrastructure.

In Chile, the Enlaces\(^{39}\) Project started in 1992 as a pilot program of Educational Informatics of the Improvement of Educational Quality Program (MECE) with the aim of establishing a computer-based inter-school communications network among learners and teachers at elementary schools and professionals of educational institutions. Enlaces was guided by three principles: ICT are tools to be used by all participants in the educational process; Equip schools with computers, connect them with each other and the world through an educational network, thus enabling them to exchange ideas and experiences regardless of their location; No single formula can be applied uniformly to all schools and the uses to which computers and networks are put will depend on each school’s educational projects, needs and social, cultural and geographic environment.\(^{40}\)

In Guyana, the National Centre for Educational Resource Development (NCERD) has had the responsibility to train all teachers, including ICT capacity building. NCERD’s mandate has been to train all teachers to basic computer literacy level by 2011; to train all 109 secondary school teachers to effectively teach the Caribbean Examinations Council subject, Information Technology and Electronic Document Preparation and Management; to identify, train and implement low cost technologies with the schools system; to train 2,000 teachers to use the SuccessMaker software; and to research and develop modules for all aspects of ICT training within the education sector.\(^{41}\)

The Ministry of Communications and Information Technology (MCIT) of Egypt, formed in 1999, oversees the development of ICT in the country, guided by two strategic objectives: nationwide dissemination of ICT tools and establishment of a strong export-oriented ICT industry. MCIT sees ICT as integral to the development of Egypt as a nation, and has established partnerships with the

---

\(^{39}\) Enlaces is Spanish for Links.  
private sector, UN agencies, and civil society organisations to maximise the outcomes of its mission and vision. The National ICT policy in education is jointly coordinated by MCIT and MoE.\(^\text{42}\)

Namibia’s TECH/NA! is the country’s comprehensive strategy for ICT integration into the whole education sector, utilizing local expertise and international support to improve the quality of the education system. The main goals are to equip educational institutions with hardware, software, connectivity, curriculum, content and technical support; to educate administrators, staff, teachers and learners in ICT literacy and ICT integration across the entire curriculum; and to empower whole communities in bridging the digital divide and meeting the goals of Vision 2030.\(^\text{43}\)

**Category 3: The Minimal model/by-the-way approach**

These are 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.\(^\text{44}\)

**Category 4: The Minimal + Model/on-the-way approach**

In this category, 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 equipment as well as training teachers for effective use of the equipment.\(^\text{45}\) Government also funds some projects.

India\(^\text{46}\) has a strong tradition of advocating for and supporting use of ICT to improve the quality of education which began with the 1992 National Policy on Education, and which is prominent in the norms for schooling recommended by the 2005 Central Advisory Board of Education’s report on Universal Secondary Education and also evident in the 11\(^{\text{th}}\) Five-Year Plan. India has a new draft National Policy on ICT in School Education which proposes implementation of an ICT literacy skills curriculum for all secondary schools so that learners acquire basic to advanced ICT skills. The National Knowledge Commission (NKC) of India, established in 2005, has been driving educational reform to meet the demands of the knowledge society. The NKC is focused on leveraging ICTs to strengthen the education system and skills development in India, to improve access and quality of education, and led the formation of the National Knowledge Network (NTN), which will be distributed across 378 Universities and 18 064 colleges. NTN will drive the digitization and networking of educational institutions, and enable access to bandwidth for efficient collaborative research and knowledge sharing.


\(^{43}\) TECH/NA! Namibia’s ICTs in Education Initiative. Available at: http://www.tech.na/

\(^{44}\) ibid

\(^{45}\) ibid

\(^{46}\) Information for this case study is current and has been sourced from: PricewaterhouseCoopers (2010). Survey of ICTs for Education in India and South Asia, Country Studies. Available at: http://www.infodev.org/en/Project.103.html
South Africa has quite an extensive offering of ICT teacher professional development programmes being driven by universities, NGOs, and provincial education departments. 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. The University of Johannesburg (UJ) and 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; the Bachelor of Education Honours (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. The ACE is mainly for in-service training.

SchoolNet South Africa (SNSA) has played a leading role in 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 in their sites of practice, and there is a very strong evaluative element to their training, to judge its effectiveness.

2.3 Digital Learning Resources

2.3.1 Introduction

This section presents a broad overview of concepts and issues relevant to DLRs, with an emphasis on the development of open education resources (OER) that are responsive to development needs using especially Web 2.0 platforms. Selected illustrative examples are used in the discussion. A more detailed discussion

2.3.2 Digital Content Creation Tools

When considering software tools to produce, use and distribute content, perhaps the most relevant development in recent years is the emergence of Web 2.0 platforms and the potential that this offers. Early web sites provided information to users, premised on assumptions that the teacher (or text book) is an expert whose role is to provide information to learners. With Web 2.0 platforms, the user becomes the source of new information. The implications of this are that it levels the playing field so that all users and contributors have a potentially equal ‘voice’ within the community. In addition, it changes the concept of ownership of intellectual property, with the result that all content becomes accessible and usable with continuing development by the community, rather than being ring-fenced by copyright laws. Furthermore, it carries the implication that the service automatically gets better the more people use it.

47 University of Johannesburg. Faculty of Education. B Ed Degree: http://www.uj.ac.za/LinkClick.aspx?fileticket=hKI8qrrPOxy%3d&tabid=2896
48 University of Johannesburg. Faculty of Education. Advanced Certificate in Education (ACE), Educational Computing: http://www.uj.ac.za/LinkClick.aspx?fileticket=vz02wxqknng%3d&tabid=10532
Examples of Web 2.0 technology applications which are available to support education and development initiatives include: 49

**Social network sites:** These are web-based services that allow people 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 list of connections and those made by others within the system. Possibly the most well known of these sites are Facebook and MySpace. Social networking sites have massive potential for influencing the way in which we organize and find information and how we interact with people.

**Blogging:** Blog is an abbreviated version of ‘weblog’, which is a term used to describe websites that maintain an ongoing chronicle of information. Given the personal perspectives presented on blogs, they often generate ongoing discourse and a strong sense of community. Blogs provide diverse, alternative sources of information for higher education, as well as providing tools that can be used by academics and students for a wide range of educational purposes. The [https://edutechdebate.org/](https://edutechdebate.org/) for example was used to post blogs related to this study in order to solicit wide stakeholder input.

**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. This ease of interaction and operation makes a wiki an effective tool for mass collaborative authoring, the most well known example of which is Wikipedia, an online phenomenon that has played a massive role in challenging notions of what constitutes ‘expertise’ and about reliability of information. Wikis are already extensively used in many higher education programmes for educational purposes, and are one of the authoring tools being used to generate ‘open’ content (see below).

**Podcasting:** This refers to any combination of hardware, software, and connectivity that permits automatic download of (usually free) audio and video files to a computer, smart phone, or MP3/MP4 player to be listened to or watched at the user’s convenience. Growing numbers of universities and academics are making lectures available as podcast series, usually making these freely available to anyone around the world with Internet access.

**Online applications** – these are web-based programmes that run in web browsers and typically replicate the functionality currently available on desktop-based applications. A good example is Google Apps, which provides access to office productivity, communication, and file storage tools. Another more specialized example is Lulu, which offers online access to the tools one needs to design, publish, and print original material, facilitating inexpensive production of publications. The online nature of such tools is intended also to facilitate collaboration, peer review, and collective generation of knowledge.

---

49 The descriptions contained in this section have drawn heavily on documentation prepared by the Educause Leaning Initiative – [www.educause.edu/eli](http://www.educause.edu/eli) - and especially its ‘7 Things You Should Know About...’ series.
By drawing on the potential of these and other technologies, several new possibilities have emerged. An example is Mashups – whose value for education lies in the way they help us reach new conclusions or discern new relationships by uniting large amounts of data in a manageable way – are web applications that combine data from more than one source into a single integrated tool. Other examples include digital storytelling (combining narrative with digital content to create a short movie or presentation), open journaling (manage the process of publishing peer-reviewed journals online, allowing authors to track submissions through the review process), and virtual meetings (which are real-time meetings taking place over the Internet using integrated audio and video, chat tools, and application sharing).

2.3.3 Open Source Software Applications in Education

The term "open source" refers to "open source software": software (or programs) whose source code (the human-readable instructions defining the software's behavior) is available, enabling both developers and users to be to modify or add features to the source code and redistribute it. With closed source software, the only people who are allowed to look at and change the source code are the developers and owners of the software.

Open source is the concept and practice of enabling access by both users and developers to the programme source code. In this regard, collaboration and circulation are central tenets to the open source movement. Open source software is cost effective as it does not entail licence fees, has open standards that facilitate integration with other systems, and can be easily customised. Aberdour has highlighted that the low cost of open source Learning Management Systems (LMSs) allows institutions to dedicate funds they would otherwise have spent on licensing, to further development or on professional development for efficient use of the LMSs. Further, open source LMSs open up spaces for participation in communities of practice that support each other in the development of the software.

Recommended key criteria for selecting open LMSs include:

i. Have an open source initiative approved licence;
ii. Have an active development community
iii. Have released stable versions
iv. Are Sharable Content Object Reference Model (SCORM) compliant
v. Have published details about previous adopters
vi. Have a stable organization supporting ongoing development
vii. Have had third party reviews published.

Examples of some commonly used Open Source Educational Software and their compatibility and usage are specified in Table 1.

---

Table 1: Examples of Commonly used Open Source Software in Education

<table>
<thead>
<tr>
<th>LMS Tool</th>
<th>Compatibility</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moodle</td>
<td><a href="http://www.moodle.org">http://www.moodle.org</a> Linux, UNIX, Windows, Mac OS X, FreeBSD, and any other system that supports PHP</td>
<td>Downloaded about 500 times a day. More than 28,000 registered sites, over a million courses, a learning community of 10 million.</td>
</tr>
<tr>
<td>Bodington</td>
<td><a href="http://www.bodington.org">http://www.bodington.org</a> Shibboleth, Linux, Microsoft, Mac OS X, or UNIX</td>
<td>Implemented at University of Leeds, UHI Millennium Institute, and University of Oxford. Provides services to 15,000 users with a single server.</td>
</tr>
<tr>
<td>Claroline</td>
<td><a href="http://www.claroline.net">http://www.claroline.net</a> Microsoft, Linux/GNU, Mac OS X; complies with SCORM and IMS/QTI.</td>
<td>Available in 35 languages and has users in more than 80 countries.</td>
</tr>
<tr>
<td>Dokeos</td>
<td><a href="http://www.dokeos.com">http://www.dokeos.com</a> Supports SCORM import and LDAP. Data can be imported using CSV or XML files.</td>
<td>In 30 languages and more than a thousand organizations. Implemented at Ghent University and Vrije Universiteit Brussel. More than 28,000 users and 3,600 courses.</td>
</tr>
<tr>
<td>LRN</td>
<td><a href="http://www.dotlrn.com">http://www.dotlrn.com</a> LORS Central, Curriculum, LORS Management, .LRN Ecommerce, Project Manager, Page Editor, Staff List, Syllabus, Expense Tracking</td>
<td>Almost half a million users in 18 countries.</td>
</tr>
<tr>
<td>ATutor</td>
<td><a href="http://www.atutor.ca">http://www.atutor.ca</a> Complies with W3C WCAG 1.0 and W3C XHTML 1.0; supports content developed in IMS or SCORM.</td>
<td>More than 17,000 registered installations worldwide.</td>
</tr>
<tr>
<td>OLAT</td>
<td><a href="http://www.olat.org">http://www.olat.org</a> Microsoft Windows, Mac OS X, Linux, Solaris, and UNIX. Conforms to SCORM, IMS QTI, and IMS Content Packaging.</td>
<td>Popular within the European higher education community.</td>
</tr>
<tr>
<td>Sakai</td>
<td><a href="http://www.sakaiproject.org">http://www.sakaiproject.org</a> Complements commercial software like WebCT, Blackboard, ANGEL Learning, and Desire2Learn.</td>
<td>Adopted by many reputable universities worldwide.</td>
</tr>
</tbody>
</table>

The criteria by which software can be licensed as open source are set by the Open Source Initiative as follows:

i. Unrestricted distribution. Users can distribute or sell the software without paying royalties.

ii. Source code distribution. The source code of the entire open source product must be easily modifiable. In the absence of the source code, the product must cite a low-cost resource where users can obtain it.

iii. Modifications. The license allows modifications, and its terms remain unchanged for distribution of improved versions.

---

iv. Author’s source code integrity. If the license allows patch file distribution along with the original source code, a user cannot modify the code and distribute it except by giving the new version a new name.

v. No personal discrimination. No person or group shall be discriminated against during open source product distribution.

vi. No restriction on application. Open source software can be used in any field and for any purpose.

vii. License distribution. The privileges attached to the original program extend to all who receive the programme, so recipients do not need to apply for a separate license.

viii. License must not be product-specific. The rights associated with a license extend to products extracted from a larger software aggregate.

ix. No restriction on other software. No restrictions are allowed on distribution of open source products bundled with products developed on other software platforms.

x. Technology neutrality. Licenses should not be issued on the basis of the specific technology involved.53

Open source programs are valuable to OER because of their adaptability and freedom. While most open source programs are too complicated for the average person, or even those with basic programming skills, to modify and change, many find reassurance in knowing that at least open source software could be changed legally without having to obtain permission or pay a fee. Some in the OER community like to support open source programs because they see philosophical parallels between goals of OER and open source programs.

**Considerations for educational institutions**

Educational institutions that are serious about teaching and learning will need to ensure that their spending on personnel and other related expenses reflects a sustained effort to invest in creating more effective teaching and learning environments for their students. The most cost-effective way to do this is to embrace open licensing environments and harness existing OER. The increased investment in teaching and learning is offset by the increase in efficiency and productivity of those investments by providing new ways of developing better programmes, courses and materials. Importantly, this implies a demand-driven approach to content, where the initial rationale for embracing open licensing environments is not to release an institution’s own intellectual capital, but rather to draw in the growing wealth of openly available OER to improve the quality of the institution’s own teaching and learning.

A further advantage is that it will typically lead to institutions starting to share a growing percentage of their own educational materials online, released under an open licence. Most institutions and educators are nervous about this, but evidence is now starting to emerge that institutions that share their materials online are attracting increased interest from students in enrolling in their programmes. This in turn brings potential commercial benefits, because the sharing of materials online raises an institution’s ‘visibility’ on the Internet, while also providing

---

students more opportunities to investigate the quality of the educational experience they will receive there.

All governments and educational institutions in all education sectors, regardless of their primary modes of delivery, need to invest in an ongoing basis if they are serious about improving the quality of teaching and learning. The key benefits of embracing OER are that 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.

Institutional decisions to harness OER will more than likely need to be accompanied by a review of policies if there are to be successful and sustainable:

i. *Provision in policy of clarity on IPR and copyright* on works created during the course of employment (or study) and how these may be shared with and used by others. The rights of the institution and its employees and sub-contractors, as well as students regarding intellectual capital must be specified, and there should be options for reserving copyright where necessary.

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

iii. *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.

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

Capacity building will be required across the institution so that the relevant players can develop the requisite skills for effectively harnessing OER. These include:

i. Expertise in advocacy and promotion of OER as a vehicle for improving the quality of learning and teaching in education.

ii. Legal expertise relating to content licensing.

iii. Expertise in developing and explaining business models that justify, to institutions, individual educators, and other creators of educational content (including publishers), the use of open licensing.

iv. Programme, course and materials design and development expertise.

v. Technical expertise.

vi. Expertise in managing networks/consortia of people and institutions to work cooperatively on various teaching and learning improvement projects.

vii. Monitoring and evaluation expertise.

viii. Expertise in curating and sharing OER effectively.

ix. Communication and research skills to be able to share information about OER.
Capacity building should also focus on the people and institutions required to enable effective use of OER. This would involve raising awareness of the potential of OER and the requirements for successful use; supporting policy-makers and heads of institutions to understand the key elements necessary to create supportive policy environments, develop materials, use technology, and conduct research; and identifying best-practice examples of use of OER and facilitating institutional visits, so that participants have an opportunity not only to observe effective use of OER in practice but also to start developing support networks and communities of practice.

**Considerations for government**

The ability to share information quickly and cost-effectively that is of relevance to African leaders making decisions relating to the knowledge society is a key benefit of ICT. In addition, networking opportunities created through collaborative online environments – including access to a dynamic repository of policy frameworks, case studies of African and international experience, legislative frameworks, and monitoring and evaluation outcomes relating to the use of ICT for education and development – should be harnessed in any capacity building programme for, and would be of great potential benefit to African leaders. In this way, the strengths of the online environment and the information repository, knowledge production, and networking benefits of an online space can be experienced directly by leaders engaged in such programmes.

In order to ensure effective utilization of digital learning resources, African governments can benefit by:

1. Reviewing and adjusting as appropriate existing national/institutional policies and staff incentives schemes to ensure that they encourage teaching staff to invest time in ongoing curriculum design, creation of effective teaching and learning environments within courses and programmes, and development of high quality teaching and learning materials.
2. Ensuring that budgets for purchasing educational materials allow for procurement of materials across a wide range of media types and formats.
3. Ensuring that institutions have in place robust, enforceable IPR, copyright, and privacy policies (addressing possible full-time, part-time and contract staff as well as students any and all of whom might become involved in a team-based curriculum and materials development process). As part of this policy process, consider the relative merits of creating flexible copyright policies that automatically apply open licenses to content unless there are compelling reasons to retain all-rights reserved copyright over those materials.
4. Investing in ongoing awareness-raising, capacity-building, and networking/sharing activities to develop the full range of competences required to facilitate more effective use of educational resources in education delivery.
5. Adopting and supporting the use of content management and authoring tools (web content editing tools, content management systems), templates, and toolkits that facilitate the creation of adaptable, inclusively designed educational resources.
6. Investing in knowledge management systems and strategies to store, curate, and share educational content. Ideally, to ensure cost-effectiveness, this would be done as part of a coordinated national strategy or in partnership with emerging global OER networks and repositories. This should ideally be accompanied by ongoing investments to ensure that
teaching staff have access to the necessary ICT infrastructure and connectivity to access the Internet and develop or adapt educational materials of different kinds.

The following questions may be useful to assess whether policies are effectively addressing effective use and development of digital learning resources:

i. What policies are in place to ensure that a portion of public spending in education is invested in ongoing curriculum design, creation of effective and accessible teaching and learning environments within courses and programmes, for the development of high quality teaching and learning materials?

ii. What intellectual property regimes should govern public investments in education programmes and materials?

iii. How do government officials policies tackle the IPR and copyright challenges posed by digitization of content and the variety of open licences available to help to deal with these challenges?

iv. Are government officials aware of the potential to use OER to meet legal and policy commitments to equal access to education?

2.3.4 Examples of Education Content Models

There are several international examples of educational content models: Britain holds an annual competition for digital content development. Criteria used to evaluate these materials are design, cost-effectiveness, support of higher order skills and effective learning and teaching styles, and technical robustness and resilience, as well as accessibility for groups with specific needs. Australia has a robust environment in digital content. Examples of some of the educational portals are EdNA Online and different state education department portals (for example, the Queensland government’s education portal). The Enlaces Programme in Chile created a website which offers educational content and services for teachers and students. The website is seen as an educational portal where teachers can access curriculum-oriented content, fora and up-to-date educational information. The Chinese government has partnered with the USA to use advanced multimedia and simulation to develop web-based courseware for English and Chinese instruction. The Thai Ministry of Education has worked with the National Electronics and Computer Technology Centre (NECTEC) to develop an extensive range of materials, web sites, and other resources.

The detailed discussion of DLRs in Annex 3 gives more illustrative descriptions and examples of best practice with regards to their creation and distribution within developing nations and others across the globe.

2.3.5 Strategies to procure and develop Digital Content

This section considers various models African countries could use to invest in procuring and/or developing suitable digital content for the education systems. Each model and its various strengths

54 Becta (2006). Quality principles for digital learning resources.
55 http://www.edna.edu.au
and weaknesses are analysed below as if they are distinct, but it is possible to adopt different models for different purposes across a country’s system.

i. **Stimulating the publishing and software industries by defining curriculum statements and publishing criteria for approval of educational materials on national procurement lists**

This is the current model adopted for Learner Teacher Support Material (LTSM) in South Africa. In this model, development of the content is left to the materials development market. Schools and colleges are given an LTSM budget to encourage market competition. The focus of materials developers is on ensuring that their materials meet the review criteria and get onto the provincial pre-approved lists.

The model gives room for innovation and competition in the publishing market, offers choice through a wide range of resources to choose from, and the Ministry of Education does not have to make its own preliminary investments in developing LTSMs.

This model however discourages publisher investment in niche courses and materials with limited distribution potential. The commercial risk of not knowing sales volumes typically results in a higher per-product cost, as publishers have to increase their margins to manage this risk. This model also discourages ongoing revision as well as collaboration amongst the best materials developers in producing materials, as each is competing for a fixed market. Another disadvantage is that the intellectual property of the materials developed vests with the publisher and author, barring adaptations or revisions: the education system is therefore structurally incapable of building a public domain intellectual property base off which new knowledge can be constructed.

ii. **Stimulating the digital content industry by providing educational institutions funding to spend on digital content and quality assuring products that are eligible for purchase with these budgets**

This model builds on the above model as materials development is left to the publishing and digital materials development industries. However, in this model, Government intervenes to ensure that there is a market for schools and colleges to buy certain types of materials from the developers. This is done by providing ear-marked funding to schools and colleges for the procurement of specific types of materials – such as digital content, or for example content in languages other than English. This model has been adopted by the United Kingdom Government.

The model helps to support development of a competitive materials development industry while encouraging schools and colleges to shift procurement practices, but still have control over what they select. A shift in allocation of expenditure shifts the industry to invest in new areas of digital content.

The model however requires a functional materials development and publishing industry and companies that can take on commercial risks in anticipation of schools or colleges selecting their products. There are ongoing license costs as materials are unlikely to have their Intellectual Property open.
iii. Stimulating the publishing Industry by shifting competition away from the point of sale

In this model, the point of competition is shifted, so that rather than encouraging publishers and materials developers to compete at the point of sale of completed products, this competition occurs at two separate stages. The first is at the point of development of the materials; and second is at the point of production, for example printing and distribution.

This approach leaves LTSM development and printing in the private sector, thus retaining the benefits of competition. It also gives companies the option of specialising in any of the two functions, opening the way for greater participation. Government, as part of the contract, can require tenderers to cooperate during the development phase for improved quality, and it also retains the intellectual property, creating a commercially viable, globally accessible pool of Open Educational Resources on which other materials developers can build.

The challenge with this model is that once a tender is awarded, there is no further competition as there is a guaranteed market for the product. The quality of products therefore needs strict processes to meet quality criteria at agreed milestones (prior to production). Secondly, the outcome of this process is a single resource for a specific purpose, which does not, in the short term at least, create market competition with a range of options from which schools or colleges may select.

iv. Government investment in content development for priority areas

In this scenario, Government commissions specialist content development projects for priority interventions. This may involve developing materials from scratch, or adapting internationally developed content to suit a local context; or translating and adapting existing content to be presented in languages other than English and to suit the local African context. The South African History Online project is a current example of Government investment in a priority area. The South African History Online project has a Schools History Project which is conducted in partnership with the Department of Education and hosted by the Thutong Portal.

This model may adopt the approach of shifting the point of competition from the point of sale to the point of development and of production. Alternately, it may adopt a partnership approach working with a parastatal, NGO, or Corporate Social Investment (CSI) Entity.

This model enables Government to define priority areas and ensure that the appropriate content is developed. There is little or no commercial risk, as the number of resources to be developed is agreed up front and production costs can be reasonably accurately forecast, the cost per product is significantly lower. The intellectual property may be opened or may vest with Government, creating opportunities for adapting and ongoing improvement.

The challenge with this model is that it may be difficult to maximize public value and minimize negative impact on the industry. While the tender award is competitive, once the tender is awarded there is no further competition, requiring strict processes to ensure that products meet

quality criteria at agreed milestones (prior to production). The outcome of this process is also a single resource for a specific purpose so it does not, in the short term at least, create market competition with a range of options from which schools may select.

v. Investments in repositories of open educational resources

The OER movement provides a compelling case for different economic models of educational content development. Teachers and instructional designers may adapt and improve materials available within OER, 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.

A key challenge with OER is to ensure that the resulting products are educationally effective and of a high standard. OER projects also often do not provide enough upfront investment to allow for sustained development of structured learning pathway through a set of content. The resulting OER are therefore often fragmented and represent only a partial covering of the curriculum.

vi. Sourcing available content to create a free resource repository that maps it against the curriculum

In this model, teams of materials evaluators review materials, approve and catalogue them according to the national curriculum frameworks. In this ways educators may quickly locate quality, reviewed materials at the point at which they are required in the curriculum. This differs from the above description of OER, in that there is no investment in developing open resources. This is one of the key approaches adopted by EDNA in Australia, which aims to ‘place at your finger tips Australia’s leading quality assured online resources’, making it ‘a large repository referencing thousands of online resources for education, training and research’.

This approach provides resources that are free for educators and learners to use as they require them, and a relatively small upfront and ongoing investment can result in a huge repository of content. Educators may select resources that suit their specific pedagogical requirements, though this can be a challenge where educators are not sufficiently skilled and require the support of structured learning pathway (as frequently provided by a textbook) through which to guide their learners.

Drawbacks include unavailability of specific resource requirements that have not been developed already, and the fact that the model is unlikely to provide an overall structured and sequenced learning pathway through a curriculum area.

vii. Communities of Practice

Communities of practice can 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\(^6\). The intention is to create and support communities of practice to develop and share content through professional development and award of Continuous Professional Training Development (CPTD) points.

In Australia, states contribute a selection of their own developed online resources to the national EdDNA online service so as to gain access to all of the nation’s online linked resources. There are quality frameworks and standards that have been developed to ensure consistency and interoperability of data.

Having 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 is key benefit. 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.

The model is however not responsive to specific resource requirements and is unlikely to provide an overall structured and sequenced learning pathway through a curriculum area. In addition to this, the ICT skills level the educators need to be relatively high for them to be able to select and adapt resources as they require them.

### 2.3.6 Potential content development agencies

From descriptions of the above models of content development it is clear that there are several types of agencies that could be used to develop content, ranging from the private sector to communities of educators. Some of these are highlighted below, including a discussion of the main strengths and weaknesses of using each type of agency.

**i. Private sector**

Using the private sector as the primary development agency encourages industry competition and growth as well as innovation in the publishing market. The private sector is usually able to attract the appropriate high quality staff by paying competitive salaries and ensuring cutting edge development.

Since this agency type is partly driven by a profit motive, the private sector may however be more expensive than other agencies, and will lead to a retention of intellectual property\(^6\), discouraging ongoing revision, updating, and improvement of materials over academic years because it makes business sense to sell the same LTSM in as many years as possible. It may also discourage collaboration among experts. Publishers tend to focus on print materials, and shy away from more innovative digital materials development processes.

**ii. Non Governmental Organizations (NGOs)**


\(^6\) This is not always the case, and by changing the model adopted – by for example contracting publishers at the point of development and not at the point of sale, this may be shifted. Given this shift in approach it may also be possible to negotiate different intellectual property rights to the usual models used in the private sector.
Using NGOs has several advantages: they have a developmental and not a profit motive, and may be more cost-effective than private sector agencies; they often couple materials development with effective distribution and uptake – frequently including research, training and orientation services with the materials development offering; and they are less likely to aim to protect intellectual property for future sales revenue of the LTSM. Some NGOs such as SchoolNet focus specifically on ICT in schooling and as such have a depth of research, contextual experience and materials on which they can draw for the development process.

However, they may not offer market-related salaries so may not be able to attract the best materials developers and experts in an area. Their capacity may be stretched by their existing core functions, and they may not have the management capacity to scale up to the capacity required for large-scale materials development processes. NGOs also sometimes find it difficult to shift their established way of approaching things to take into account new client requirements.

iii. CSI Entities

Several companies have directed their CSI funds towards education in Africa. In some cases this has included materials development and distribution to support their project objectives.

Learning materials lend themselves to leveraging some degree of marketing, making an attractive investment for CSI projects, as companies can make a positive social contribution and be seen to be doing so through brand exposure before and after television programming, on web sites, and in printed materials. Most, if not all, production and distribution costs are paid for by the CSI and not by the Government or end consumer. Both Government and the company concerned benefit from the relationship and the public sees the contribution of the private sector in concrete products.

However, requirements for company brand exposure may interfere with the learning objectives, and thus have to be monitored. Requiring adherence to a set of guidelines for corporate advertising norms and standards in learning materials may help to minimize this risk. Secondly, since all or most of the funding may come from the CSI, this may result in an uneven partnership between Government and the CSI, leading to quality and content choices that do not align with Government policy.

iv. Ministry of Education special projects

The Department of Education may opt to pursue a special materials development project by using any of the materials development agencies listed above. It may also opt to develop materials in-house, making use of existing departmental expertise and staff. In-house production by government is exemplified in Egypt, where educational television programmes in line with the curriculum are designed by Ministry of Education staff for seven of the ten channels. The Ministry of Higher Education develops materials for the other three stations.64

This model has benefits in that materials are owned and approved by Government at every stage of development as they are being developed by an in-house team. This may be a relatively cost-

---

effective approach, as there are no other agencies involved and no profit margins or NGO management fees to pay.

The challenge is the need to set up an in-house unit has to be established, appropriately staffed, and managed. It will also be very difficult to secure and manage the wide range of expertise needed.

v. *Communities of educators*

Communities of educators may also be used to develop materials as earlier discussed. Educators are often used by several agents – private sector, NGOs, CSI and parastatals – to develop and review materials. Thus, they form a key part of the materials development cycle.

Educators may perform different functions within the content development processes, from production to quality review. This is exemplified in the United Kingdom, where the private sector develops content but invites teachers to contribute suggestions on content development through online discussions.\(^{65}\)

With this approach, materials are developed by people who know the learning context. Capturing and sharing what they already do with a wide community is a very cost-effective contribution to the system. Multilingual African educators can translate and adapt materials into languages other than English.

A key challenge is that educators who are teaching or lecturing in a school or college seldom have sufficient time to develop entire sets of materials; and removing them from their teaching or lecturing roles takes them out of the system and they may lose touch with the classroom context.

**2.3.7 Distribution Options for Digital Learning Resources**

There are various options to consider when reflecting on distribution options for ICT applications or digital electronic content distributed to schools or colleges.

Schools and colleges, for example can initiate downloads from the Internet whenever required. The key feature of this option is that there is a pull strategy to request installation and then to request updates. The strength of this option is that it gives the local site level some degree of control and autonomy. Scheduling of upgrades can be planned to suit the local context. Reporting on download activity can still be collated centrally, so there remains a monitoring function at the national level.

Datacasting, another option, is a push strategy, where installation and updates can be conducted remotely. The advantage of this approach is that updates and installations can be controlled remotely and centrally. The disadvantage of this model is that a central store of content is required. This requires management and investment in ongoing development. The school or college is not able to request or download ICT applications or content which is not part of the managed central store of content.

\(^{65}\) Becta. 2007. Industry and developers – Learning resource development library. Available at: http://industry.becta.org.uk/display.cfm?catID=1732
Schools and colleges may also be able to order ICT applications online, leading to physical delivery of the software product. The advantages of this approach are that the local site receives a physical CD version which can then be appropriately stored and used in the future. This is also often accompanied by manuals, which can then be used as reference in troubleshooting and training on using the applications.

### 2.4 Affordable Technologies

#### 2.4.1 Introduction

This section outlines some of the emerging trends in the use of technology in education. Specific examples of projects using some of these technologies are provided in Annex 3.

There are three major trends that reflect technological innovation directions in the ICT sector as details in Table 2. However, it is also import to recognize that technology is always changing and there will be continued innovation both on the technology and cost side. This means that what we are using now or considering using will change and there will be a new set of tools that we have not even considered yet.

**Table 2: Technology Trends for access and computing devices**

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

These technology trends should also be considered in the context of the broader trends in ICT in education. Robert Hawkins wrote a useful summary of these in 2010:

i. Mobile learning.

ii. Cloud computing – the practice of accessing data and applications through the internet rather than from a local computer.

iii. One-to-one computing

iv. Ubiquitous learning – the ability to provide learning opportunities to students “anytime, anywhere”.

v. Gaming.

vi. Personalized learning.

---

vii. Redefinition of learning spaces – “schools around the world are re-thinking the most appropriate learning environments to foster collaborative, cross-disciplinary, students centered learning”\(^{67}\)

viii. Teacher-generated open content.

ix. Smart portfolio assessment – the collection, management, sorting and retrieving of data related to learning.

x. Teacher managers/mentors – “role of the teacher in the classroom is being transformed from that of the font of knowledge to an instructional manager helping to guide students through individualized learning pathways, identifying relevant learning resources, creating collaborative learning opportunities, and providing insight and support both during formal class time and outside of the designated 40 minute instruction period”\(^{68}\)

Many of the above trends assume availability and affordability of learning devices and connectivity which remain key challenges in Africa. For instance, the trend toward one-to-one computing assumes that schools can ensure the provision of learning devices to all students and support their use. Cloud computing also offers significant potential in the education sector but requires the availability and affordability of connectivity of sufficient speed and quality. This means it is not currently viable option for many citizens and schools in Africa, especially outside major population centres.

### 2.4.2 Low-Cost Computing Devices (LCCD)

Currently, low cost computer prices typically range from 200 USD to 500 USD. Lower cost netbooks and smaller laptops are becoming increasingly popular. Netbook computers are smaller, lighter weight and cheaper than laptops but also have smaller screens and keyboards and reduced computer power. These commercial low cost computer models mostly target urban professionals. There are also initiatives such as the One Laptop per Child (OLPC)\(^{69}\) and Intel Classmate PC\(^{70}\) which are seeking to provide low cost computers to children in developing countries.

Each of these devices have different features which impact on their use in education. The OLPC XO, for example, is specifically aimed at primary school children and may not be suitable for older students. Commercial laptops may also not be as appropriate for primary school students. Some countries also have policies to adopt or favor certain operating systems and software which may also impact on the selection of devices.

Recycling continues to be an option with organizations such as Computer Aid providing recycled computers to schools. The importing of recycled computing, however, is now part of the “dumping debate” with environmental groups claiming that developed countries are using developing

\(^{67}\) Ibid
\(^{68}\) Ibid
\(^{69}\) http://laptop.org/en/
\(^{70}\) http://www.intel.com/Intel/learningseries.htm
countries as emerging economies as “dumping grounds” for e-waste.\textsuperscript{71} Uganda, for instance, has implemented a controversial ban on the import of second hand electronics.\textsuperscript{72}

LCCD are dropping in prices and will continue to do so. Shared use of computing can also significantly reduce costs and so offer a more realistic approach for low cost computing projects targeting children’s education.

LCCD face several challenges:

i. Localisation is still a major challenge. Low-cost computing devices still depend on large-scale production and increased scalability which limits their ability to be customized to local needs. Secondly, the dominance of Latin characters (with exceptions like Mandarin and Arabic) and lack of technical standards / solutions continue to negatively impact on use of local language in software and hardware.

ii. High-income consumers continue to be the target market for manufacturers. Of the 58 devices reviewed by Vital Wave Consulting that were launched 2008, only nine have been “ultra low-cost” or priced below $300. They conclude in their report that “this trend demonstrates that the ultra low-cost device segment is not a priority to manufacturers.”\textsuperscript{73}

iii. Large scale deployments of low cost computing devices have 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, which has contracted around half a million of these laptops\textsuperscript{74}. 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 5 years.\textsuperscript{75}

iv. One-to-one computing in schools and single-user device is a challenge in developing countries given the cost even with low cost computing devices. It is likely only achievable in the longer term.

v. Total cost of ownership needs to be considered since the cost of the devices is only a fraction of the costs involved.

\textbf{2.4.3 Mobile phones}

Mobile phones have a large reach with over 5 billion mobile phone connections in the world – they are owned by more students and teachers than other computing devices. The ITU “World in 2010

\textsuperscript{71} APC and Hivos (2010), “Global Information Society Watch 2010: Focus on ICTs and environmental sustainability”,


\textsuperscript{73} Vital Wave Consulting (2008), “Landscape analysis of low cost computing devices”, Vital Wave Consulting,

\textsuperscript{74} “Disseminating low-cost computing devices in schools”, http://www.connectaschool.org/itu-html/8#177

\textsuperscript{75} “Free laptops will have Tamil Nadu logo burnt on chip”, June 2011, http://www.deccanherald.com/content/169738/free-laptops-have-tamil-nadu.html
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. Developing countries, especially Africa and Asia, have been early adopters of mobile phones. 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 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 the same via computers.

However, there remain issues in terms of access. Price of service remains an issue, and in some poorer sub-Saharan African countries mobile penetration remains low. Recent studies also highlight, that there remains a significant mobile phone gender gap – the study published in February 2010 by the GSMA and the Cherie Blair Foundation in February 2010 states that a woman is 23% less likely to own a phone than a man in Africa.

The 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 uptake, pricing of services remains 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.”

There are several pilot projects targeting specific communities which are 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 tend to be focused on use of mobile outside of school. Some of the major trends include educational quizzes, multi-media content to solve puzzles (e.g. for math), interactive literacy programmes, simple question and answer, text and/or audio based short lessons, alerts by schools/teachers to students or parents and provision of support to teachers and learners. They can also play a major role in informal education (e.g. to provide health

education information). The USAID\textsuperscript{83} and Gates Foundation, for instance, are investing large sums to change the behaviour of women and immediate family members through using mobile phones to provide educational information on material health.

Examples of some of the ways in which use mobile phones are being used to support education and learning include:

- **Using IVR (Interactive Voice Response) to support language learning:** BBC Janala which is being implemented by the BBC World Service Trust in Bangladesh is delivering educational content on mobile phones, the internet, television and print media. It aims to increase the number of people able to speak English. For the mobile phone component, by dialing “3000” users can access English language audio lessons and quizzes. The content is updated weekly and each lesson lasts three minutes. Through a special agreement, facilitated in part by coordination with the telecom regulator BTRC, all six 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 3 pence). Between the launch in November 2009 and October 2010 over two million audio lessons have been listened to and 46% of first-time users have returned to the service.

- **Using mobile phones to distribute educational videos to teachers:** With the Bridge IT Tanzania project teachers download educational videos onto mobile phones which are then connected to classroom televisions which display the videos. Students watch the videos, which usually run four to seven minutes, and then teachers use BridgeIT-designed lesson plans to build on the ideas set forth in the videos. BridgeIT is the result of a partnership that includes the Pearson Foundation, Nokia, the International Youth Foundation, and United Nations Development Programme (UNDP). It aims to use mobile phone and digital technology to increase quality of teacher instruction and pupil achievement in primary school in math, science, and life skills. Many schools are in rural locations, and mobile phones allows 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 set out to explore the viability of using mobile phones to support reading and writing by youth in South Africa. Yoza cellphone stories are short and free – some stories are published every day with new stories published on the first of every month on a mobisite and on MXit, a free instant messaging application, in South Africa and Kenya. Readers are encouraged to read them, leave comments and vote. There is also the Young Africa Live (YAL) mobile portal developed by the Praekelt Foundation which consists of a combination of regularly updated, dynamic stories and live chats and a series of permanent content pieces. It aims to share information and education, generate discussion and promote HIV testing. By having Vodacom as the mobile partner makes it possible for YAL users to visit the site for free with no download or bandwidth charges.

The uptake has been high. From September 2009-September 2010, the m-novels collectively been read more than 60,000 times, readers posted more than 40,000 comments and submitted more than 10,000 competition entries (Mxit, Mobi and YAL). Steve Volsoo, project leader of Yoza, wrote that the lessons from the project include that: “mobile is a content monster”; “mobile is instant” (and they did not always moderate on time); “mobile is always on” (and there is a need to moderate constantly); “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”.

The costs include marketing, content development, hosting and software development.

- **Use of mobile phones to support learning math:** The Math for Mobile project of the Project of the University of Haifa provides free mathematics applications for Java J2ME capable mobile devices. Since 2008/2009, the applications are being downloaded globally and downloads range from hundreds to thousands monthly, the more frequently downloaded being Graph2Go and Solve2Go. Teachers occasionally write to the project team about their use of the applications in their schools, from teachers’ centers using the applications for professional development at teachers’ workshops, from secondary and higher education students reporting and asking for further improvements, and from resources being created for Math4Mobile independently by users. They report that the development challenges include lack of technical standards with the continuing fragmentation of the market a major obstacle with scalability and sustainability (requires 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 yet unknown health effects of extensive use of mobiles by children; and investing in a variety of application types such as games and location-based applications.

- **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 own personal cell phones and their own personal airtime to discuss their mathematics homework with a tutor using MXit. Learners send a maths question to a Dr Math Jabber account and enter into a discussion with a tutor ready to answer any question from the entire high-school mathematics syllabus. After one year it had 1000 learners and now 19 000 children are registered on the server, which last year made use

---

84 [http://m4lit.files.wordpress.com/2010/10/m4lit_unesco_barcelona_oct2010_2.pdf](http://m4lit.files.wordpress.com/2010/10/m4lit_unesco_barcelona_oct2010_2.pdf)
85 [http://m4lit.files.wordpress.com/2010/10/m4lit_unesco_barcelona_oct2010_2.pdf](http://m4lit.files.wordpress.com/2010/10/m4lit_unesco_barcelona_oct2010_2.pdf)
86 [http://www.youtube.com/watch?v=eW16PywMSqg&feature=related](http://www.youtube.com/watch?v=eW16PywMSqg&feature=related)
87 See Annex 3 for more detail.
of 30 volunteer tutors for its online tutoring services. Dr Math also provide games and competitions using Mxit to entice pupils to practice mathematics skills.

- **Using mobile phones to support health education**: Text to Change (TTC) is operational in Kenya, Uganda, Madagascar, Cameroon, Namibia and Tanzania and uses incentive based quizzes, sent via SMS, to educate, engage, and empower people on health related issues. They also collect participants’ data for analysis, which helps them to plan their 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. They write that “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 realize its full potential.”

- **Using mobile phones to support literacy**: In Pakistan, Mobilink and Unesco with a local NGO Bunyad as the implementing partner, have an SMS-based literacy program. The pilot involved 250 female learners aged 15-24 who were each provided with a low cost mobile phone and pre-paid connection. They received Urdu text messages daily and were expected to practice reading and writing them down and to respond via SMS. They received up to six messages a day on topics including health and nutrition. The project had the support of 10 teachers who were enlisted and trained by Bunjad to teach students to read and write using mobile phones. The project reported that the learners had higher grades at the end of the programme and improved confidence. However, that funding was provided for both the phones and connectivity for learners raises questions about scalability.

**Opportunities**

While the use of mobile phones in education is relatively new and still evolving, there is growing interest in looking at the opportunities for mLearning which is being driven by the high (and increasing) levels of access to mobile phones in the developing world. Bas Hoefman, for instance, writes in his essay in Annex 3 that “the fact that Mobile is the most widely used technology in Africa and more people have access to a phone than a computer or even to good quality educational material offers vast opportunities for mLearning”. The level of access and use of mobile phones offers opportunities in terms of reach as well as scalability and sustainability of initiatives.

Proponents argue that:

i. They are popular, even with illiterate communities, and their multi-media facilities can be an important tool to provide informal education to people in developing countries.

ii. They can support learning that is personalized and contextual which can make learning more meaningful.

---

iii. They allow students to access resources and collaborate digitally in a more affordable manner.

iv. Mobile phones are an affordable technology for many without government, private or development sector support (which many low cost computing device programmes have relied on). This also provides an opportunity for stakeholders to invest more in items such as relevant content rather than the provision of devices.

v. Mobile phones are popular and familiar to many of the target users (e.g. youth) who have already built sufficient capacity to use the device. This reduces the level of support/capacity building required to use custom built applications on mobile phones.

vi. Mobile phone use in education can be either very customized to groups with specific needs or can provide mass education support to a particular group if adequate investment is made in relevant content.

Merryl Ford and Teemu Leinonen from the Meraka Institute 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”\(^\text{91}\).

Some of the challenges to the use of mobile phones in education include:

i. Software applications to run on mobile phones (e.g. Frontline SMS, Mxit) are often free and less expensive. Mobile development practitioners often modify those applications to suit customers’ needs. However if developers want to build to build special software, tailor content to customise their services to their target users, or ensure that those services are exclusively pushed by all providers, it can be expensive affair.

ii. Support from the regulator to ensure the participation of all mobile operators in the delivery of a service is often required as well as a strong business case to attract the operators to push the services as required.

iii. Even with the proliferation of low cost handsets, pricing of services remains a constraint on uptake and usage of mobile phones. The RIA Comparative Sector Performance Review 2009/2010 states that “national pricing still hampers the accessibility of mobile services. Tariffs are not only influenced by the number of players and level of competition, but

regulatory aspects such as interconnection fees, taxes and levies increase the costs of telecommunication services”

iv. A critical element for creating impact lies in provision of customised content at minimal cost.

v. Text based m-learning excludes text illiterate population but the introduction of IVR (audio) and the requirement of smart phones to use multimedia services can be more expensive.

vi. Ensuring compatibility on all phone types and provision by all national providers is an issue. Scaling up m-learning at a national level generally requires policy and regulatory support.

vii. Lack of standards – Yerushalmy and Weizman write in their essay in Annex 3 about the challenges of the Math4Mobile project that the “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.”

viii. The fact that many schools and teachers do not allow the use of mobile phones in classrooms.

ix. Usability due to issues such as the small screen size.

2.4.4 Tablet PCs, iPads and eReaders

Tablet PCs, iPads and eReaders are innovative technologies but remain expensive to most developing countries and are at very early stages with regard to their use in education in these countries. With the creation of the iPod a new chain of devices were born which are touch screen, multi-media friendly, web-friendly and relatively intuitive to use. They presume connectivity in order to upload content and to access the explosion of interactive, location specific and customer-centric software applications. Current experiments of using tablets PCs, eReaders and iPads in education are therefore largely confined to developed countries due to cost and connectivity.

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.

Case Study: Worldreader.org

WorldReader.org is a not-for-profit organization deploying e-Readers and are testing the use of eReaders in schools in Ghana. They argue that “Digital books have three principal advantages over physical books. First, once e-readers are in place, schools and families have near-immediate access to hundreds of thousands of books, from new textbooks to current best-sellers like Twilight. Second,
the cost of shipping these books is nearly zero, even to very remote areas, compared to $1.00 or more per book just to ship a container to port. And finally, 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". 

Their donors help subsidize the gap between the cost of the e-readers and the price local governments are willing to pay. Their model is that the books initially loaded on the e-readers will be included in the donor-subsidized price paid by local schools and communities. Each community will decide which books are pre-loaded onto e-readers, based on their needs and interests.

They found in their trial at the OrphanAid Africa school that the 6th-grade students were able to learn to use the Kindle after several hours and training and several days of practice; that ready digital books was an acceptable alternative to reading paper books; and that kids read more using the Kindle. Readers used the built-in dictionary to look up new works and the text-to-speech capability for pronunciation. For their iRead pilot study some e-readers were left in the school library for borrowing and which they report is an approach which has been successful. They are considering transitioning from a single user e-reader model to a library model.

The main challenges they observed were around the preparation and set up of the e-readers; the cost of e-Readers and books, along with digital rights management (DRM) policies; lack of local content available on e-readers; bandwidth issues; and some usability issues (e.g. several ways to accidentally hide books and a setting that drains the battery quickly).

[www.worldreader.org](http://www.worldreader.org)

Opportunities

i. Some of the key features mentioned in support these devices include the touch-interface provide an intuitive experience for learning; the growing number of low cost applications; the portability of large volumes of content; the ability use the mobile phone GSM network to access content; and long battery life.

ii. Some e-readers also have additional functionality which can also offer benefits such as built-in dictionaries, access to Wikipedia and text-to-speech which can help, for instance, new readers or the visually impaired.

Challenges

Cost remains a key barrier, even though this is declining quickly with ereaders, the cheapest of these devices, currently costing about $200 which is half of what they cost about 18 months ago.

97 The following shows a 2 year old trying an iPad for the first time: [http://www.youtube.com/watch?v=pT4EbM7dCMs&feature=player_embedded](http://www.youtube.com/watch?v=pT4EbM7dCMs&feature=player_embedded)
Importantly the cost of the device is only a fraction of the total cost of ownership. There are also concerns about their ruggedness to survive in dusty, tropical environments.

The other major barrier is that they are intrinsically designed to be dynamic tools which function, interact and update content through the internet, which is an unrealistic expectation in environments with limited and expensive bandwidth. Connecting with various social networks are also part of the tablet PC and iPad experience that make them exciting for users. These networks and their content need to be relevant to users in developing countries.

eBooks and iPads have proprietary and closed standards and formats – the digital rights management of one device’s content is restricted to its own device and not shared with other machines/readers. There is a need to consider how content is (un)locked to specific users or machines and inter-operable digital rights management arrangements for educational content. Innovative inter-operable and unrestrictive versions for educational purposes in future cannot be ruled out.

Digitizing content, developing new digital content and distributing this content to users is a challenge (e.g. in terms of costs, capacity, connectivity, establishing new policies and regulatory practices). Locally relevant content needs to be available at affordable prices. Digitizing local content in different languages is likely to be a major challenge in developing countries.

2.4.5 Cross-cutting Opportunities and Challenges

In discussing opportunities and challenges here, the focus is not about advocating for the primacy of any specific technology. It is more about bringing out examples that point to good practice that could be applied in any situation. There is an increasing range of technology tools available and there is not any one device that is best for every situation.

**Opportunities**

Affordable technologies offer learners additional mechanisms for accessing content and provide opportunities for learning and collaboration which compliment existing education and learning programmes. They can also support sharing of information, experiences and collaboration. The increasing availability and affordability of mobile technologies and mobile networks enables users to engage in learning activities at times and locations convenient to them.

The proliferation of mobile phones has meant that more learners have access to ICT devices than has been the case previously. This offers opportunities to look at how access to these devices can be used to support learning. As Prof Traxler writes in his blog essay in Annex 3 that “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”.

However, the application of technology in education is context specific. There is need to consider issues such as content, training and support to enable the technology to be effectively used by teachers and learners. It is important to undertake a clear needs assessment and evaluate and learn from the use of ICTs in education to understand where and how the use of technology might be effective. Leigh Linden, for instance, evaluated a computer assisted learning programme in India that implemented both an in-school and out-of-school model. She found that “the format of the program can make the difference between providing needed assistance to weak students and generally causing all students to learn less than they would have learned without the intervention”98.

Challenges

The number of challenges that needs to be addressed by African countries is quite long and can appear daunting. All challenges are however amenable to solutions provided the correct approaches are used.

i. Electricity in Africa has a huge impact on access to the devices and power-back up will only increase the running cost of these devices. Nearly 600 million people in Africa – about 60 percent of the continent’s population - lack access to electricity. This number is expected to reach 700 million by 2030. Africa’s rural poor are particularly energy starved, accounting for 88 percent of those without electricity.99

ii. There is lack of reliable and affordable internet. Less that 12% of the population in Africa are internet users100. Bandwidth costs for broadband in Sub-Saharan Africa are 30-40 times that in the US.101 Research ICT Africa reports in their 2009/2010 sector review that sub-Saharan Africa trails North Africa with internet penetration rates below 3% on average and a broadband penetration rate below 2%.102

iii. The challenges around digital learning content and teacher capacity building that have been discussed under these specific themes also apply here.

iv. The dynamic nature of technology means that most of the technology covered in this document is new and so its impact in education is not fully understood. Technology selection should be more about understanding the parameters for making the correct choices rather than specific focus on any technology type.

---

99 http://www.lightingafrica.org/component/k2/item/22.html?layout=item
101 IEMP, https://confluence.slac.stanford.edu/display/IEPM/New+E.+Coast+of+Africa+Fibre
v. Scalability has not been well addressed in the literature and practice: many of the projects are pilots implemented on a small scale. This is also linked to gaps in research in the use of ICT in education: Much of what is written has positive biases and is often written by members of implementing organizations. There is an ongoing need for rigorous impact evaluation studies on educational technology initiatives in developing countries. Ongoing monitoring and evaluation is required to build up the evidence base of what works and what does not work.

vi. Total Cost of Ownership has been discussed under DLRs. There are few studies available on the total cost of ownership of different technologies. The total cost of ownership is often underestimated when calculating costs of ICT in education initiatives in development countries. One analysis by Vital Wave Consulting shows the TCO of an ultra-low-cost PC to be in the $2000-3000 range for developing country schools. A similar analysis by OLPC News suggests $972 over five years for OLPC (the very optimistic advertised lifespan of an OLPC laptop), and $753 for an OLPC implementation in Nepal (cf., OLPC’s current cost of $188).

vii. There is a need to consider the provision and cost of technical support and maintenance, skills that continue to be scarce in most African countries.

viii. There are often logistical challenges in terms of distributing both the hardware and content to teachers and learners.

ix. Technology tends to reinforce existing social and cultural inequities. There is a need to understand and pro-actively seek to address these challenges.

It is also useful to consider the blog that Michael Trucano wrote on worst practices related to the large scale use of ICTs in education in developing countries. He lists the following as what he considers some of the pre-eminent worst case practices:

i. “Dump hardware in schools, hope for magic to happen”

ii. “Design for OECD learning environments, implement elsewhere”

iii. “Think about educational content only after you have rolled out your hardware”

iv. “Assume you can import content from elsewhere”

v. “Don’t monitor, don’t evaluate”

vi. “Make a big bet on an unproven technology (especially one based on a closed/proprietary standard) or single vendor, don’t plan for how to avoid ‘lock-in’

---

vii. “Don't think about (or acknowledge) total cost of ownership/operation issues or calculations”

viii. “Assume away equity issues”

ix. “Don't train your teachers (nor your school headmasters, for that matter)”

2.4.6 Critical Success Factors

From a consideration of the many examples here and in Annex 4, the following are critical success factors in taking decisions about technology for a particular project:

i. There is a clear understanding of the needs of teachers and learners and how these can best be addressed (including equity issues).

ii. Educational content has been considered from the start.

iii. There is an understanding of lessons learnt from other projects and that tools and that approaches are piloted to learn what works and what does not work before they are scaled up

iv. There has been an analysis of the total cost of ownership

v. Stakeholders are consulted, engaged and supportive (e.g. teachers, learners, principals, parents and communities). Any intervention needs to be supported by those who will institutionalize and embed the use of the technology and educational change.

vi. Sustainability is considered from the start (e.g. looking at who can support and help take the project forward once the initial pilot or funding has been completed and what will they require to convince them and enable them to do so; technology transfer and localisation issues).

vii. The dependencies and risks have been identified with strategies in place to address them. These include issues such as infrastructure requirements, logistics, teacher training and technical support.

viii. Other critical success factors include the establishment of effective partnerships (e.g. with content providers, mobile operators, etc.).

2.5 Education Management Information Systems

2.5.1 Introduction

The increasing recognition of the importance of ICTs in education in the recent years led to many countries emphasizing the role of Educational Information Systems in their ICT policies. For example, EMIS is part of national education sector ICT policy of the Ministry of Education and Vocational Training (MoEVT) of Tanzania. The ICT for Education Policy states that the “MoEVT will

---

ensure adequate training of administrative and management staff in relevant ICT systems, including standard office software and EMIS.” Similarly, the ICT sector policy of the Ministry of Education of Trinidad and Tobago endorses the establishment of an “integrated online Educational Management Information System (EMIS) to expedite access to information resources, to strengthen education management capabilities and facilitate effective decision making”\textsuperscript{108}.

However, the implementation of EMIS varies widely from countries with no cohesive plan to those with policies in paper but lack of structure and political will and stakeholder buy-in to implement to those with well defined plan and objectives including time-bound strategies for EMIS.

2.5.2 EMIS Experience in Africa and the Rest of the World

A survey of EMIS development in Southern African Development Community (SADC) member States 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”\textsuperscript{109}. Key challenges facing EMIS data is summarized in Table 3.

Table 3: Major challenges facing EMIS in African countries\textsuperscript{110}

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

In addition the majority of the countries:

1. have had difficulty in pulling data from different sources together and recasting it into meaningful information,
2. suffer from capacity and integration problems where data is only available to a handful of analysts and statisticians in the ministries of education,

\textsuperscript{108} Ministry of Education of Trinidad and Tobago, Draft ICT in Education Policy, 2005, www.carib-is.net/ictpolicies/draft-policy-information-and-communications-technology-education-trinidad-tobago


\textsuperscript{110} Based on: Ellison, Robin, A practical guide to working with the Education Management Systems, Guidelines for DFID advisors, 2008
iii. hold data that is old, inaccurate and cumbersome to use\textsuperscript{111}.

The development of EMIS in Africa has been largely driven by the donor agencies. The United Nations Scientific and Cultural Organization (UNESCO), the European Union, the Department for International Development (DFID), the Swedish Agency for International Development (SIDA), GTZ, the French Cooperation, the United Nations Children’s Fund (UNICEF), the World Bank and the United States Agency for International Development (USAID) were among the main players along with the Association for Education Development in Africa (ADEA) that was used as a vehicle for EMIS capacity building throughout the continent.

In 1990s EMIS was promoted under the National Education Statistical Information Systems (NESIS) project that was executed by the Association of Development in Africa (ADEA)’s Working Group on Education Statistics. NESIS has been devoted to developing EMIS capacity in sub-Saharan Africa for over a decade. Some progress has been made in building the capacity for collecting and organizing educational statistics at national levels through the NESIS project. However, the substantial investments made, principally by donors, have not produced the desired results.

Attracting and retaining staff with the required technical skills in EMIS has been another challenge in Africa. In addition, most countries lacked data on early childhood, non-formal, vocational and higher education along with information on financial expenditure. Capacity building of data providers as well as training on web design and methods for estimating and projection data was also found critical\textsuperscript{112}.

The Asian Development Bank review of the EMIS status in the Asian region depicts a similar picture where donors and international institutions play a key role in its deployment. Similarly, while data in the primary and secondary education sector is widely available, there is substantial lack of information on tertiary institutions\textsuperscript{113}.

In the Caribbean, Jamaica was cited as a best practice in the collection, management, and use of educational information, along with development of ICT policy in education. EMIS initiatives were launched in Barbados, Antigua, and St. Lucia. An in-depth review of EMIS in the Caribbean and other Latin American countries shows that apart from the development of individual EMIS at central government levels there is an increasing trend for interactive online information systems for routine management and administration of educational services at schools, district and municipal levels\textsuperscript{114}. This is in contrast to African countries where EMIS remained underfunded and generally centralized with government.

\textsuperscript{111} Knoxville Chamber of Commerce, The Knox model: Education Management Information System, \texttt{\url{www.knoxvillechamber.com/pdf/EMIS-knox-model.pdf}}


Jamaica was among the first countries in the Caribbean to pursue development of a single comprehensive EMIS in 1990s\textsuperscript{115}. The EMIS was used to produce school profiles that include summary data on enrollments, the qualifications of teachers, and the condition of the facilities. The profiles also included some basic indicators including student-teacher ratios, class sizes, and male-female enrollment ratios. The objective of the school profiles was to facilitate the sharing of school data with a wider audience of stakeholders in an effort to generate more attention and commitment to school improvement. The EMIS data was also used to generate a short focused-analysis (policy brief) using readily available data that responds to a specific immediate information request of an education leader. The objective was to provide leadership with an initial assessment of a particular question or issue in a very short period of time using readily available data. Between 1994-96 the Jamaican EMIS was used as the basis for the generation of a series of 17 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 the EMIS can achieve.

Progress in Africa, and elsewhere in developing countries, shows mixed outcomes in terms of EMIS deployment at national level. While there has been improvement in collection, the actual use of the data remained low. The challenges cited include lack of funds, inadequate connectivity, limited access for teachers to computers in schools, and limited capacity and experience with EMIS. Nevertheless, there has been increasing attention to educational data due to growing interest in monitoring education outcomes, in particular within the framework of internationally agreed goals such as the MDGs and due to availability ICT tools and capacities at schools levels in the recent years.

2.5.3 **EMIS Development Process**

EMIS is a relatively complex process involving data and its use for decision making, therefore the starting point in its development process should be the application of data rather than ICTs. Information and communication technologies are just one of the inputs in the Educational Management Information System development process. An effective EMIS process involves planning including the positioning EMIS, identification of the objectives of the system and the role of different actors, designing data requirements, putting the necessary technical resources (hardware, software and human capacity) in place, and promoting sharing and use of data. The simplified EMIS value chain in Figure 2 shows that technical implementation is one of the many components of EMIS deployment.

\textsuperscript{115} ibid
The positioning of the EMIS is a key aspect in the EMIS value chain that often determines its success or failure. Education as a sector, particularly pre-university, is in most countries the responsibility of the Ministry of Education where EMIS unit is often located. The function and positioning of the EMIS unit varies from one country to the other. In Namibia, the Education Management Information System is part of the Directorate of Planning within the Ministry of Education, Sports and Culture. In Ethiopia the Ministry of Education has an independent unit charged with EMIS.

The role of the EMIS unit is to:

i. Ensure that comprehensive and accurate data on all aspects of education including student performance, staff efficiency, institutional, physical and financial resource inputs and demographic trends are systematically collected and processed so as to provide education planners with all the information required for optimum policy and program development,

ii. Promote cooperation, information exchange and data integration among multiple sources and levels within and outside of the education system,

iii. Provide technical assistance and advice to provincial, state or district education departments and institutions in collection and analysis of data to enable them to monitor and evaluate their own system performance at the local levels,

iv. Develop indicators for planning, project management and evaluating all aspects of the educational system,

v. Disseminate information on educational achievement through print and online media to enable researchers to utilize comprehensive educational data and information,

vi. Co-ordinate research, development and training activities on education management information systems in collaboration with other partners in the education community,
vii. Secure funding support from national and international agencies for the expansion and development of EMIS.

Identification of the necessary data is the next important step in EMIS deployment. From the Ministry down to the schools, the main issue is often getting data right and making it available in a timely manner. EMIS data issues range from understanding needs of decision makers and maintaining data quality, data structures, data validation and maintenance, to putting in place mechanisms for the integration of multi-level, multi-source, multiple year data. Emphasis on monitoring progress towards international education commitments and attaining universal access to education implies, educational data on EFA is required almost by all countries. The data required for monitoring EFA are shown in Table 4.

**Table 4: Data Required for Monitoring EFA**

<table>
<thead>
<tr>
<th>Data Layer</th>
<th>Indicators and data elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult literacy</td>
<td>Adult literacy rate (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Number of illiterate 15+ (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Adult literacy numbers (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td>Youth literacy</td>
<td>Youth literacy rate (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Youth literate numbers (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td>Pre-primary education</td>
<td>Gross enrolment rate of early childhood (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Percentage of entrance to primary education (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td>Primary education</td>
<td>Gross intake rate in primary education (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Net intake rate in primary education (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>School life expectancy (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Primary age group</td>
</tr>
<tr>
<td></td>
<td>Primary school age population (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Gross enrolment ratio in primary education (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Net enrolment in primary education (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Percentage of overage (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td></td>
<td>Percentage of underage (total, male, female, female/male ratio)</td>
</tr>
<tr>
<td>Secondary education</td>
<td>Secondary age group</td>
</tr>
<tr>
<td></td>
<td>Secondary school age population (total, male, female)</td>
</tr>
<tr>
<td></td>
<td>Secondary enrolment ratio (total, male, female, female/male)</td>
</tr>
<tr>
<td>Human</td>
<td>Percentage of trained teachers (pre-primary, primary, secondary) and total, male,</td>
</tr>
</tbody>
</table>
### Resources

- Female and ratio
- Pupil to teacher ratio in primary and secondary education

### Internal Efficiency

- Repetition rate in different grades (total, male, female, ratio)
- Survival rate in different grades (total, male, female, ratio)
- Transition to secondary/tertiary (total, male, female, ratio)

### Finance

- Public expenditure on primary/secondary education as percentage of GNP
- Public expenditure per pupil in primary education as a percentage of GNP
- Public expenditure on primary/secondary and tertiary education as a percentage of total education expenditure
- Public expenditure on primary/secondary and tertiary education as a percentage of total government expenditure

### Private enrolment

- Private enrolment as percentage of total enrolment of pre-primary, primary and secondary education

### Out of school children

- Estimated out-of-school children (total, male, female, female/male ration)

Other data elements for monitoring education at all levels include:

i. Teachers and principals demographics
ii. Data on text books
iii. Data on students on special education
iv. Reading, writing and mathematics proficiency indicators
v. School level costs, and
vi. School level cost drivers
vii. Teacher qualification tests
viii. Teacher assignment and positions
ix. Teachers awards and penalties

Tertiary education level EMIS data has become increasingly important in recent years for monitoring educational attainment and progress. EMIS data in higher education includes graduation and withdrawal rate, faculty specialization in different fields, and faculty to student ratio in different fields of study.

Integrating the multiple sources of data is the most important step in the EMIS data supply chain followed by its dissemination and use as shown in Figure 3.

A supply of relevant data also depends on definition of the key data elements, training of data providers such as school principals, putting effective procedures for data verification and merging in place, creation of effective mechanisms for data security and maintenance and the development of useful reporting formats and strategies for data dissemination based on user needs.
2.5.4 Technical Implementation: ICT Application Trends

The growth of the Internet, World Wide Web, broadband and wireless technologies and increasing availability of database tools has created a significant boost to ICT based educational administration and information management. EMIS has seen a significant transformation over the last three decades beginning with fragmented approach where data was collected individually using basic tools such as Microsoft Access applications and disseminated through floppy disks to the present stage where large distributed databases that are interconnected via the World Wide Web provide access to information at school, district, regional and national levels. Figure 4 depicts the progress from fragmented operation of EMIS to largely minimalist approach up to the current trend where decentralized information systems can be integrated using interoperable web-based tools.

Figure 3: The EMIS Data Supply Chain
The majority of African countries are still at the minimalist stage where data is collected using database tools provided by donor agencies and analysis and integration takes place centrally at the Ministries of Education using spreadsheets and statistical tools such as SPSS and SAS. The United Nations Education, Cultural and Scientific Organization (UNESCO), the World Bank and the United States Agency for International Development have forged a strong collaboration in the area of EMIS and have played a significant role in providing assistance in utilizing different software tools such as EDucation Automated StatiStical Information Toolkit (ED*Assist) software 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 USAID Africa regional programme. EDAssist was promoted within the Association for Development of Education in Africa (ADEA) Working Group on Education Statistics (WGES). The software features modules for data gathering, data processing and data utilization. It is possible to implement modules in isolation, and some countries have done this.

ED*ASSIST is a Windows-based software system that was designed for the collection, processing and dissemination of education data. The ED*Assist funding supported joint needs assessment, technology, training, and on-going support for building the capacities of the ministries of education and local stakeholders. The system is oriented towards getting accurate data to users quickly. It goes beyond the core data entry, processing and output to feature a Questionnaire Tracking System.

---

Figure 4: Progress with ICT Applications in EMIS

Integrated (2005+)
- Proliferation of independent information systems at school, municipal, district and provincial levels
- Web-based data manipulation
- Integration with Geographic Information System
- Business intelligence tools for trend analysis
- Advanced relational database systems
- Experiments with wireless and PDAs
- Integration of Web 2.0

Minimalist (1995+)
- Data collected using database tools and spreadsheets
- Transfer of data by email and help
- Analysis and integration of data using spreadsheets and statistical tools such as SPSS, SAS

Fragmented (1985+)
- Data gathered manually by different educational establishments
- Individual desktop used for analysis

116 www.aed.org/edassist
and to support areas such as reviewing information requirements and assessing staff workloads. ED*ASSIST was originally used in a dozen of African countries including Djibouti, Liberia, Malawi, Uganda and Zambia. However, the discontinuation of support by the USAID after initial introduction of ED*Assist in certain countries made it one of the least successful ventures in promoting EMIS in Africa. In Uganda for example, difficulties with LAN, lack of technical expertise, inaccurate and incomplete data and absence of resources dissipate the gains that were made at early years.

While commercially developed EMIS software is growing there has also been a mounting trend towards the use open software for managing educational data in developing countries. UNESCO is at the forefront of this effort with the development of OpenEMIS\textsuperscript{117} software that facilitates the setting up of an EMIS adapted to the needs of the users at central, regional and local levels. The tool is freely available for use by all those who wish to adapt it to the features and information needs of their national education system. The source codes are also made available for adaptation. The revised version of OpenEMIS was released in January 2011\textsuperscript{118}.

OpenEMIS is composed of two modules: EMIS Builder and EMIS User. The first module allows database administrators to adapt the generic tool to the particular characteristics of a national education system. The second allows the actual data inputs and queries, and the production of reports, charts and indicators. OpenEMIS provides tools for information management and data collection at various levels including at school levels operating both in online and off-line 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, test results and tools for automatic calculation, query, reporting and aggregation. OpenEMIS has interfaces to Geographic Information System and automatic geolocalisation of educational institutions with GPS.

The other tool that is used in the region and promoted by the Association for the Development of Education in Africa was the Statistical Information System (SIS) that was promoted in French speaking countries. NESIS SIS was originally developed by the Dakar node, and piloting took place in Burkina Faso. The system has three elements: data collection, data capture (‘StatEduc’ in French), data reporting (‘Annuaire’ – to produce an annual abstract) and data exploration (‘Exploram’). A GIS module to support school mapping was also developed as integral part of the NESIS SIS\textsuperscript{119}.

Other countries such as Botswana, Ethiopia and Kenya were supported by donors to custom develop EMIS software. While this has increased the possibility for tailoring for local needs, it creates a significant burden on the capacity of these countries to upgrade the system.

While commercially developed EMIS software is growing there has also been a mounting trend towards the use of open software for managing educational data in developing countries. UNESCO is at the forefront of this effort with the development of OpenEMIS software. The revised version of OpenEMIS was released in January 2011\textsuperscript{120}.

\textsuperscript{117} http://openemis.codeplex.com/wikipage?title=OpenEMIS%20Overview&referringTitle=Documentation
\textsuperscript{118} http://openemis.codeplex.com/
\textsuperscript{119} http://nesis.easyenet.fr/
\textsuperscript{120} http://openemis.codeplex.com/
Geographic Information Systems (GIS) have been a major component of EMIS since the beginning of the 1990s. In South Africa and Lesotho, the Ministries of Education incorporate GIS into EMIS to plot the schools and educational institutions\textsuperscript{121}. Other applications of GIS in EMIS include capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth, and creating static maps\textsuperscript{122}.

A significant development in recent years is the availability of web-based student information systems also known as Student Record System (SRS) that are intended to manage information about students. SRS is used for entering student test and other assessment scores, building student schedules, tracking student attendance, and managing many other student-related data needs in schools. The Higher Education Information Systems address 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 that in turn can easily be integrated into the Higher Education Management Information System.

This growing decentralization implies that schools, colleges and universities can take the responsibility of record keeping, managing their resources in efficient and transparent manner and improving local administration. Districts, provinces and central governments should then focus on integrating the various data sources in order to formulate operational plans and implementation projects at their levels. As the case of Rwanda shows, this can be achieved through Public and Private Partnerships.

The government of Rwanda, Agile Learning Company and Microsoft, have been working together on the Education Management Information System (EMIS) that was aimed at generating educational data for Rwanda\textsuperscript{123}. The EMIS platform digitizes information that is traditionally filled by schools by allowing teachers and administrators to input directly into a database. Schools were provided with computers and laptops to collect the data at source. This includes data on the number of students attending each school, grades, teachers, resources such as books and infrastructure. School principals are required to collect the data as part of the routine data collection process. The data is used to manage resources at the level of schools and to ensure that resources are well distributed according to local needs throughout Rwanda. The program’s rollout phase has been launched to provide the country’s 5,000 schools with computers, Internet connectivity, EMIS database and relevant training by 2011. Rwanda has seen a substantial progress in availability of broadband that facilitated access to Internet for easy data transfer from schools to the central data base in Kigali. The increasing access to the Internet and availability of broadband network is making it easier for schools to enter the data on real time basis. The EMIS tool also provides a program to generate school profiles to promote effective decision making at local levels. The data can also be aggregated to facilitate planning at district and national levels.

2.5.5 The Application of Mobile Technologies and Social Networking in Managing Educational Information

\textsuperscript{122} http://www.education.gov.za/EMIS/tabid/57/Default.aspx
The widespread use of mobile and wireless technologies has brought about another potential for data gathering and upload at the level of schools. The possibilities for integrating wireless tools with Geographic Information System (GIS) and Global Positioning System (GPS) to facilitate school mapping are enormous, although the actual implementation is still very low in Africa. School mapping using GIS has the potential for greater local use of EMIS data and hence improved data quality for all users. The use of mobile phones for gathering EMIS data is being explored in Ghana, Kenya, Rwanda, South Africa and Uganda.

Recognizing the great 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, that 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 device for EMIS is still in early stages and is often constrained by costs, security and inadequate technical support.

Other ICT opportunities lie within the area of social networking, which is on the rise in Africa and can therefore be exploited to facilitate real time reporting on school data and other related aspects, such as resource usage. Social networking applications like Checkmyschool.org in the Philippines showed a high potential for participation of students, teachers and principal in updating information on school on real time basis, thus improving decision making and planning.

2.5.6 Challenges Facing EMIS Deployment in Africa

Notwithstanding the progress in technology and tools, EMIS deployment in Africa faces considerable challenges in moving away from a minimalist approach to decentralized and integrated data exchange at all levels using web, GIS and wireless tools. EMIS was largely donor driven, thus there is limited progress in promoting organic growth in collection, management and use of educational data. The deployment of EMIS lacks sustained funding and financing models.

The limited involvement of policy makers and users in the design of EMIS is compounded by lack of political will and sustained support from decision makers. The lack of coordination and shared vision among various stakeholders (horizontally between ministries and agencies and vertically between schools, districts, regions and federal ministry) means that EMIS development has been ad hoc and often left to the ministry of education and school principals who gather and send data on an annual basis. EMIS data is often incomplete and inaccurate due to lack of full participation of all the stakeholders. Other challenges include:

i. Inadequate clarity between the mandate of ministries of education and statistical offices in collection, managing and dissemination of EMIS data,

ii. Tendency to view EMIS as a threat by some teachers and principals and very low level of enthusiasm for its implementation,

iii. Absence of policy and regulatory frameworks that address the legal requirements of all education and training institutions to provide timely and accurate data,
iv. Difficulties in integrating data from multiple sources and multiple years due to lack of harmonized and interoperable coding of key educational variables,

v. Absence or non-reliable data on private education sector,

vi. Absence of tertiary and, pre-primary and non-formal education data and other including data on finances and resources

vii. Lack of multiple data dissemination strategies.

At the technical level, there has been a tendency to overemphasize technical at the cost of the organizational and capacity issues including literacy of users and information providers. While it is often easier to roll out the technology and database, actual data collection and integration remains tedious and difficult. Most countries face high EMIS staff turnover and skill shortages in advanced web-based content management systems, data aggregation, indicators development and analysis.

Moreover, the availability of a wide range of tools poses significant interoperability problems. Other technical challenges include the need to convert data from historic records to new web-based interactive environments; limited capacity to utilize modern distributed web-based tools to develop EMIS and apply business intelligence tools to make sense out of the data; and connectivity to the Internet and broadband networks at schools and district level, in particular in the remote areas that have not been able to access to communication networks.

Although the challenges remain many, they can be surmountable if concerted efforts are made by donor agencies, the private sector and governments.

2.6 National Research and Education Networks

2.6.1 Introduction

NRENs are rapidly becoming an established feature even among African countries, the last frontier as far as research and education networking is concerned. This section examines the structure and practices among NRENs in order to point to ways in which they can grow and play their role in educational and national development on Africa.

All developed countries, and now most developing countries, have NRENs. NRENs start at the campus level: campuses therefore need have high quality data networks, a sufficiency of user devices for user access, and a competent human to assure the availability and integrity of both the network and the content it provides access to. At the national level, these campus networks are inter-connected using a high speed data backbone to form the National Research and Education Network – such as JANET\(^{124}\) in England or KENET\(^{125}\) in Kenya. As the need for collaboration extends beyond national borders, NRENs, typically within the same geopolitical spheres, NRENs created regional overlays, the Regional Research and Education Networks, which enable collaboration across national boarders. Internet\(^{2}\)\(^{126}\) and the National Lambda Rail\(^{127}\), for example interconnect the state research and education networks in the USA; GÉANT\(^{128}\) interconnects NRENs in the

124 www.ja.net
125 www.kenet.or.ke
126 http://www.internet2.edu/
127 http://www.nlr.net/
128 www.dante.net
European Union; CLARA\textsuperscript{129} interconnects NRENs in South America; and UbuntuNet Alliance\textsuperscript{130} has started interconnecting countries in Eastern and Southern Africa. The regional networks, connected together, form the global research and education network, serving the global research and education community.

As is discussed later in this report, African NRENs, and RRENs, still face major start-up and operational challenges that, if addressed, have the potential to yield high dividends for the transformation of education in Africa.

\textbf{2.6.2 The Structure of NRENs}

NRENs can be envisaged as having two layers:

i. Inanimate: The data network transport and application layer, consisting of high speed data networks interconnecting the member institutions, the applications that run on this network, and the shared access to resources permitted by this layer; and

ii. Animate: The human layer where content sharing and collaboration (in research and education) occur.

The network transport and applications layer is all about technology and, given the right human capacity and resource, can always be addressed. The human layer, where the real benefits occur, is the most challenging because it is built on trust and a willingness to collaborate, both of which cannot be forced.

Figure 5 is an illustration of the multi-layered structure of the global research and education community.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{image}
\caption{Layered Model of the Global Research and Education Community}
\end{figure}

\textsuperscript{129} \url{www.redclara.net}
\textsuperscript{130} \url{www.ubuntunet.net}
NRENs fall into the following common models:

i. **Bottom-up or Grassroots**

These are NRENs that are initiated, owned, and funded by universities and research institutions. Examples of these are Internet2 (USA); the Tertiary Education Network (TENET) of South Africa; and the Research and Education Network of Uganda, RENU. Grass-roots NRENs have the benefit of organisational structures that permit rapid decision making and organisational agility that are in consonance with the nature of the sector they work in. They also respond to member needs because the members are the top policy body that sets up the Board and executive arms of the NREN. They will however 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 needed.

Grassroots NRENs can also face competition – which is not necessarily bad, but can be very challenging. In the USA, the National Lambda Rail (NLR) 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 the universities and research institutions, and running the most advanced NREN network in Africa. Government has however also set up SANREN – the South Africa Research and Education Network. SANREN has established a gigabit backbone interconnecting the South African Universities and operated, through a formal agreement, by TENET, which also uses it to distribute the 10Gbps international connectivity they procured as indefeasible rights of use (IRUs). This functional collaboration has however not yet resolved the question of which of the two is the South African NREN.

ii. **Top-down**

These are NRENs initiated and owned by government, for example the Ethiopia Education and Research Network, EthERNet; and the Sudan Universities Information Network, SUIN. Top-down NRENs are subject to the typical environment of any government managed institution. These include very slow and procedure bound processes that disable tactical decision making due; lack of awareness of costs; not efficiency driven; not responsive to the needs of the institutions they serve. They however have an advantage of immediate recognition and acceptance by governments because they own them.

iii. **Cooperation between government and universities**

In this model, there is mutual recognition of the roles of both parties. SUIN, for example, is now moving to the state where government is happy to continue with funding support while devolving management and control to the universities.

---

131 IRUs grant to the purchaser specific rights for a specific period of time. In the case of data communication networks, this translates to a given amount of bandwidth that will be available for the sole use of the purchaser for the defined period. TENET purchased a 10Gbps IRU on SEACOM for a period of 20 years.
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 and executive arrangement selected by members.

2.6.3 NREN Growth in Africa

The growth of NRENs in Africa started just over ten years ago, and was initially motivated by the high costs of bandwidth that have led to intellectual isolation of researchers and academics in Africa.

Towards the end of 2008, data from TeleGeography’s Wholesale Bandwidth Pricing Database showed that the median price of a 2Mbps circuit between London and Johannesburg was nearly USD15,000 – the same price that could lease 10Gbps between London and New York. While costs have dropped in some location to $300 and lower per full duplex Mbps per month (About 3% of what it was three years ago), costs remain well beyond what is typical in the richer developed countries (of the order of $20 - $30 for the same capacity), and countries like Zambia are still paying the old rates.

One of the earlier cooperative initiatives was the African Universities Bandwidth Consortium\textsuperscript{132} (AUBC). AUBC was supported by the Partnership for Higher Education in Africa, and was able to negotiate costs for participating institutions to less than 50% of the original VSAT prices.

This was followed during the 2004/5 the 11\textsuperscript{th} General Conference of the Association of African Universities (AAU), where the AAU secretariat was given a mandate to establish a “Working Group on Information and Communication Technology (ICT) to guide the Association’s support of the ICT capacity of its member institutions and, especially, the development and implementation of an action plan to set up a network of African higher education institutions to negotiate the acquisition of higher bandwidth at lower cost.” In their recommendation about the actualization of this, the consultants, Tusubira and Mulira, specifically recommended that\textsuperscript{133}:

“While the focus of this report relates mainly to the challenge of getting access to more bandwidth at a lower cost, the authors feel very strongly that this alone does not provide a sound platform for the role of the AAU. The role of the AAU must be seen within the broader context of using its unique positioning to enable the higher level benefits of a consortium approach to learning, research and community outreach, with the integrating ICT services and systems in institutions as an enabling layer. This particular function has been highlighted in the report as the long-term justification for the AAU initiative, bandwidth being just one facets of the many challenges”.

The Research and Education Networking Unit of the AAU\textsuperscript{134}, which has played an increasingly key role in promoting REN activities and awareness in Africa, was subsequently established.

\textsuperscript{132} http://www.foundation-partnership.org/index.php?id=29
\textsuperscript{134} Give url
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 the starting stage, KENET in Kenya. Librarians in Sudan and Malawi had also set up infrastructure for sharing resources, though these had not yet evolved to become NRENs.

The creation of the UbuntuNet Alliance, the pioneer RREN in Africa, was motivated by a combination of factors: the SARUA Fibre Study that brought to light the substantial reservoir of unutilised optical fibre capacity in Africa, owned especially by utility companies; the new wave of liberalisation as monopoly and other limited competition provisions stipulated during the first wave of liberalisation in the late nineties expired, creating opportunity for such fibre to come on the market; and the plans for the first east coast submarine cable, known as the East African Submarine System, or EASSy. Embryonic and developed NRENs in five countries came together to initiate the development of an African regional REN, leading to the birth of the Alliance.

The UbuntuNet Alliance has as its principle objective the enabling the integration of African universities and research centres into the global research and education community through provision of intra-African connectivity and enabling access to sufficient and affordable international internet bandwidth, the underlying hypothesis being that:

“Improved and affordable connectivity will enable African researchers to produce proportionate intellectual output and generate a proportionate amount of intellectual property goods”

Over the last four years, there has been a spurt of growth of NRENs, most of them still at the organisational level and not yet delivering services. Figure 6 shows the existing NRENs in the Alliance, and the RRENs of Africa, by July 2011.

---


136 The pioneers were Victor Kyalo of KENET, Kenya; Margaret Ngwira of MAREN, Malawi; Duncan Martin of TENET, South Africa; Americo Muchanga of MoREN, 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.
Figure 6: Growth of NRENs in Africa

Figure 7 is a descriptive presentation of the current operational status of the NRENs in Eastern and Southern Africa, showing that many of them still have a long way to go.

### Formal REN, fairly advanced network and sufficient bandwidth: South Africa, Kenya

### Formal REN and underlying operational infrastructure: Sudan, Malawi, Uganda, Senegal

### Formal REN but not operational: Rwanda, Tanzania, Zambia, DRC, Mozambique, Ethiopia, Somalia, Ghana

### REN in formation: Botswana, Swaziland, Lesotho, Namibia, Burundi, Angola, Mauritius, Djibouti, Nigeria, Zimbabwe

Figure 7: Operational Status of NRENs in Eastern and Southern Africa

### 2.6.4 Examples of NRENs from Africa and Around the World

This section gives a selection of examples that provide learning points for NREN stakeholders in Africa. The examples used include Internet2, CLARA, UbuntuNet Alliance, KENET, TENET, and XNet.

a. **Internet2**, USA

Internet2 is organized as not-for-profit and takes pride in being community led and member focused. Internet2’s 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”. Started in 1996 with 34 universities, Internet2 now has 372 members and 131 sponsored education group participants. Members include U.S. universities, corporations, government research agencies, and not-for-profit networking organizations representing over 50 countries.

Internet2 developed a K20 Initiative to connect university members to the broader education community through a process called Sponsored Education Group Participants. The result is connection to the Internet2 backbone network of 66,000 Community Anchor Institutions (CAI) in 38 U.S. states. CAIs are community-based organizations that include K-12 schools, libraries, community colleges, health centers, hospitals and public safety organizations.

Opening Internet2 membership to industry partners has reciprocal benefits. Benefits from industry include significant contributions in support of the development and deployment of advanced

---

137 See Blog Essay by Maria Beebe and Internet2 url - http://www.internet2.edu/
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 to industry partners include 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 opportunities, among other things.

Members are engaged and opportunities for membership engagement abound 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 discipline areas, such as the arts and humanities, health sciences, and sciences and engineering. Members also have access to a comprehensive menu of services, tools, capacity building, and R&D as detailed in Annex 6.

The success factors of Internet2 include:

i. The provision of a critical suite of services and opportunities to members as highlighted above;

ii. The close collaboration with industry to the extent of creating a class of membership for them and getting them fully involved;

iii. Members ownership and direction;

iv. The many opportunities provided through which human networks are developed and strengthened.

b. Red CLARA – the South American Regional REN

CLARA is the RREN of South America. The impetus to form the regional network was provided by funding from the European Union Commission (EUC) under the ALICE project, with implementation through DANTE, the organisation that manages the European RREN, GÉANT.

The bigger NRENs then existing, specifically in Brazil and Argentina, have played a major role in enabling the weaker NRENs to get to the level of participation and actually start benefitting from the services, by both providing expert support and assuming a disproportionately large financial burden.

CLARA faced challenges of sustainability at the end of ALICE because sustainability was not factored into the planning by the member countries early enough. The start of the second phase of EUC support, ALICE2, diverted this challenge that has nevertheless been a learning point for CLARA and other RENs (like the UbuntuNet Alliance).

Success factors include:

i. The willingness of established and financially able NRENs to meet costs above their direct benefits;

138 Insert url
ii. There has also been a very strong focus on engineering design, creating a very strong engineering team that was able to keep CLARA functioning despite the transitional challenges.

c. **The UbuntuNet Alliance for Research and Education Networking**\(^{139}\)

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. The other emphasis has been on stakeholder identification and engagement, and focusing on roles that provide value for members while not violating their autonomy. This is illustrated in the UbuntuNet Alliance Stakeholder Map in Figure 8.

The Alliance was able to get initial support from the International Development Research Centre\(^ {140}\) of Canada.

The Alliance focused on an operational presence from the start, establishing a router (donated by Cisco) in London connected to the GEANT and through that to the rest of the world. The other POP is in Johannesburg. The total connected capacity through the UbuntuNet router in London has increased from less than 1Gbps when it was set up to about 12Gbps now. The interconnection with GEANT has also been increased from an initial 1Gbps to 20Gbps now, inclusive of a 10Gbps point to point route.

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

\(^{139}\) www.ubuntunet.net

\(^{140}\) http://www.idrc.ca/EN/Pages/default.aspx
Figure 8: UbuntuNet Alliance Stakeholders Map showing the Value Addition Layer of the Alliance

The Alliance has been able to establish a very strong human network on which the NRENs draw for support and guidance in their growth and operations. This is easily the strongest point. Other success factors to date include:

i. Sustaining members interest through capacity building and support, creating value beyond bandwidth;

ii. Planning for sustainability as part of the strategic plan priorities, and insisting that members pay their contributions without fail, key to building sustainability.

iii. Established an operational POP from the start (supported by donations);

iv. Strong stakeholder engagement that has earned the Alliance international recognition;

v. Active support for the establishment of the West and Central African Regional Network, WACREN;

vi. Starting off with a Board and CEO who were internationally recognised pioneers;

vii. Focus on creating trust from the start;

viii. Running a thin delocalised organisation with outsourced operations;
Support from the stronger members, much like South America. TENET has provided the core of this support.

d. **KENET, Kenya NREN**

The Kenya Education Network, KENET, is a member founded organisation that, from the beginning, actively involved the regulator. They have enjoyed a lot of government goodwill and support. They received a start off grant of USD 500,000 that enabled their operations in a situation where there was very limited connectivity within Kenya.

Until recently, KENET was run by a CEO and support staff whose time was donated by the member institutions, saving KENET from the challenge of human resource cost during the start-up and stabilisation phases.

KENET exists in an environment where government is fully committed to ICT. The Kenya ICT Board (who founding executive vice chair is the founding CEO of KENET) is charged with the responsibility of 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 very active in supporting KENET. KENET received a donation from government of an STM-4 international bandwidth on the TEAMs marine cable, and a $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 gone up to 5xSTM-1 of external connectivity, a very improved internal network, and a modern data centre. Prices for member institutions have gone down from $4,000 to $300 per Mbps per month in two years.

KENET’s key success factors have included:

i. Starting off with very low operational overheads because of seconded staff and office space;

ii. Very strong support from government and the regulator, all within an environment where the importance of ICT has risen to be one of the major development strategies. There is an integrated government strategy for ICT that recognizes the role of the NREN;

iii. A start-up grant to establish operations and connectivity;

iv. Effective and dedicated CEOs who have seen KENET through the start-up and growth phases;

v. Coastal location of Kenya, with easy access to marine fibre without intervening cross-border challenges;

vi. A large member base that distributes operating overheads

---

141 [www.kenet.or.ke](http://www.kenet.or.ke)
e. **TENET, South Africa**\(^{142}\)

TENET, easily the oldest operational NREN in sub-Saharan Africa, was founded about 12 years ago by the member universities that wanted to address the challenge of bandwidth cost. They received a start-up grant of $1 million from the Andrew Mellon Foundation. TENET started with an agency model, getting price reductions through aggregation and negotiation with service providers. They underwent a major change when, through guarantees provide by the member universities, they were able to secure a $20 million bank loan to purchase 10Gbps 20 year IRU on SEACOM.

With the need to distribute this bandwidth, TENET moved into operating infrastructure, enabled, like more than 300 commercial Internet Service Provider, by a court decision that permitted them to own and operate infrastructure, including internal gateways.

About the same time, the government of South Africa decided to establish the South Africa Research and Education Network, SANREN, through which a 10 Gbps 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 price of TENET members drop to about $130 per Mbps per month, down from $1,200 two years ago.

TENET hosts Google caches in South Africa, and that has boosted their negotiating power with commercial providers.

Key success factors for TENET include:

i. A government that has committed a lot of resources to education and research, creating a general supportive environment, despite some of the tensions;

ii. A very effective CEO who also have an outward focus and has committed a lot to regional networking. This will, in the medium to long term, benefit both South Africa and the region;

iii. A start-up grant;

iv. Thin organisation. Even in the current phase, TENET uses a lot of outsourcing;

v. A strong membership base of well established universities;

vi. A vibrant and expert private sector that makes outsourcing viable;

vii. A high volume of traffic and a very large network, giving it a very strong negotiating position with the private sector and service providers;

viii. The court decision that cleared the way to full operations

f. **XNet, Namibia**

XNet was formed as a partnership between SchoolNet Namibia and Telecom in 2003 as a vehicle to provide affordable bandwidth connectivity to a variety of social sectors e.g. agriculture, health,
SME, etc beginning with the Education Sector. Schools could connect via a dial-up modem or through wireless links via high masts owned by SchoolNet Namibia or Telecom Namibia. Subsidized dial-up rates were negotiated for poorer schools.\(^{143}\)

Additionally, SchoolNet Namibia played a pioneering role in experimenting with low-cost connectivity alternatives to connect rural schools to the Internet one of which was a pilot involving a narrow-band radio network connected via a series of forty five towers bringing coverage to about 900 schools.\(^{144}\) Through the Xnet structure, SchoolNet was able to provide affordable connectivity to more than 1000 schools throughout Namibia. Telecom Namibia is the main provider of the access network – between institutions and national backbone and is also the major provider with access to international gateway in Namibia.\(^{145}\) Connectivity via Telecom Namibia comes with guaranteed “fixed access rates for all schools, irrespective of how they connect”.\(^{146}\)

Key factors that have made this collaboration a success:

i. The emphasis on open source software and Creative Commons content is especially central to its success. Working with open source has stimulated SchoolNet to explore the real costs of ownership of ICTs in schools and has ensured that the technical solutions SchoolNet Namibia provides are affordable to schools, and are therefore viable in the long term.\(^{147}\)

ii. Strong relationships with stakeholders are another key factor. SchoolNet Namibia operates in line with Namibia’s ICT policy for education and has built a strong relationship with the Ministry of Education. So much so that the Ministry has begun to take ownership of the SchoolNet implementation mechanisms. Similarly, a symbiotic relationship with Telecom Namibia, and lengthy negotiations, resulted in discounted Internet connectivity rates for schools.\(^{148}\)

During late 2010, Xnet became the first member of the Alliance that evolved from a Schoolnet. They still face the challenges of full acceptance by the higher institutions, especially the University of Namibia – the largest public university. This is a challenge they need to address before Xnet can become a fully effective NREN

### 2.6.5 Opportunities

The current environment holds out many opportunities for NRENs:

i. There is growing awareness among governments about the importance of increased investment in higher education as a key pillar for national development.

ii. Increasing liberalisation of the telecommunications sector has bought hitherto dormant fibre, held especially by power and railway companies, on the market, reducing local access.

---

\(^{143}\) [http://wikieducator.org/The_Case_of_SchoolNet_Namibia/Operations/Activities/Connectivity](http://wikieducator.org/The_Case_of_SchoolNet_Namibia/Operations/Activities/Connectivity)


\(^{145}\) [http://www.powershow.com/view/5690-ZTdhN/Telecom_Namibia_is_main_provider_for_the_access_network_b_flash_ppt_presentation](http://www.powershow.com/view/5690-ZTdhN/Telecom_Namibia_is_main_provider_for_the_access_network_b_flash_ppt_presentation)


\(^{147}\) [http://www2.unescobkk.org/elib/publications/111/Schoolnet_LLVol.3.pdf](http://www2.unescobkk.org/elib/publications/111/Schoolnet_LLVol.3.pdf)

\(^{148}\) [http://www2.unescobkk.org/elib/publications/111/Schoolnet_LLVol.3.pdf](http://www2.unescobkk.org/elib/publications/111/Schoolnet_LLVol.3.pdf)
costs. Figure 9 shows the evolving map of global and intra-African fibre that is maintained and updated by the UbuntuNet Alliance\textsuperscript{149}. Sector liberalisation has also given opportunity to NRENs to set up, own and operate private networks, including international gateways.

iii. Over the last three years, many governments (for example Uganda, Kenya, Rwanda, Tanzania, Ethiopia) have moved to establish extensive national data backbones. Access for the education and research sector is been made a priority in most cases. All these countries have received support from bilateral and/or multi-lateral development agencies: data backbones are now considered as key development infrastructure.

iv. Increasing research linkages between African and non-African universities that require connectivity and therefore create advocates of those universities in the richer countries. A specific current example is four leading schools of medicine in the USA (John Hopkins, University of Washington, University of California San Francisco, University of Pennsylvania) establishing linkages with four leading schools of medicine in Africa (Makerere University, Muhimbili University of Health and Allied Sciences, University of Botswana, University of Nairobi) in a programme to train leaders in global health. These have identified sufficiency of connectivity as a key challenge to be addressed from the outset.

v. The landing of new and competing marine optical fibre has had tremendous impact on international bandwidth prices. SEACOM, EASSy, and TEAMS have been completed, and WACS is close to completion. Capacities are respectively 1.28Tbps, 640Gbps, 40Gbps, and 3.84Tbps respectively.

vi. There has been a wave of increasing development partner support for the nascent African NRENs and RRENs over the last two years, starting with IDRC support for the UbuntuNet Alliance. In Somalia, SomaliREN is getting support from Sweden. The World Bank is supporting (or planning to support) through the national governments NRENs in Kenya and Mozambique, and possibly Malawi and Tanzania. In Uganda, equipment and services close to USD 700,000 have been deployed to light up the first phase of the RENU backbone to provide 10Gbps internal connectivity. This was through USAID and IEEAF along with other private sector partnerships. In ZAMBIA, a NUFFIC intervention of €2.25m to support NREN infrastructure and capacity development is starting. The EUC support for the Alliance through DANTE has been already discussed.

\textsuperscript{149} \url{www.ubuntunet.net}. This map also draws on data from \url{www.manypossibilities.net} through the kind permission of Steve Song who maintains the map of fibre to Africa.
2.6.6 Challenges

One of the biggest challenges faced by African institutions and NRENs is the dearth of people who are technically competent to design, operate, and maintain advanced data communication networks. The scarcity is compounded by competition with a rapidly growing private sector able to offer much better terms. The shortage is largely due to curricula in training institutions that supply human resource not matched to needs, taught by lecturers who do not yet understand the real needs of the sector. This has to be addressed through guidance to institutions about curricula, sharing expertise among NRENs, and creating opportunities for attachments and secondments.

There is also limited understanding of the multiple roles of research and education networks. A successful NREN has got to achieve a fine balance between providing and assuring availability of sufficient and affordable connectivity – the entry point for African NRENs; enabling and promoting content networks; and researching into advanced infrastructure. All this comes with experience and understanding best practices: the overwhelming majority of African NRENs are very young and do not yet have the necessary exposure. This challenge can be addressed through the dissemination of good practice and learning events.

Disabling Policy and regulatory environments are a major challenge. The UbuntuNet Alliance carried out a situational survey of the telecommunications sector policy and regulatory environments covering 22 countries in their membership region. The following were found to be the key environmental barriers to access to broadband communication:

- Slow reforms in the communication sector
- Inadequate access to backbone infrastructure at affordable prices
• Inadequate policies and regulation with regards to ownership and access to essential infrastructure by universities and research institutions

Competition from and cherry picking by service providers is a common challenge for young NRENs. In any NREN, there are institutions that are the largest and most affluent. It is very tempting for the supplier, especially if there a positioning among consumers for individual advantage, to enter direct agreement with these at concessionary terms. The only solution to this is for the stronger institutions to appreciate that it is actually in their interest to work as part of the group, providing the necessary backbone during negotiations.

Weak financial bases are another challenge. Where there are no tangible services being offered, it is difficult for member institutions that are themselves cash-strapped to contribute to a start-up organisation. This challenge can only be addressed by moving rapidly, necessarily with development partner support, to offer tangible services that are seen to reduce the costs of members and therefore provide incentive for payment of membership and agency fees. For African NRENs, the only commodity that can achieve this in the short to medium term is much cheaper bandwidth.
3. OPPORTUNITIES AND CHALLENGES

3.1 Introduction

It has been stated earlier that it can be misleading to characterize Africa with single statements. Nevertheless, based on the theme specific landscape analysis and the authors’ knowledge of Africa, the challenges and opportunities discussed in this Chapter apply to the overwhelming majority of Africa countries. The challenges point to the interventions that need to be made by African governments, development partners, and other stakeholders in order to progress the agenda of ICT in education. The challenges, if not addressed become the barriers.

The view is taken in this discussion that within most challenges is an opportunity to be seized to advance the sector – in some of the cases, this will be an entry point for the use of ICT. This section starts with a discussion of challenges that have been identified with some focus on how some of these could be turned into opportunities. This section seeks to build on, rather than repeat, the opportunities and challenges identified in the landscape analysis in Chapter 2 while specifically responding to the TORs.

3.2 Challenges/barriers that can be addressed by specific interventions

The following major challenges and barriers, most of them cutting across the five themes discussed have been identified:

i. Absence of comprehensive policy and strategy;

ii. Lack of awareness and ownership of initiatives;

iii. Funding constraints;

iv. Lack of competent human resource;

v. Lack of incentives for teachers;

vi. Wide range of stakeholders in the sector;

vii. Technology led initiatives;

viii. High cost of technology;

ix. Limited access to the Internet;

x. Limited access to power;

xi. Underdeveloped private sector;

xii. Limited impact evaluation literature;
xiii. Social, economic and cultural issues

xiv. Sustainability

3.2.1 Absence of comprehensive policy and strategy

A well thought out policy and strategy for the integration of ICT in the entire education system can be a major tool for mobilizing approaches, consensus and resources. The lack of comprehensive policies addressing the integration of ICT in education remains one of the major barriers in Africa. As has been illustrated in Figure 1, policy and strategy are required to enable and support interventions across all the themes. In many countries, ICT in education is actually mentioned within the national ICT policies in general terms, but it does not go further than that. An effective policy must be complete with a time bound implementation strategy and the necessary institutional arrangements, resource allocations, and monitoring plan to ensure that implementation can and will take place.

While the central policy referred to here is within the education sector, supportive policies are also required in other sectors. As has been noted, for example, poor policy and regulation within the ICT sector are the greatest barriers to access which is necessary to enable implementation across all the themes discussed. Tax policies and laws also impact on the cost of technology and the provision of tax breaks that can enable a greater private sector role within the education sector. Policy and laws defining the intellectual property environment are necessary for enabling different approaches to OER, and to technology transfer and adaption.

The development of a cross-cutting policy and strategy is one of the greatest opportunities for spreading awareness and ownership through involvement of stakeholders in the entire process: countries that have poor or policy gaps should use this as an opportunity when they restart the process.

Because of the multifaceted nature of ICT in education, guides and model policy frameworks could be a very useful resource for countries at different stages of implementing ICT in education.

3.2.2 Lack of awareness and ownership of initiatives

Awareness here refers to an appreciation of the potential of ICT as an enabler for the learning process and the consequent impact of ICT enabled graduates on national development. Awareness of the potential of ICTs at decision making and project formulation levels has been the key constraint in Africa due to inadequate flow of knowledge, over reliance on external advice and more importantly the dynamics of the ICT sector which presents choice, alternatives and challenges. Lack of awareness also leads to lack of ownership, and if this happens to rest at the government levels where priorities and funds allocated, it will in turn lead to lack of funding. If there are teachers and head-teachers where there is no awareness and ownership, there will be implementation failure, not necessarily due to lack of resources. Ownership stems from involvement in the formulation, planning, and implementation processes. Lack of awareness is a
threat to sustainability: the policy, strategy, or initiative will collapse as soon as the external drive and funding support are withdrawn.

As an example, the limited involvement of policy makers and users in the design of EMIS has been compounded by lack of political will and sustained support from decision makers in some African countries. The lack of coordination and shared vision among various stakeholders (horizontally between ministries and agencies and vertically between schools, districts, regions and federal ministry) means EMIS development has been ad hoc and often left to the ministry of education and school principals who gather and send data on annual basis. EMIS data is often incomplete and inaccurate due to lack of full participation of all the stakeholders. There is, in addition, often inadequate clarity between the mandate of ministries of education and statistical offices in collection, managing and dissemination of EMIS data; and a tendency by some teachers and principals to view EMIS as a threat, leading to very low level of enthusiasm for its implementation.

Awareness and ownership at the highest levels of government is key to success. The examples of Rwanda and Kenya have been cited where clarity and understanding at the President’s level (Rwanda) or Permanent Secretary levels in key ministries (Kenya) makes a big difference to the direction and what can happen in the sector.

Stakeholders need to be given access to resources through which they could learn more about ICT in education, especially through the same kind of medium expected to be put in place – digital learning resources. Initiatives in developing graduated interactive on-line learning materials for various stakeholders, through which they can fully understand and appreciate the role, importance, and issues around ICT in education could be beneficial. This could include the stages and content in developing policy frameworks and implementation strategies for ICT in education. While this is envisaged as beneficial means of delivery, reality must accept that materials will have to be availed in both hard and soft form, along, where necessary, with stakeholder capacity building events.

3.2.3 Funding constraints

Many governments do not allocate resources that are necessary and sufficient for the education sector to achieve the MDGs, partly because of overall insufficiency of resources and partly because of priority setting challenges. The UNESCO recommended level of budgetary allocation to education in developing countries is 26% of the national budget. In Uganda, one of the case study countries, this is about 16% in the current (2011/12) budget150. South Africa, at 20%, ranks among the highest in the world151.

Low funding levels are compounded by sometimes severe deficits in classroom space, teachers, requisite skills to enable the mainstreaming of ICT in education, learning materials; absence of campus networks; high cost of access devices; and massification. Whatever the cause, there is perpetual under funding of the education sector in most of the countries. This is aggravated, again in many countries, by corruption.
Funding constraints can become an opportunity in that they lead to creativity and innovation in order to achieve objectives through alternative means. Collaboration through communities of practice and open educational resources become the preferences both as a good choice and out of necessity. Institutions like NRENs have been driven by the common need for economies of scales and collective bargaining for bandwidth.

Funding constraints are one of the greatest opportunities for introducing initiative in ICT-enabled distance learning, in essence bypassing the resource constraints outlined above and increasing access to educational opportunities. Supplementing the current approaches to learning, we picture a group of children in a rural community without any classrooms, sitting under a tree, benefiting from effective learning based on interactive material delivered through the mobile platform, moderated by one of the teachers or informed parents. With all the pedagogical and other challenges around this picture, this is what needs to be achieved. A caution is that this is not a substitute for the traditional resources needed, but a very useful complement in creating an ICT-ready body of students and also sharing scarce expertise.

Support for policies and initiatives that promote the OER approach to learning content will offset the otherwise huge cost of learning resources. This goes hand in hand with supporting technology environments that enable access to online resources.

### 3.2.4 Lack of competent human resource

Human resource required for an ICT-enabled education sector is wide-ranging, including:

1. Suitably trained teachers able to use available tools and resources to develop digital content and engage students effectively in an ICT-enabled learning environment. Maintaining an e-learning environment requires consistent improvisation and skills that are not readily available to most African educational institutions;\(^{152}\)

2. Teacher trainers and tutors who are able to support trainee and in-service teachers in acquiring the requisite skills for the environment;

3. Administrators, education managers, and policy makers who fully understand the environment, its challenges, and its opportunities in order to create and sustain the necessary policy strategy and ensure ongoing availability of the required resources;

4. Technical human resource that enables the technical back-end processes and also offers technical support at all levels;

5. Programmers and software engineers who are able to engage in the open source communities and support institutions in Africa;

6. Managers and implementers of the large scale ICT for education programmes;

---

vii. The private and NGO sectors that can play a role within all the themes discussed;

viii. The legislators who approve government policies and expenditure allocations.

The shortage is largely due to curricula in training institutions that supply human resource not matched to needs, taught by lecturers who do not yet understand the real needs of the sector. The absence of high managerial and technical skills is one of the chronic challenges facing the implementation of ICT projects aimed at school computerization, the deployment of EMIS and National Research and Education Networks.

Shortage of human capacity is always an opportunity for training institutions and training initiatives in the public, the private, and the NGO sectors. These shortages also promote collaboration as communities of practice take up the role of mutual support, or private sector and NGO entities engage stakeholders to understand the challenges and formulate capacity building programmes for mutual benefit. The UbuntuNet Alliance, for example, has benefited from the open and honorary approach to mutual technical and organizational support.

Capacity building for ICT in education is one of the best opportunities for using ICT in education in that the key players get direct exposure to the environment they want to create. This approach has been discussed under the context of teacher professional development: it applies in a similar way to all the players. Key players need to experience the digital learning environment in order to fully appreciate both the opportunities and challenges. That way, policy and strategy will be modulated by personal experience.

3.2.5 Lack of incentives

The integration of ICT in learning will require retraining and call for new time demands on teachers 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.

Incentives extend beyond this to innovators in the area of ICT in education for either developing products with concepts, or scaling up products and approaches that have demonstrated benefit and potential for sustainability. At this level, both local and development partners support would be beneficial

3.2.6 Wide range of stakeholders

The wide-range of stakeholders is more a process challenge that an intrinsic challenge. It means that any consultations related to policy and strategy and defining roles need to be well thought out, starting with the identification of all stakeholders. It also takes longer to create common positions and to get to the stage of implementation.

If the consultation process is well managed, a wide range of stakeholders brings on board multiple perspectives and multiple players, and creates the kind of vibrant environment where users can get choices say in digital learning resources, access technologies, and capacity building opportunities.
3.2.7 Technology-led initiatives

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

An example is when technically orientated people who have no knowledge of pedagogy are used to train teachers (pre-service or in-service) about the integration of ICT in learning. The training is de-contextualized from teachers’ work as a result, becoming a standalone subject. When teachers do not develop a clear correlation between what they are learning and their work, the training is likely to be ineffective, as teachers will fail to recognize the value of the training, and fail to transfer skills learned to their classroom.

Within the field of information, it has been recognised that it is critical to permit those who understand the business processes of the organisation to be the drivers: this ensures that the information system is responsive to the actual needs. The field of ICT in education needs to have the same level of awareness that people who understand pedagogy – normally the teachers, should define the need, identify good strategies, and drive the integration of ICT in education. The technology people then provide a supporting role to the process. It would be useful for all stakeholders if models of good practice that outline the stakeholder, the roles, and the steps for implementing ICT in education are developed and disseminated.

3.2.8 High cost of technology

It was noted during the Affordable Technology study that there are hardly any technology companies in Africa, with almost total reliance on 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 soft side of technology, a lot of the key applications are still imported. Open source offers a lot of solutions, but there is still a lack of sufficiency of skills (in terms of both depth and numbers of people) to engage open source confidently. There is therefore still near total dependence on imports. Considering the wide range and the massive numbers the African countries have to deal with to make ICT-enabled education the norm rather than the exception, the cost is not sustainable. In addition to this, devices that are being produced for low cost access at the user end where the biggest challenge is are not low cost for the typical school.

Universities, the private sector, and NGOs can position themselves to seize this opportunity. The easier point of entry is the soft resources and capacity building for software development. Harder and more demanding especially for start-ups is the hardware side of technology that might requires PPPs.

There has been a lot work around the area of technology adaptation and transfer through UNIDO and other organisations which could be instructive to those making technology choices – either for usage or as a commercial opportunity.
3.2.9 **Limited access to the Internet**

Limited access to the internet results from:

i. Limited coverage up to and including the last mile (fibre, microwave links, wired and wireless distribution within the campus)

ii. Limited availability of access devices (PCs, laptops, mobile phones, tablets, etc)

iii. High recurrent cost of local and international bandwidth

If ICT-enabled education is to become the norm, the challenge of access at the different levels needs to be addressed.

Less than 12% of the population in Africa are internet users. Bandwidth costs for broadband in Sub-Saharan Africa are 30-40 times that in the US. Research ICT Africa reports in their 2009/2010 sector review that sub-Saharan Africa trails North Africa with internet penetration rates below 3% on average and a broadband penetration rate below 2%. They cite low bandwidth and high prices as major challenges with many countries relying on satellite communication for bandwidth, due to the limited reach of the traditional fixed-line networks and lack of access to undersea cables.

NRENs have an opportunity here because they are the best positioned, within the social services sector, to reach out to schools within the schools. The private sector also has an opportunity both for public good and commercial interventions to address the access gaps.

Interventions required to enable high volume low cost access always start with the need for fully liberalised telecommunication sectors, something which is under the direct control of governments. Any support to any government for the integration of ICT in education will be wasted if governments have not taken the obvious steps that are within their powers. A related approach is the introduction of educational rate (e-rates) for telecommunication services as has been done, for example, in South Africa.

3.2.10 **Limited access to power**

Electricity in Africa continues to be a major challenge that has a huge impact on access to the devices, and power-back up will only increase the running cost of these devices. Nearly 600 million people in Africa – about 60 percent of the continent’s population – lack access to electricity. This number is expected to reach 700 million by 2030. Africa’s rural poor are particularly energy starved, accounting for 88 percent of those without electricity.
Distribution networks, especially in the rural areas, tend to be very limited and, where available, actual supply intermittent. Wireless and mobile technologies that are very promising in terms of achieving mass access need to have independent access to power.

The power demands of most devices (outside the data centers) are fortunately low and battery life is increasing both due to better designs of the batteries and lower consumption of user devices. This makes it relatively easy for small start-ups to come up with charging solutions to address the needs of individual devices.

Transformation of the power sector in African countries to the extent required is a major initiative that needs to be handled principally by government. It is also a long term undertaking. Quick win areas of intervention are those that can be support the production of low technology devices that can be used for charging the growing multitude of portable of handheld devices, including laptops.

### 3.2.11 Underdeveloped private sector

The potential role of the private sector has been highlighted across the themes. The private sector 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.

The private sector in many African countries was unfortunately suppressed for a long time due to a high dependence on monopoly parastatals and lack of government policies that 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 supply of human resource. A 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 a lone exception to this – and even they have their limitations.

Targeted capacity building for the private sector (for example working with publishers to get them to move into digital learning resources; or the emerging electronics sector to move into the assembly and maintenance of low cost access devices) is a possible intervention.

### 3.2.12 Limited impact research

There are gaps in research in the use of ICT in education in so far as it relates to it impact. Much of what is written has positive biases and is often written by members of implementing organizations. There is an ongoing need for rigorous impact evaluation studies on educational technology initiatives in developing countries. Ongoing monitoring and evaluation is required to build up the evidence base of what works in the long term and what does not.

### 3.2.13 Social, economic and cultural issues

Technology tends to reinforce existing social and cultural inequities. As governments move to the full integration of ICT in education at all levels, the groups that normally suffer from technology
marginalization (urban-rural; rich-poor; male-female) are likely to be disadvantaged even more. There is a need to understand and pro-actively seek to address these challenges.

### 3.2.14 Sustainability

Sustainability is summative. Major government initiative are sustainable if they are conceived within the framework of a comprehensive policy and strategy; are owned by the leadership and stakeholders; have sufficient allocation of resources; are supported by a competent human resource; take into account all environmental factors; and are well-defined.

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 often also not looked at sustainability.

### 3.3 Theme Specific Challenges

#### i. Teacher Professional Development

**Absence of ICT in learning in pre-service training curricula:** While the ideal is that ICT integration should be an integral part of pre-service teacher training, and some countries have gone a long way towards achieving this, in many other countries, both internationally and regionally, this is far from being realized. According to Balsanti\textsuperscript{157} who draws extensively from research on ICT teacher development, factors impinging on the realization of universal training of teachers for ICT integration at pre-service teacher education level include the lack of significance that colleges of education attribute to ICT integration, let alone ICT skills. Those who require their students to learn anything about ICT often just require them to use a word processor for submitting assignments. Often, colleges of education do not address ICT integration because the faculty members themselves have not been prepared to use technologies effectively and cannot support students in integration. In some cases where student teachers are taught about ICT, this is taught as a separate subject, and not as part of curriculum integration. Colleges that teach it as part of curriculum integration may have the challenge that students do not get a chance to model lessons using technology, as their practice teaching schools may be technologically deprived, or the supervising teachers may lack ICT integration skills to support the student teacher meaningfully. This is likely to be the case in many African countries, as there is generally still poor ICT infrastructure, which is partly responsible for lack of teacher ICT integration training and acquisition of skills.

The possible intervention here is support for curriculum review. A country like South Africa that has gone through this kind of exercise would be a good source of expertise in supporting other countries that must address the gap.

**Making the right choice about training programmes:** There are many programmes on ICT integration for teachers. This sometimes makes decisions about which programme to choose harder. As a result, some governments are being coerced into subscribing to specific courses by

---

some private sector ICT companies, based on negotiated deals that include discounts, without
governments necessarily evaluating the quality of the programmes. These deals often expose the
disadvantages of lack of training of a leadership in the Ministry of Education to make informed and
valuable choices for schools and teachers.

Making the right choices is about the capacity of the people who make the choices.

ii. **Digital Learning Resources**

*Lack of locally contextually relevant curriculum frameworks*: Country reports on InfoDev’s Survey of
ICT and Education in Africa (2007) reveal that there is little digital education content that is locally
contextually relevant or based on local curriculum frameworks. According to Adam, in Africa,
appropriate and improvised content ranging from learning materials such as textbooks, journals,
web pages, video, television, radio, audiotape, and multimedia packages to learning support tools
such as study guides, exam sheets, worksheets, laboratory manuals, and field exercises are in short
supply in education systems on the continent. This dearth of learning materials is, for example,
evident when one compares African higher education libraries to the developed world. ¹⁵⁸ Content
currently available online often does not cover the specific requirements of African curricula, so
tends to be supplementary in nature. The absence of educational content directly linked to
curricula is one of the key inhibitors of ICT use by teachers and learners. This is exacerbated by
educational content on the broader Internet being currently predominantly in English. Furthermore,
there is a lack of content covered in certain subjects, especially where curricula need
to be updated regularly.

As education is a contextualized practice, it is important to make it easy to adapt materials
imported from different settings where this is required, and this should be encouraged rather than
restricted.

*Short supply or lack of appropriate content*: Another challenge with regards to material
development, is the short supply of appropriate and improvised content ranging from learning
materials to learning support tools. The development and use of digital content at both national
and institutional levels should be aligned to need and contextualised. Content should not be
developed for its own sake: the goal and intended outcomes and implementation of the project,
should drive the development.

*Intellectual property issues*: Digitization of information in all media has introduced significant
challenges regarding how to deal with issues of intellectual property and copyright. Copyright
regimes, and their associated business models, that worked effectively prior to the development of
ICT are increasingly under threat, and in some cases rapidly becoming redundant.

iii. **Affordable Technologies**

JHEA/RESA Vol 1, No. 1, pp. 195–221
**Rapid technology evolution**: The changing nature of technology literally means that before one generation is evaluated, the next generation is on the market. Technology can therefore be evaluated only from general principles, not specifics. Much of the technology covered in this document is new and so its impact in education is not fully understood.

**Scalability**: Many of the projects are pilots and implemented on a small scale.

iv. **Educational Management Information Systems**

On the technical level EMIS faces similar challenges cited above including inadequate infrastructure, lack of human capacity to implement and sustain the system. There are sometimes data gaps especially relating to the private education sector; the informal education sector; and pre-primary school sectors. All these play a very significant role in the sector, and lack of data, or inaccurate data, will result in policy initiatives and decisions that are based on the wrong premises.

v. **National Research and Educational Networks**

*Limited understanding of the multiple roles of research and education networks*: A successful NREN has got to achieve a fine balance between providing and assuring availability of sufficient and affordable connectivity – the entry point for African NRENs; enabling and promoting content networks; and researching into advanced infrastructure. It must also understand the distinction between providing services for a member group and competing with the private sector. All this comes with experience and understanding best practices: the overwhelming majority of African NRENs are very young and do not yet have the necessary exposure.

*Lack of authorizations to operate and cross-border barriers*: An NREN needs authorizations from regulators that enable it to deliver services to members. They need licensing to own and operate a network for a closed user group that is national in scope; connect with NRENs across the national borders; and transit traffic for other NRENs. This has been a major hurdle in most African countries. Even when that is achieved, cross border physical connections run into other challenges that often force them to work through expensive incumbent service providers.

*Weak Financial Base*: Where there are no tangible services being offered, it is difficult for member institutions that are themselves cash-strapped to contribute to a start-up organisation. This has been a major barrier to the organizational and operational development of African NRENs.

### 3.4 Cross-Cutting Opportunities

The major cross-cutting opportunities identified include:

i. Interest of development partners in supporting ICT in education

ii. Communities of practice

iii. Increasing rollout of competitive fibre to Africa and within African countries

iv. Increasing penetration of wireless and mobile platforms
v. Increasing affordability and choice among devices that link through mobile and wireless platforms

3.4.1 Interest of development partners in supporting ICT in education

There is a wide range of development partners including bilateral, multilateral, and private sector that are interested in supporting the implementation of ICT-enable education in African countries. For example, UNESCO, the European Union, DFID, Sida, GTZ, the French Cooperation, UNICEF, the World Bank, and USAID have all supported EMIS; IDRC, the World Bank, and the European Union are all supporting research and education networking. While, due to sustainability concerns, development partners should not support recurrent funding except for pre-defined timelines, they can help in addressing the start-up capital (which can be very high for some initiatives) as well as innovation, research, and evaluation.

3.4.2 Communities of Practice

Communities of practice, bringing together groups of people facing the same challenges and likely to benefit from common approaches, are an opportunity that can be exploited across all sectors. In the Uganda Case study, associations of teachers and associations of head teachers are an example of what could be a good entry point for teacher professional development and digital learning resources. Most of the NREMs in the UbuntuNet Alliance as well as the Alliance itself were started by IT Directors from different institutions seeking cheaper bandwidth and to learn. NGOs exist around the OER movement, and industry associations, for example publishers who often come together with the initial purposes of addressing IP issues, are also opportunities.

Within the digital content arena, communities of practice can 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’.

3.4.3 Increasing rollout of competitive fibre to Africa and within African countries

Over the last five years, many governments (for example Uganda, Kenya, Rwanda, Tanzania, Ethiopia) have moved to establish extensive national data backbones, supplementing private sector initiatives that were observed to move very slowly. Access for the education and research sector is been made a priority in most cases. All these countries have received support from bilateral and/or multi-lateral development agencies: data backbones are now considered as key development infrastructure. At the same, better regulation has allowed fibre from utility companies (especially power, railways, and oil pipelines) to come on to the market. Increased competition has led to reduced prices.

During the same period, there has been a sharp rise in actual fiber construction projects targeting Africa and creating real competition within the international bandwidth market.

---

160 http://www.manypossibilities.net
3.4.4 Increasing penetration of wireless and mobile platforms

The new wave of opening up telecommunication markets and the growth of regional operators has lifted completion in the mobile sector to a new high. Many countries have at least three operators (Uganda has five). This has led to rapid rollout, very competitive price offerings, and fast improvement in capability with all providers offering 3G services that enable much faster internet access than before.

In addition to the mobile platforms, WiFi and WIMAX penetration is increasing rapidly, creating the opportunity for wide scale deployment of wireless access devices.

3.4.5 Increasing affordability and choice among devices that link through mobile and wireless platforms

The proliferation of mobile phones has meant that more learners have access to ICT devices than has been the case previously. This offers opportunities to look at how access to these devices can be used to support learning. As Prof Traxler writes in his blog essay in Annex 3 “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”.

The use of mobile phones for gathering EMIS data is being explored in Ghana, Kenya, Rwanda, South Africa and Uganda.

3.5 Theme Specific Opportunities

i. Teacher Professional Development

Availability of multiple professional development pathways for teachers: Multiple professional development pathways can be made available for teachers, based on their needs and circumstances, as well as cost. Models like communities of practice are inexpensive in that schools do not have to budget large sums of money as they would for facilitator driven training. The major cost of communities of practice would be cost of bandwidth, if communities require online participation. Another major investment in this modality of professional development is time, which can be set aside outside teaching time. This is potentially a very good model as it enables teachers to decide how to shape their professional development, that is, they decide what they need to focus on. In this regard, sharing of ideas and practice is needs based, a factor that can ensure sustainability.

Life-long professional development approaches: The realization that once-off workshop type training does not yield effective change in pedagogy is shifting the focus to more sustained, lifelong
professional development, focusing on pre-service and continuing teacher professional development. The UNECSO ICT-CST and the Nepad parameters support a lifelong approach to ICT professional development, with the UNESCO ICT-CST providing standards against which teacher ICT competencies can be measured. This ensures that teacher training programmes are modelled along competencies that adequately skill teachers to integrate ICTs in complex ways. The competency framework also narrows global differentiation of competencies against which teachers will be certified, and provides opportunities for a shift from simplistic professional development practices based on basic ICT skills training that assumes teachers will change their practice because they can use the technology applications.

**Reputable worldwide programmes**: The availability of reputable worldwide programmes like Intel Teach, IEARN, and Microsoft PiL could lead to cost savings in course development if these courses are adopted for teacher training. The courses could be adapted so that they are contextually relevant. The available courses can also be improved through use in practice.

**ii. Digital Learning Resources**

**Availability of online content**: The ready availability of multimedia resources is making it easier for students to become more invested in their own learning as they explore the Web to locate information to supplement their own understanding of various topics. Online content can be greatly beneficial for rural and poorer institutions that have inadequate access to traditional resources such as printed materials. If online content resources are good, this can increase the demand for access to the Internet;

As more educational institutions become connected, the development of online content becomes relatively more cost-effective. Online resources can encourage educators to contribute content, thereby altering the dynamics of content production. Digital content becomes more effective to learn from and more efficient to produce if it is a product of collaborative endeavours that draws upon different knowledge and skills sets and is defined for a clear purpose and context.

**Open Educational Resources**: Digital content can become more effective and efficient if it is built upon the prior work of others. OER offer greater scope for new work to be built upon existing works and for people to share in the development and use of such new works. OER has potential to build capacity by providing institutions and teaching staff access, at relatively low cost, to the means of production of educational materials. This can help to develop their competence in producing such materials and carrying out the necessary instructional design to integrate such materials into high quality programmes of learning.

**iii. Educational Management Information Systems**

Opportunities for further deployment of EMIS include the availability of distributed database resources that integrate Geographic Information Systems and web for the collection and analysis of data. Potential also exists in the use of low cost technologies such as PDAs, low cost computers and cellular phones for collection and dissemination of educational data.
Social networking is on the rise in Africa; it can therefore be exploited to facilitate real time reporting on school data and other related aspects such as resource usage. Social networking applications like Checkmyschool.org in the Philippines showed a high potential for participation of students, teachers and principal in updating information on school on real time basis thus improving decision making and planning.

3.6 Conclusion

Through an identification of challenges, especially those that are cross-cutting, this Chapter has pointed to the most important consideration in creating an eco-system that supports the integration of ICT in education. They translate to success factors that countries that are just starting out, or countries that have ongoing implementation, need to take into account as they evaluate their ICT in education programmes.

The Chapter has also identified possible areas of intervention especially for governments and development partners. Some of these are carried through to the recommendations in Chapters 6 and 7.
4. CASE STUDIES

4.1 Introduction

Three country case studies were conducted with the objective of seeking a clearer understanding of the barriers to wider adoption and the factors for success. The first one, South Africa, was a desk study based on the rich literature about both the education and ICT in education. Apart from being the most advanced economy in sub-Saharan Africa, South Africa is also known to invest heavily in education in a structured and focused fashion, and is therefore an African best practice country that can provide valuable lessons. South Africa is highly developed in the use of distance education, and also has a strong emerging culture of mobile learning and starting to use the NREN to reach out to schools. South Africa was expected to bring out the issues in a country at an advanced stage of ICT in education implementation.

The other two countries are Uganda and Senegal, both having the potential and often cited for education initiatives, but still having a long way to go in terms of effective implementation of ICT in education. Uganda and Senegal are in the very early stages of development and were supposed to tease out issues at that stage.

This Chapter starts with a summary of the three cases that are detailed in Annexes 7, 8, and 9 for South Africa, Uganda, and Senegal respectively, and then discusses the lessons and insights they provide.

4.2 South Africa

4.2.1 Introduction

South Africa has a population of approximately 50 million people distributed across nine provinces. The average national life expectancy at birth is 54.3 years. The literacy rate for adults aged 20 and above was 80% in 2009.

South Africa has the most advanced telecommunications network in Africa, development of which was recently boosted by government investment of R300 million into broadcasting and telecommunications ahead of the 2010 Soccer World Cup.

4.2.2 South Africa’s Education Context

South Africa has one of the highest rates of public investment in education in the world, with Education expenditure accounting for 20% of total government expenditure.

---

162 SouthAfrica.info, South Africa’s television channels: http://www.southafrica.info/about/education/education.htm.
Basic education is compulsory for children aged 7 to 15. In 2009, almost 99% of children within this age range were enrolled in an educational institution.\(^{163}\) Higher education and training takes place in universities, leading to the attainment of undergraduate and postgraduate degrees.

Responsibility for management of schools is shared between national and provincial government. The nine provincial education departments set their own priorities and programmes in line with national policy determined by the national Department.\(^{164}\)

Schooling provision in South Africa takes place in public and private schools. In 2009, there were 24,693 public schools in South Africa, enrolling 12 million learners who were taught by 386,587 teachers. Private schools include primary, secondary, middle, and combined schools. In 2009, there were 1,174 private schools enrolling 386,098 learners being taught by 24,557 teachers.

There are 50 FET Colleges in South Africa, and by 2009, they were enrolling 420,475 students, taught by 6,255 lecturers.\(^{165}\) Currently, the country has 23 state-funded tertiary institutions, comprising 11 universities, six universities of technology, and six comprehensive institutions. In February 2011, there were also 87 registered and 27 provisionally registered private higher education institutions (HEIs). In 2009, 117,797 staff, including 43,446 academic staff were employed in public HEIs. The HEIs enrolled 837,779 students, including 684,419 undergraduate and 128,747 postgraduate students.\(^{166}\)

### 4.2.3 Curriculum

Since 1994, the schooling curriculum has undergone comprehensive changes to make it responsive to the education of a diverse body of learners and to the needs of the 21\(^{st}\) century labour market. The current curriculum for Grade R to 12 is encapsulated in the NCS,\(^ {167}\) which recently went under review. The review recommended making the NCS more accessible and easier to implement by:

i. Creating a consolidated, single curriculum document;

ii. Clarifying the role of the subject advisors;

iii. Reducing administrative requirements being imposed by the curriculum to reduce teacher workload;

iv. Simplifying and streamlining assessment requirements and processes;

v. Reducing the number of subjects in Grade 4 so that learners cope better with the transition from Grade 3 to Grade 4; and

vi. Targeted teacher training support for curriculum implementation.\(^ {168}\)

---


\(^{167}\) Council on Higher Education. Higher Education in South Africa. Available at: http://www.che.ac.za/heinsa/

The NCS encourages use of ICT in education through specific learning areas in Information Technology (IT) and Computer Applications Technology (CAT).

4.2.4 Implementation of ICT in education in South Africa

i. The policy environment

There is a specific policy addressing ICT in Education, the e-Education White Paper, 2004. This policy and others espouse the benefits of ICT for education and national development. The e-Education White Paper stresses the benefits of ICT for teachers, learners, managers and school administrators. Similarly, the White Paper on Science and Technology, 1996 postulates benefits in terms of national innovation, and the Public Service IT Policy Framework, 2001, highlights the benefits of ICTs for government operations and access to government services by citizens.

The most significant benefit of ICT advocated in the e-Education White Paper is that it can enhance the quality of the teaching and learning process. This is also emphasized in policies like the National Education Policy Act, 27 of 1996, which promotes enhancing the quality of education and educational innovation, and the Further Education and Training of Colleges Act, 16 of 2006, which stipulates that FET institutions should strive to provide education that meets the skills needs of the country. According to these policy statements, ICT can improve efficiency for teachers.

The skills shortage in ICT has been raised as a concern by the Accelerated Shared Growth Initiative for South Africa (ASGISA). ASGISA locates this skills shortage within the whole education context, from primary to tertiary education. To alleviate skills shortages in ICT, schools and FET colleges will have to play a critical role in skilling learners and motivating them enough to pursue ICT related careers. The importance of ICT in the workplace is reflected in policies like the Public Service IT Policy Framework, 2001, where the vision of a modernized government is one that enables citizens to access government services 24 hours a day using various ICT tools. However, this vision can only be achieved if the citizenry is ICT literate. The White Paper on Science and Technology, 1996 supports a vision where the seeds of ICT for innovation can and should be planted in the education system and should be done as equitably as possible.

To support access to technology infrastructure, the e-Education White Paper specifies that the Department of Basic Education supports refurbished facilities for second-hand computers, but sets minimum specifications for refurbishments. These specifications guard against the acquisition of outdated technologies by schools. To enable facilitation of implementation of ICT in teaching and learning, the e-Education White Paper stipulates that the Department of Education will work closely with the Department of Minerals and Energy to prioritize electrification of GET and FET institutions.


\[172\] Department of Science and Technology. White Paper on Science and Technology. Available on per.pdfhttp://www.dst.gov.za/publications/white_papers_Science_Technology_White_Par, Chapter2, Section 6

The State Information Technology Agency (SITA) Act, 88 of 1998 is mandated to help the DBE to access technologies in a manner that ‘leverage(s) economies of scale to provide cost effective procurement.’\textsuperscript{174}

The e-Education White Paper recognizes the importance of internet connectivity for e-Education. While the e-rate formalized in the Electronic Communications Act, 36 of 2005 alleviates connectivity costs for schools, the policy directive does not however specify what minimum bandwidth schools should be getting in relation to this e-rate. Consequently, schools may be getting very low bandwidth which is insufficient for meaningful connection of computers for teaching. Thus, it is unclear whether schools ever really derived any financial benefits from this policy provision.

The National Framework for Professional Teacher Education and Development (NFPTED) 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.\textsuperscript{175} The e-Education White Paper envisions a teacher education training system where teachers are trained on using ICT in pre-service teacher training. However, this provision is not supported in the NPFTED.

The e-Education White Paper, addresses the issue of change management explicitly:

\textit{Educational leaders do not yet fully appreciate the benefits of e-learning and administration for institutions and for provincial and district offices. It is important that educational leaders at all levels of the system are provided with the necessary support to enable them to manage the introduction of ICTs and the related change processes.}\textsuperscript{176}

The e-Education White Paper emphasizes the importance of research to improve practices, and advocates a multi-pronged, multi-stakeholder approach to research that will improve understanding of ICT pedagogies and lead to their improvement. The white paper mandates the formulation of a research agenda on ICTs for e-learning. The SITA Act also mandates SITA to conduct research that informs planning for ICT development.

The South African government has approved policy and strategy for Free and Open Source Software (FOSS). FOSS is identified as a viable way to bridge the digital divide. Moreover, OSS is proposed to enable South Africa to develop content and programmes in education using local languages. This content can easily be accessed by other users as there is no activation required with OSS. No recent information is available on the implementation of OSS. However, 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. SITA anticipated that

\textsuperscript{175} DoE. 2007. The National Policy Framework for Teacher Education and Development in South Africa. Pretoria: DoE, Section 43
budget restrictions at local government level would make FOSS an attractive option in municipalities.\(^{177}\)

\(\textit{ii. Initiatives and successes}\)

ICT initiatives in schooling in South Africa include content development, equipment provision, and capacity-building activities. Rollout of initiatives mainly follows governance of the education system in the country, where the national Departments primarily supplies direction and support of ICT, and most implementation is managed at provincial government level. South Africa has achieved varying levels of success in its implementation of ICTs in education, driven by a degree of political will, a reasonably robust policy environment, willing corporate organizations, an active and interested non-governmental organization (NGO) sector, an enabling environment to try out new interventions to improve teaching and learning, government investment, and research informed interventions beyond the pilot phase.

\(\textit{iii. Government support}\)

The South African government has articulated commitment towards the development of ICT in general, and ICT in education specifically. This is evidenced by the existence of ICT public entities and agencies, and a national commission to advise on ICT development in the country; The existence of explicit policy on e-education and other policies that create an enabling environment for ICT development and implementation; Government investment in school infrastructure that enables ICT rollout and several ICT-in-education projects.

There are also agencies that support ICT in education as part of their mandate. The Universal Service Access Agency of South Africa (USAASA), established in terms of section 58 of the Telecommunications Act (1996) USAASA manages the Universal Service and Access Fund, which is dedicated, among other aspects, to providing infrastructure for telecentres and school computer laboratories with ICT equipment which enables access to the internet and provide multimedia services.\(^{178}\) The Presidential National Commission on Information Society and Development (PNC on ISAD), constituted in 2001,\(^{179}\) has a mandate to focus on policy and development of ICT in five priority areas of e-Government: e-Health, e-Education, Small, Micro and Medium Enterprises (SMMEs), and content development

\(\textit{iv. Government investment in ICT in education}\)

The government has invested large amounts of money to make South Africa’s telecommunications system the most developed on the continent. Investments have been made in the development and implementation of integrated management information systems at national and provincial levels, including the Higher Education Management Information System (HEMIS) and Further


Education and Training MIS (FETMIS). Government has also initiated and invested in the South African Schools Administration and Management System (SA-SAMS).

The Departments of Communication, Health, and Education invest in the development of content for the Mindset Network (www.mindset.co.za), which is responsible for content dissemination to the schooling and health sectors. The Department of Basic Education has developed and maintains the Thutong portal (http://www.thutong.doe.gov.za/) for the schooling sector, to support provision of content, school administration and management, and teacher professional development. All provincial education departments invest in provincial ICT initiatives in the schooling sector. The Teacher Laptop Initiative (TLI) managed by the Education Labour Relations Council (ELRC), was officially launched in May 2009 through a policy specifying the conditions for educator participation in this initiative. This specified that the Initiative would be phased in over two years. The TLI is open to all permanently employed teachers employed in terms of the Employment of Educators Act. Minimum specifications for teacher laptops to be supplied by the 12 participating consortia are given, and the minimum purchase price for such laptops, over 60 months, is R11,750. The government provides teachers on this scheme with a monthly allowance of R130 (about US$20), for assistance with repayment for their laptops, based on the cost of R195.83 a month for repayments.

4.2.5 Infrastructure and connectivity

ICT rollout is dependent on power supply, and South Africa has made great strides in the electrification of schools, with power supply emanating from three sources; the municipal grid connection, solar systems and generators. Electricity supply is approaching universal penetration, with 85% penetration in 2009. As a result, a greater percentage of schools is ready to operate ICT equipment that requires electricity. In 2009, of the 24,460 public schools in the country, 20,857 had electricity.

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%) had computer centres that were adequately equipped, that is, with an adequate number of computers and other technologies for classroom teaching and learning.

A national project of note, with provincial input for implementation is the Dinaledi Schools project. This project was launched in schools through the 2001 Mathematics, Science, and Technology strategy, aimed at improving learner achievement in Mathematics and Science in high school. To

---

180 Mindset. Our partners. Available at: http://www.mindset.co.za/partners/content
181 Teacher Laptop Initiative: http://www.teacher-laptop.co.za/
achieve this objective, Dinaledi schools are well resourced with teaching and learning materials, including computer laboratories with computers loaded with mathematics and science software and curriculum and educational content. Currently, there are 500 Dinaledi schools nationwide.  

In all, 3,161 South African Schools had internet connectivity in 2009. Many of these schools are linked to the e-Schools network comprising of 1,700 schools nationwide. The Network 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.

### 4.2.6 Teacher professional development

In keeping with current thinking on ICT professional development, for example the UNESCO ICT Competency Standards for Teachers Framework, 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 University of Pretoria (UP) are offer pre-service and postgraduate courses in ICT integration as part of their teacher training programmes. UJ has three qualifications focusing on ICT integration; the Bachelor of Education Honours (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. The ACE is mainly for in-service training.

Training by universities in ICT teacher professional development has been greatly complemented by the efforts of SchoolNet South Africa (SNSA), which has played a leading role in 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 in their sites of practice, and there is a very strong evaluative element to their training, to judge its effectiveness. SNSA manages three large teacher development programmes: 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 Commonwealth Certificate for ICT Integration is an Advanced Certificate in Education level distance learning qualification for teachers and school leaders to successfully achieve integration 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, implementation of which is

---


186 ibid

187 e-Schools network. About the e-Schools Network: http://www.esn.org.za/

188 University of Johannesburg. Faculty of Education. B Ed Degree: http://www.uj.ac.za/LinkClick.aspx?fileticket=hK8qrrPOXy%3d&tabid=2896

189 University of Johannesburg. Faculty of Education. Advanced Certificate in Education (ACE), Educational Computing: http://www.uj.ac.za/LinkClick.aspx?fileticket=vzO2wqek%3d&tabid=10532

now underway. 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, has a strong focus on online communities of practice through discussion forums and blogs, where teachers can share ideas on ‘best practice’ and also share resources.

4.2.7 Integrated management information systems

South Africa has management information systems for the various educational sectors. DBE has an Education Management Information System (EMIS) which is used for the acquisition, processing, dissemination, and reporting of quality education data.¹⁹¹ EMIS collects data from ordinary schools, adult education and training, inclusive education, early childhood development, and further education and training institutions at provincial level, which is analysed and consolidated at national level.

The 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.’¹⁹²

Information inputted into SA-SAMS by schools enables the provincial departments and national departments to access quick and up to date data for snap and annual surveys that enables appropriate educational planning.

4.2.8 Digital education content and open educational resources

Several initiatives provide free educational resources, a few of which are highlighted here. Through this dissemination of free educational resources, 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 and do not have any open licence, many are effectively OER because they are available for re-use by others, free of charge.

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.\(^{193}\)

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 targeted for the education sector\(^{194}\) addressing different subjects and target groups.

The Siyavula project (http://siyavula.org.za/), 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 (http://cnx.org/), a 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 (http://cnx.org/lenses/siyavula).

4.2.9 Multiple modalities of dissemination of content

There are multiple forms of dissemination of free content to accommodate variations in ICT provisioning in schools. This improves the reach of the materials, and ensures equal access by all that bridges the digital divide. Some materials are distributed through satellite, podcasting, printed format and video streaming.

Mindset, for example, uses a wide range of distribution channels to increase reach and improve accessibility. These include broadcast, through DStv Channel 319 for Mindset Learn and on free to air digital broadcast for Mindset Health; Datacasting, where large volumes of content are sent via satellite to computers in South Africa (Mindset has installed the equipment for this to take place at 800 schools and 360 clinics); website (accessed by the public fee of charge: http://www.mindset.co.za; http://www.mindset.co.za/learn; http://www.mindset.co.za/cabanga; and http://www.mindset.co.za/health).

4.2.10 Mobile learning

Because of the high penetration of mobile technology in South Africa, especially among the youth, South Africa is piloting projects that make use of mobile technology for learning. The projects that have been piloted so far capitalize on the popularity of the social networking platform MXit, to motivate leaners to direct the use of this platform to educational purposes.

The m4Lit (mobile phones for literacy) pilot project was initiated in 2010 to explore teen leisure reading and writing around fictional texts in South Africa (SA), using mobile media. This project was initiated in response to evidence that ‘teens do not read, teens do not write enough, and teens love

\(^{194}\) Mindset Network – programmes. Available at: http://www.mindset.co.za/about
their phones,’ and that there are no leisure books in 51% of South African Households. The story, Kontax, is targeted at teens between 14 and 17 years and was published in English and isiXhosa. Readers could interact with the story as it unfolded, discussing the plot, voting in polls, commenting on the story, and writing a piece as part of a competition for story sequel ideas. The project aimed to contribute to the understanding of mobile literacies, and teen reading and writing using their mobile phones. The MXit platform was used for this project because of its popularity among youth, and because it has a low cost for mobile data.

In 2008, the South African Department of Education partnered with Nokia and Nokia Siemens Network to pilot a mobile mathematics project for Grade 10. This project made use of MXit to disseminate mathematics quizzes, exercises, and theory and content for Grade 10 learners. To participate in this project, learners needed a mobile phone that could access the internet, and they had to register on the social networking programme MXit.

The project was piloted in six public schools in Gauteng, Mpumalanga, Northwest, and the Western Cape in 2008, and then scaled up 30 schools, representing various school contexts. Learners could choose exercises from a database of approximately 10,000 questions, in multiple choice format, and also choose to engage with the theory which offered explanations on mathematical concepts. While completing the exercises, learners could chat to their friends and collaborate to solve mathematics problems. Learners received immediate feedback on the exercises, and teachers can monitor learner progress and see where learners are struggling and initiate proper intervention. Aware of the digital divide, the project made provision to mobi-kits comprising ten mobile phones that the school could manage for use by learners.

4.2.11 Private sector investment in ICT in education

There is significant involvement of companies investing in ICT in education, mainly through their corporate social investment (CSI) programmes. The financial assistance from the various CSI sources ensures quicker expansion of ICT projects, and in some cases, ensures their sustainability if the funding is provided on a long term basis.

An example is the Mindset Network which is sustained not only through private donors or corporate organizations but also government partnerships and other various stakeholders who provide funding for the project. These stakeholders include:


195 Vosloo, S. (2010). M4Lit (mobiles for literacy) project findings. Research developed and conducted in collaboration with Ana Deumert and Marion Walton (both University of Cape Town). Available at: http://m4lit.files.wordpress.com/2010/03/m4lit_project_findings_svosloo_2010.pdf
196 Shuttleworth Foundation. M4Lit. Available at: http://www.shuttleworthfoundation.org/projects/m4lit/
• South African founding partners – The leading founding members are: The Liberty Foundation and Standard Bank, and other founding members are Nelson Mandela Foundation, Multichoice, Intelsat, The Sunday Times, and Sentech.


• International partners - the World Health Organization, USAID, NEPAD, and Ford Foundation.

IBM has set up computer laboratories in under-privileged schools to encourage a love for technology and related careers. Additionally, IBM has made financial and technology investments to enhance learning in selected tertiary education institutions and universities across the country. With the Wits Centre for Students with disabilities, among their many projects, IBM is trialling web adaptation technology, which is aimed at making web pages more accessible and usable for by older adults and people with visual, motor or cognitive disabilities.

MTN is also piloting a tele-teaching project, which was launched in May 2010 at Kgaphamadi High School. In this project learners from multiple classes can connect at the same time and can interact with the instructor in one classroom, with all classrooms linked through technology.

Nurturing ‘digital natives’

Despite the digital divide in South Africa, mostly defined by social class, several initiatives are focused on nurturing ‘digital natives’ by introducing technology to children at a very young age. Exposed to technology early in their lives, children are most likely to embrace technology and exploit its educational potential for their social and economic upliftment as they progress through schooling.

The Meraka Institute (http://www.meraka.org.za/ICTeducation.htm) has several projects intended to reach children from a very young age and include among them: MobiLed, which harnesses a mobile platform to create informal and formal learning opportunities; The Young Engineers Programme, which makes use of various strategies like technology clubs, holiday programmes, extra classes, competitions, and workshops to nurture a passion for ICT and engineering among young people; and Tekkie Tots, a programme that exposes pre-school children to technology.

4.2.12 Research and evaluation

198 Mindset. Our partners. Available at: http://www.mindset.co.za/partners/content

199 ibid

200 MTN. MTN alleviates shortage of skills through tele-teaching. Available at: http://www.mtn.co.za/AboutMTN/Press%20Room/Current%20Press%20Releases/May2010/Pages/MTNalleviatesshortageofskillsthroughtele-teaching.aspx

There is a strong culture of research and evaluation in the ICT interventions being implemented, be they at national or provincial level, or institutional university level. Evaluation of projects is useful for providing useful feedback for change and improvement.

SNSA commissions external evaluators to evaluate their teacher training and the Khanya and GoL projects have also been evaluated at various points of implementation, to inform subsequent planning for the projects.

The Nokia Mobile Learning for Maths project was evaluated in its second year of implementation in 2010, and the evaluation findings showed that two thirds of the teachers in the 30 schools used the service, with a quarter using it regularly. Learners whose teachers did not use the service also used the service, showing that the service motivated learners to practice their mathematics.202

The Meraka Institute has an ICT in Education Research Group that directly supports the South African e-Education policy through the application of innovative ICT to support teaching and learning in schools and creation of hands-on exposure to science and technology careers among the 3 to 18 age groups.

4.2.13 Demand and supply of ICT in the higher education sector

The higher education sector has responded positively to a demand for technology by students, and all universities are at various stages of piloting and implementing ICT initiatives. Although there is no updated data on the level of ICT access in higher education institutions, there is strong evidence of implementation of ICT initiatives, which suggests adequate access of ICTs.

Almost all public universities have a centre that supports ICTs in teaching and learning. All of the centres are involved to varying degrees in supporting integration of ICT for teaching and learning, focusing on deployment of learning management systems (LMSs), initiatives to tackle teaching and learning challenges, mobile learning initiatives; open educational resources, and a research network. Selected examples from the many initiatives are used here as an illustration.

i. Learning management systems

The University of South Africa (Unisa), with a student population of over 250,000, and administering over 4,500 courses, provides a good example of an operational initiative in higher education in South Africa. Unisa uses a Web environment to provide general information on programmes and courses, and a secure environment that provides access for staff and students. Through Lecturers Online, lecturers can access online course resources, student information and feedback, and support and teaching tools. MyUnisa is the space for students, that provides access to course materials and library resources, e-mail and discussion forums, timetables, help desk, calendar of events and queries. Through e-learning, Unisa has established collaborations with other

African and international higher education institutions and expanded the reach of Unisa’s programmes.\textsuperscript{203}

\textit{ii. Mobile learning}

South African universities are also making use of mobile technologies to support academic administration and community work. At UCT, 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 students use SMS to access these. Academics also use SMS broadcast to send notifications about online resources and lecture scheduling (\url{http://www.cet.uct.ac.za/projects}).

\textit{iii. Open educational resources}

Some universities are 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 through encouraging them to publish their teaching resources as open educational resources.\textsuperscript{204} UCT’s Faculty of Health Sciences and UWC’s School of Public Health, as well as the Faculty of Dentistry 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.\textsuperscript{205} 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.\textsuperscript{206}

In addition to the institutionally driven ICT initiatives, there are also donor-funded and NGO-driven ICT initiatives in higher education. A notable, one based on open source principles is the Peer to peer University (P2PU) (\url{http://p2pu.org/}). P2PU, funded by the Shuttleworth Foundation, is an online community initiated in 2009 for university students wishing to learn collaboratively using the internet and open source materials. The initiative complements formal university education programmes. In P2PU, individuals submit a course idea and volunteer to run a course, based on input from experts and community members. Members of the P2PU community evaluate the course facilitators through a peer review process. Over two years, P2PU has grown from five members when it was launched to a community of 1,000. P2PU has formed ‘schools’ that constitute a focused learning focus for a particular community.

Research network

\footnotesize
\bibitem{ibid} ibid
\bibitem{204} CET. OER UCT: \url{http://www.cet.uct.ac.za/oer}
To support research efforts, the South African National Research Network (SANReN), was launched in 2007. SANReN ‘is a high-speed network dedicated to research traffic and research into research networking and broadband infrastructures.’ In the first two phases of implementation, SANReN aims to connect up to 204 sites across the country with research networks hosting over 3,000 research and education organizations from across the globe. The Meraka Institute is responsible for the implementation of SANReN, and the SANReN network is currently being actively rolled out in Durban, Cape Town and Pretoria.207

4.2.14 Challenges to implementation of ICT in education

Even though South Africa has achieved relative success in its implementation of educational technology initiatives, there are still challenges that need to be surmounted. These range from infrastructure and connectivity to management of initiatives, and processes associated with achieving sustainability of initiatives, for example teacher training.

i. Differentiated provision of infrastructure and connectivity

Although relatively significant progress has been made in deployment of computer laboratories and access to connectivity, provision is highly differentiated by province. This is reflected in Table 5 and Table 6.

Table 5: Availability of computer centres in public schools, 2009208

<table>
<thead>
<tr>
<th>Province</th>
<th>Number of Schools</th>
<th>With Computer Centre</th>
<th>Computer Centre Stocked</th>
<th>Without Computer Centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Cape</td>
<td>5,715</td>
<td>596</td>
<td>211</td>
<td>5,119</td>
</tr>
<tr>
<td>Free State</td>
<td>1,643</td>
<td>353</td>
<td>109</td>
<td>1,290</td>
</tr>
<tr>
<td>Gauteng</td>
<td>1,994</td>
<td>1,510</td>
<td>828</td>
<td>484</td>
</tr>
<tr>
<td>KwaZulu-Natal</td>
<td>5,835</td>
<td>982</td>
<td>305</td>
<td>4,853</td>
</tr>
<tr>
<td>Limpopo</td>
<td>3,918</td>
<td>428</td>
<td>165</td>
<td>3,490</td>
</tr>
<tr>
<td>Mpumalanga</td>
<td>1,540</td>
<td>254</td>
<td>81</td>
<td>1,286</td>
</tr>
<tr>
<td>North West</td>
<td>1,740</td>
<td>391</td>
<td>172</td>
<td>1,349</td>
</tr>
<tr>
<td>Northern Cape</td>
<td>609</td>
<td>314</td>
<td>85</td>
<td>295</td>
</tr>
<tr>
<td>Western Cape</td>
<td>1,466</td>
<td>886</td>
<td>493</td>
<td>580</td>
</tr>
<tr>
<td>Total</td>
<td>24,460</td>
<td>5,714</td>
<td>2,449</td>
<td>18,746</td>
</tr>
</tbody>
</table>

As Table 6 shows, Gauteng, the Western Cape and the Northern Cape have the highest number of schools with computer centres that were equipped. The number of well equipped computer

207 SANReN: http://www.sanren.ac.za/
centres in the Western Cape and Gauteng are reflective of the success of computer lab deployment in the provinces, from the Khanya and GoL projects.

Similarly, access to internet connectivity was also differentiated by province as reflected in Table 3.

Table 6: Access to telecommunications and internet

<table>
<thead>
<tr>
<th>Province</th>
<th>No of Schools</th>
<th>Communication System Available</th>
<th>No System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cell Phone</td>
<td>Land Line</td>
</tr>
<tr>
<td>Eastern Cape</td>
<td>5,715</td>
<td>5,430</td>
<td>1,234</td>
</tr>
<tr>
<td>Free State</td>
<td>1,643</td>
<td>1,541</td>
<td>918</td>
</tr>
<tr>
<td>Gauteng</td>
<td>1,994</td>
<td>1,545</td>
<td>1,794</td>
</tr>
<tr>
<td>KwaZulu-Natal</td>
<td>5,835</td>
<td>5,420</td>
<td>2,599</td>
</tr>
<tr>
<td>Limpopo</td>
<td>3,918</td>
<td>3,846</td>
<td>994</td>
</tr>
<tr>
<td>Mpumalanga</td>
<td>1,540</td>
<td>1,455</td>
<td>821</td>
</tr>
<tr>
<td>North West</td>
<td>1,740</td>
<td>1,666</td>
<td>783</td>
</tr>
<tr>
<td>Northern Cape</td>
<td>609</td>
<td>554</td>
<td>452</td>
</tr>
<tr>
<td>Western Cape</td>
<td>1,466</td>
<td>1,022</td>
<td>1,421</td>
</tr>
<tr>
<td>Total</td>
<td>24,460</td>
<td>22,479</td>
<td>11,016</td>
</tr>
</tbody>
</table>

Nationally, the availability of a cellular telephone in public schools is almost ubiquitous, but fewer than half of schools have a fixed line connection. Even fewer schools have access to a fax facility. Only about 13% of public schools had access to the internet in 2009. As with provision of well-equipped computer centres, the Western Cape and Gauteng had the most number of schools with internet connectivity.

---

ii. **Lack of central coordination of initiatives**

Although there are multiple ICT initiatives being implemented across the country, there is no central coordination of these projects. As such, there is no comprehensive source of up to date information that is centrally available on status of the various initiatives. The lack of central coordination could also be the reason why there is differentiated implementation in the provinces.

iii. **Limitations of modalities of teacher professional development**

Teacher training on ICT integration is usually of fixed duration which has been reported in evaluations as too short by teachers with no prior ICT skills at the beginning of the training. Sustainability of training could be threatened because of reliance on donor funding to make the training affordable to a majority of teachers but the training of trainers within localities addresses the issue of financial sustainability as SNSA is investing in people rather than keeping a limited pool of trainers who travel to offer training. ICT professional development in universities is removed from the context of the teachers’ work.

iv. **Lack of universal access to technologies by learners**

The lack of computers in schools in the seven provinces could be reflective of lack of computers at home. If students cannot access computers at schools, this puts them at a disadvantage as they will not be able to use technologies elsewhere, at home, to access information.

4.2.15 **Conclusions: Lessons from SA ICT implementation**

In summary, several lessons can be drawn from SA’s implementation of ICTs for teaching and learning:

i. Government commitment to ICT encourages deployment from other avenues, and will lead to government investments in ICTs in education.

ii. A robust policy environment that supports the e-Education policy is an enabling, but not sufficient, condition for ICT rollout.

iii. MISs are very important for recording school level data, for example the infrastructure, connectivity and enrolment data in schools. This helps for proper planning.

iv. Open educational resources offer the potential to bridge the digital divide, especially if there is limited access to computers. Materials can be printed and disseminated for learner use.

v. It is useful to have several initiatives being implemented as this increases the reach of ICT implementation.

vi. Public sector corporate social investment can be enabling in ICT roll out.

vii. Demand for ICTs leads to active supply of ICT initiatives, as has been the case in higher education.

viii. Making ICT an integral part of pre-service teacher education is in line with international thinking on how ICT professional development should be approached, and will induct
teachers to ICT integration before they start teaching. This is likely to increase their confidence levels with ICT integration.

ix. The direction into mobile technology for teaching and learning has potential as the mobile penetration in South Africa is very high, although programmes that are developed have to take cognisance of the compatibility of the programmes with available mobile phones for the target learners.

x. National portals like Thutong can help to send a positive message and government commitment to ICTs in education, but these require ongoing support and investment.

4.3 Uganda

4.3.1 Introduction

Uganda is a landlocked country along the equator in East Africa with a population of about 33.5 million people in an area of 241,038 sq km. With one of the highest annual population growth rates in the world, 48.3% of the population is below 15 years old, highlighting the educational challenges that lie ahead. Life expectancy at birth is 53.3 for females and 52.2 for male citizens. Infant mortality is 62.5 per 1000 live births.

4.3.2 Uganda’s Education Context

Formal education in Uganda is divided into three levels—primary, secondary and tertiary/university education. This is complemented by non-formal as well as informal education. Uganda has a Universal Primary Education (UPE) Programme that has increased access to and enrollment for primary education. Through this programme, government covers the cost of tuition and basic school operations, while parents or guardians cover uniforms, writing materials and lunches. At higher levels, the Universal Post Primary Education and Training (UPPET) aims to help students who have completed UPE attain secondary or tertiary education. Efforts by government are complimented by a burgeoning private sector with for-profit institutions at all different levels of education.

The Education Act\textsuperscript{210} provides overall guidance for activities within the education sector in Uganda. This is supplemented by other legislation like the Tertiary institutions act, the University act, etc. all of whose activities must be harmonised to feed into the inter-sectoral national Poverty Eradication Action Plan (PEAP).

4.3.3 Implementation of ICT in education in Uganda

There is a draft education sector-specific ICT policy\textsuperscript{211} awaiting cabinet approval that aims to help coordinate the disparate ICT projects going on within the sector. The policy document that has been on the drawing board for a while touches on a range of issues that need to be addressed in providing a conducive environment from legal and security measures, infrastructure and high costs to curriculum revision and ICT skills training for teachers at different levels.

\textsuperscript{210} \url{http://planipolis.iiep.unesco.org/upload/Uganda/Uganda_EducationAct.pdf}
\textsuperscript{211} \url{http://www.education.go.ug/ICT/ICT%20policy%20July%2005.pdf}
Currently there are different ICT projects going on across the different study themes, but many of these are outside the control or knowledge of MoES. As a result, many stakeholders feel that the country lacks a unified national direction with which to deal with ICTs in education.

### 4.3.4 Challenges to implementation of ICT in education

One of the biggest challenges faced by many educational ICT projects is the challenge of financial sustainability. When projects are conceived and designed, many times the project initiators do not appreciate the total cost of ownership of the technology or processes involved. As a result, they do not build a realistic sustainability model to cater for the long-term, beyond the allocated funds (usually from the development partner). As soon as the funding runs out, the project is just as likely to shutdown for any number of reasons. Consider the Connect-ED project, there were a number of recurrent costs that were never incorporated within the budgets of participating PTCs like bandwidth, maintenance costs and salaries for lab technicians.

ICT projects within Education in Uganda tend to be top-down—conceived elsewhere and passed onto their intended recipients during or after implementation. Many times such project recipients do not find them relevant or may indeed feel threatened by these new projects and thus work for their detriment. Engaging with the community from the onset in terms of the different stakeholders is critical for the success of any project. CU@School is a successful on-going educational ICT project within the context of a school. The various potential stakeholders engaged include the students, their teachers, school head teachers as well as other administrative organs like the Parents Teachers Association (PTA) and school Board. Other stakeholders with an interest include parents or guardians with students in the school, the local community around the school and the local leaders in the area. All of these were engaged meaningfully from the onset, and their needs and fears addressed.

Lack of local and relevant content is another big challenge facing ICT projects within the educational sector. Where users are given the necessary skills to produce content, the incentive mechanisms that drive them to create new or adapt existing content are not be given special attention. Project promoters tend to think that providing new technology alone should inspire users to create new content. Incentives normally come as an after-thought as opposed to building them within the project from the onset. Good examples of this challenge in Uganda include both Connect-ED and RENUNet projects. RENU is still struggling to create a viable local network partly because of lack of local content for members to share or access via their network. Institutional or individual access amongst RENU members is still largely focused at external resources (outside of Uganda). The challenge of how to spur local content creation that addresses the needs of a typical Ugandan user transcends the education sector.

Infrastructure and connectivity in Uganda are still poor. The power grid’s reach into rural areas is still limited while the supply is unreliable resulting in frequent power cuts. Land-locked Uganda relies on her neighbours Kenya and Tanzania for fibre connectivity to the outside world. While the number of fibres arriving at the Kenyan and Tanzanian coast is increasing, the internal networks for efficient distribution are still inadequate. While bandwidth costs are falling, they are still high.
compared to South Africa. The cost of procuring new ICT equipment is still prohibitive for most educational institutions despite tax exemptions by government on some items like personal computers. When you factor in the cost of maintenance as well as the requisite site preparations that accompany most ICT installations, the total cost of ownership gets out of reach for most institutions.

### 4.3.5 Opportunities for implementing ICTs in education

The infrastructure challenges above highlight why people are really excited about mobile phones in supporting ICT within education. First, the mobile network is ubiquitous; with coverage reaching further into marginalised rural areas than most other infrastructure. Currently, the Uganda Communications Commission (UCC) estimates that 100% of the population is within reach of a mobile network. Thus if an ICT project leverages mobile phones, it does not need to invest in creating a new communications infrastructure, making the scaling of projects much easier. Second, the mobile phone as an end device is much cheaper compared to other end user devices (for example computers), and the costs keep on falling, making it more affordable for many teachers and students. When the end user invests in a mobile phone as an end device, the institution or project does save by passing on the responsibility to acquire an end device to the end user. Third, the cost of operating (e.g. charging) and maintaining a mobile phone (as an end device) is also passed onto the end user who owns the mobile phone. Fourth, the mobile phone presents a range of user interaction modalities that range from voice, SMS, multimedia, web, etc. that can help enrich ICT applications.

As more fibre cables arrive at the Eastern coast of Africa improving global connectivity, the cost of Internet access in Uganda is falling despite being landlocked. As internal fibre networks within Kenya and Tanzania improve to provide reliable backhaul to the coast for landlocked Uganda, competition amongst providers will intensify further reducing connectivity prices. In addition, progress has been made on the Uganda national backbone despite project management setbacks. The backbone project is funded by a government soft loan from China and will be managed privately to recover the money to repay the loan from operations. It is worth noting the government has recognised educational use of the national backbone as a “social mission,” implying that educational services will be able to use the infrastructure at cost-recovery when the project becomes operational later this year.

Politicians and local leaders now appreciate the role that ICTs can play within education although public funding for ICT projects is yet to match their rhetoric. This recognition should make it easier for ICT projects to seek funding or other waivers and exemptions that make ICT projects more affordable for local institutions. The challenge is how to translate this goodwill into actual resources and enabling legislation to support ICT projects within education.

Developments in ICTs in education (and other sectors) are spawning local innovation and creativity within an emerging community of local developers. These developers, many of who are recent

---

graduates are creating applications that add value and bring more convenience to users, primarily with mobile devices. A number of institutions have emerged to promote this innovative culture by providing a workspace and other support services, for example the Hive Collab\footnote{Hive Collab, http://hivecolab.com} in Nakawa, Kampala. UCC, has also recognised the inherent potential in this and has launched a series of annual awards aimed at unearthing and promoting novel application ideas that ride atop this growing national mobile platform. Such application development can stimulate the development of the local economy in a number of ways.

4.3.6 **Conclusions: Lessons from Ugandan ICT implementation**

In summary, we can draw some lessons from the various ICT projects within the education sector in Uganda: There is need for

i. Centralized documentation and coordination of ICT projects going on within the education sectors. Besides allowing different stakeholders to know what counterparts are working and create synergies, this can help harmonise and ensure that the different projects are contributing to the vision of MoES and development needs of Uganda

ii. Education specific ICT policy created in collaboration with different stakeholders. The sector-wide approach (SWAp) in engaging different stakeholders to define direction and implementation of activities within education has been already successful and could be extended to this endeavour.

iii. Financial sustainability of ICT projects within education to make them more viable. Practitioners need to appreciate the total cost of ownership of the technology and the processes vital to the success of the project.

iv. Nurturing local content creation to address the specific requirements of Uganda’s education curricula at different levels.

v. Reviewing curricula at different levels while rethinking the role of ICTs in implementing them. For example teacher training curricula needs to ensure that Uganda produces teachers that are not only ICT literate, but can also ably integrate ICTs within their own teaching practices.

vi. Institutional budgets that reflect the growing role of ICTs within education. Inadequate resources are currently allocated to ICT at all levels, making it hard to invest in the necessary infrastructure, connectivity, capacity building, content creation and adaption as well as the incentive mechanisms that could motivate different ICT users within any institution.

vii. Engaging with the private sector to fund potential ICT projects within the education sector that have win-win propositions for both the public and private sector. Examples like SMS examination results do not only generate potential income for the private and public institutions involved but also provide an invaluable service to the general public.
viii. Making sector-wide government policies to guide how ICTs can support data collection, analysis and dissemination across different sectors (education, health, agriculture, etc.) to guide effective decision-making and policy formulation. The data generated in one sector, for example education in this instance can be relevant or used in another sector like health. Scarce resources like human resource, computing equipment or connectivity could be more efficiently shared across sectors to facilitate operations both at different levels of administration.
5. RECOMMENDATIONS TO POLICY MAKERS, REGULATORS AND OTHER STAKEHOLDERS

5.1 Introduction

Creating an etransformation ready environment within the education sector in Africa will only come through the concerted action of individual governments working with other stakeholders that must necessarily include the private sector. The previous chapters have given examples of what is happening around the world and within Africa, highlighting opportunities, challenges, successes and failures from which lessons can be learnt. The challenges especially identified areas where interventions needed and also gave a preliminary indication of directions such interventions could take. The chapter also makes recommendations to other stakeholders who have a role in the integration of ICT in education.

5.2 Recommendations

5.2.1 Policy and Strategy:

Governments should take the following steps (the steps that have already been addressed by particular governments can be omitted by the governments, or revisited to ensure that there are no gaps):

i. Carry out a comprehensive baseline survey of the education sector to inform both the policy and strategy processes. This includes a comprehensive map of stakeholders along with their roles.

ii. Formulate a national ICT in Education policy through a consultative process that will also create awareness and ownership. This should have as a component a comprehensive implementation plan along with a budget and tools for monitoring and evaluation; should assign responsibilities to defined institutions; and should include methods of funding, indicating what will be available from government and what needs to be sourced from elsewhere.

iii. Define the education standards against which progress will be measured and assign responsibility to the appropriate agency for monitoring and compliance enforcement.

iv. As a pre-condition or concurrent requirement, elaborate and implement the national ICT Policy and e-government to provide a comprehensive environment for the implementation of ICT in Education.

5.2.2 Open Educational Resources

Governments need to:

i. Develop and implement policy and laws that protect intellectual property, along with the necessary institutions for enforcement.

ii. Develop and implement policies and strategies that will promote the growth of OER that are tailored to the curriculum, language, and context of the country. Such policies and
strategies should include engagement of the relevant organisations in the private and NGO sectors.

Institutions need to:

i. Have clear internal policies that relate to copyright ownership among the different participants in the development of digital learning content, with emphasis as licensing as much of the output as possible under the Creative Commons licensing provisions.

5.2.3 **Capacity Building**

Governments need to:

i. Develop and implement ICT in education capacity building programmes for all those involved in the implementation of ICT education, starting with the political leadership and policy makers through teacher trainers and school heads and administrators. Such programmes should be conducted as much as possible through digital learning environments. For countries in Categories 1 or 2 as earlier identified, governments should source the necessary external expertise, including the development partners, NGOs, and the private sector, to do this.

Institutions need to:

i. Review their curricula where they relate to professionals within the education sector (for example teachers), or who support the sector (for example ICT professionals) with input from the private sector, the NGO sector, and ICT in education experts to ensure that graduate match the needs of the sector.

ii. Put in place the necessary internal policies and infrastructure to ensure that ICT-enabled learning is implemented in the institutions.

iii. Develop and implement programmes that will ensure that in-service training for ICT integration in education can be availed on a continuing basis.

The private sector and NGOs need to:

i. Engage the government and institutions to identify capacity gaps that they can address in a supporting role to government and institution capacity building programmes.

5.2.4 **Connectivity and Access**

To address connectivity and access challenges, governments need to:

i. Place broadband access for educational institutions on the national development agenda as part of the social services sector. This should include access to national or commercial data back bones as well as access to international bandwidth.

ii. Establish education rates (e-rates) for the education sector

iii. Work with ICT regulators to permit full competition in the telecommunications sector.
iv. Work with regulators to ensure that NRENs, as dedicated carriers of education and research traffic have the necessary permissions, licenses, or authorisation to own and operate independent national networks for their closed user group; own and operate international gateways (including fibre); and transit traffic for NRENs in neighbouring countries.

v. Work with the private sector, NRENs, and regulators to ensure that schools have access to the internet through wired or wireless access, based on context specific evaluation of what approach is best. This could be part of the national universal access targets.

vi. Implement programmes that will ensure that teachers increasingly get more computer time until individual full time access is achieved; and that students get increasing online time through shared or individual access, according to level, so that they can engage effectively in a digital online learning environment. This could be made part of the national universal access targets.

vii. Remove barriers (where they exist) to the use of mobile phones by students for learning. This includes implementing number portability so that the individual has the choice to use any mobile network without operator imposed barriers.

viii. Remove tax barriers to access – extending from active backbone devices, servers and related equipment for NRENs, to tax barriers to recurrent use.

ix. Engage the private sector in PP arrangements that will promote access to more bandwidth at lower cost for the education sector; and technology development and transfer to reduce on imported technology

5.2.5 Sustainability

Government and education institutions need to:

i. Integrate Total Cost of Ownership in sustainability planning, which should be an integral part of policy, implementation plans, and initiatives.

ii. Plan and provide incentives to teachers who undergo training and use ICT-enabled learning approaches in their work.

iii. Work with the private sector in developing and implementing PPP initiatives to ensure that the current total dependence on importation (for most African countries) of all the technology required for both access and content is reduced over time.

iv. Carry out ongoing impact evaluation and subsequent strategy iteration to ensure continuing improvement.

5.3 Theme-specific recommendations

5.3.1 Teacher Professional Development

Governments and institutions need to:

i. Ensure that ICT teacher professional development is informed by a formal documented national strategy based on a national ICT in Education policy. The strategy should have a clear implementation plan, and draw on existing, good and effective professional
development initiatives, such as those documented in Annex 2. A strategy could also include ways of sourcing funding for professional development.

ii. Adopt a suitable global professional development framework to guide national implementation of ICT professional development. We recommend use of the UNESCO ICT Competence Standards for Teachers and Teacher Training, as a useful starting point for planning professional development strategies at national level. Adoption of this would lead to a generic national strategy along the lines presented below.

iii. Make ICT integration a mandatory aspect of pre-service teacher training so that all teachers to become aware of the value of ICT for teaching and learning, and open possibilities for them to consider using ICT for teaching and learning when they become practising teachers.

iv. Build into professional development strategies incentives for teachers linked to enhancing their knowledge of ICT integration. These incentives should not only be based on acquiring a qualification, but also on demonstration of successful integration of ICTs to enhance educational outcomes. If incentives include increase in remuneration, budgeting provisions will need to be made for this.

v. Provide teachers access to post-training support structures, for example technicians for troubleshooting, and mentors and coaches for sharing ideas and resources and encouraging teachers. It is also important for trainers of face-to-face training to offer follow on school based support.
vi. Implement schemes that enable growing numbers of teachers to gain access to their own computers (with a possible emphasis on mobile devices such as laptops or netbooks). Teachers with access to their own computers and other technologies are able to practice what they have learned. Digital access initiatives like the South African Teacher laptop Initiative have the potential to enhance teacher uptake of ICT integration as they have their own laptop to use for ICT integration.

vii. Ensure that the national system gives teachers a choice of which training they can take, to enable them to select needs-based courses. Careful selection of available training is needed, so that programmes that are selected are useful for the work of teaching and are able to help teachers improve learning outcomes. Teachers will only adopt technology if it serves their purposes, that is, help them perform their teaching duties effectively.

5.3.2 Digital Learning Resources

Governments and institutions need to:

i. Review and adjust as appropriate existing national/institutional policies and staff incentives schemes to ensure that they encourage educators to invest time in ongoing curriculum design, creation of effective teaching and learning environments within courses and programmes, and development of high quality teaching and learning materials.

ii. Ensure that budgets for purchasing educational materials allow for procurement of materials across a wide range of media types and formats. Given current bandwidth and connectivity challenges, a balanced mix between digital and printed resources is required. It will be beneficial for education curriculum experts to evaluate freely available digital content in the same way that is done for physical texts so that schools/colleges can make appropriate and informed choices between different products.

iii. Consider judicious investments in content creation to ensure compliance with African curricula, or local language demands, motivating usage by teachers and learners. In the first instance, priority content could be sourced from open content. If this is not available, it will be useful to identify and invest in priority content development focus areas that might not be covered through an open market. The latter may include:

a) Translating existing digital educational material into priority indigenous languages in priority content areas;

b) Procuring the copyright to high quality existing materials so that resources can then be freely distributed without generating additional cost; and

c) Building structured, long-term partnerships with commercial organizations, CSI Initiatives, and NGOs that currently produce free materials, and supporting their efforts to raise funds to sustain their business models.

iv. It may be worth investing in a centralized, national content development process (run through competitive tenders) which will lead to the generation of content. Additionally, it is recommended that incentive mechanisms 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, but with proper recognition, by the public.

v. Ensure that the country and individual institutions have in place robust, enforceable IPR, copyright, and privacy policies (addressing possible full-time, part-time and contract staff as
well as students any and all of whom might become involved in a team-based curriculum and materials development process). As part of this policy process, consider the relative merits of creating flexible copyright policies that automatically apply open licences to content unless there are compelling reasons to retain all-rights reserved copyright over those materials.

vi. Invest in ongoing awareness-raising, capacity-building, and networking/sharing activities to develop the full range of competences required to facilitate more effective use of educational resources in education delivery.

vii. Adopt and support the use of content management and authoring tools (web content editing tools, content management systems), templates, and toolkits that facilitate the creation of adaptable, inclusively designed educational resources.

viii. Invest in knowledge management systems and strategies to store, curate, and share educational content. Ideally, to ensure cost-effectiveness, this would be done as part of a coordinated national strategy or in partnership with emerging global OER networks and repositories. This should ideally be accompanied by ongoing investments to ensure that teaching staff have access to the necessary ICT infrastructure and connectivity to access the Internet and develop or adapt educational materials of different kinds.

5.3.3 Affordable Technologies

Governments and institutions need to:

i. Address affordable technologies as just a tool and approach it within the context of the entire eco-system (e.g. access to electricity; access to technical support)

ii. Use PPP to get technologies as close to affordable as possible.

iii. Support experimentation with technologies in education, to effectively learn from these experiences and share the lessons learnt.

iv. Carry out evaluation and research to determine the impact of a particular technology or approach as well as for understanding how, when and why something does or doesn’t work. It is also important that the lessons learnt are documented and shared with stakeholders to enable continuous learning.

5.3.4 Education Management Information Systems (EMIS)

Governments and institutions need to:

i. Build capacity at all levels in using EMIS for decision support.

ii. Design EMIS with decentralization, scalability and cost in mind while exploiting the opportunities provided by open source, wireless technologies, broadband, GIS and other emerging tools such as Web services and Web 2.0.

iii. Promote common and open systems that can be supported through the sharing of scarce human resource (this can be required for institutions under direct government direction and encouraged for others).
5.3.5 National Research and Education Networks

Governments need to:

i. Support start-up on a decreasing basis NRENs through direct funding and in-kind support to enable them to get to an operational level where they can cover recurrent costs through user-charges.

ii. Support schools and campuses in the development of wired or wireless networks; provision of access devices; and ongoing technical support.

iii. Requirement regular industry input into university curricula, involvement of people from industry as occasional lecturers, and internship requirement for students.

iv. Implement industrial training levies as well as obligatory absorption of students for internship – supported with suitable incentives like tax breaks.

v. Support the development and growth of content networks

5.4 Critical Success Factors

When considering the use of technology in education it is important to learn from both previous and existing interventions. Key critical success factors include that:

i. Interventions are based on a clear understanding of the educational needs (i.e. the needs of teachers and learners) and context and how these can best be addressed. This must include a consideration of equity issues to ensure that technology does not reinforce existing social and cultural inequities;

ii. There is a well developed and comprehensive implementation strategy which considers issues such as resource allocations, institutional arrangements and monitoring and evaluation;

iii. Stakeholders are consulted, engaged and supportive (e.g. policy makers, teachers, learners, principals, parents, communities and potential partners). Any intervention needs to be owned and supported by those who will institutionalize and embed the use of the technology and educational change.

iv. Educational content is considered from the start;

v. There are the required human capacities (e.g. that there are suitably trained teachers, managers, administrators and technical staff);

vi. There is an understanding of lessons learnt from other projects and that tools and that approaches are piloted to learn what works and what does not work before they are scaled up;

vii. There has been an analysis of total cost of ownership of the proposed technology;

viii. Sustainability is considered from the start;

ix. The dependencies and risks have been identified with strategies in place to address them. These include issues such as infrastructure requirements, logistics and technical support.

There are also critical success factors specific to each of the five thematic areas covered in this report – more details the key issues in each thematic area are provided in the Report Annexes.
6. RECOMMENDATIONS TO DEVELOPMENT PARTNERS

6.1 Introduction

Development partners have two entry points: direct support to governments for specific initiatives, or direct support to institutions or organizations of institutions that are addressing any of the main thematic interventions.

6.2 Initiatives that fall under government direction

i. Support governments in the development of a cross-cutting policy and strategy for ICT in Education.

ii. Develop reference guidelines as well as model policy frameworks for ICT in education for countries at different stages of inception or implementation.

iii. Develop graduated interactive on-line learning materials along with equivalent printed formats for various stakeholders, through which they can fully understand and appreciate the role, importance, and issues around ICT in education. This could include the stages and content in developing policy frameworks and implementation strategies for ICT in education.

iv. Support governments in defining and establishing policy and legal environments as well as initiatives that promote the development and use of OER.

v. Support governments in defining approaches and frameworks for PPP arrangements that will support the growth of locally produced hard and soft resources for ICT in education, with some focus on affordable technologies.

vi. Address, through incentives, innovations (technology or strategy) that address the needs of the ICT in education undertakings, including scaling up. This applies for example to support for the production of low technology devices that can be used for charging the growing multitude of portable handheld devices, including laptops.

vii. Support research aimed at rigorous impact evaluation studies on educational technology initiatives in developing countries.

viii. Support governments in conducting curriculum reviews especially where external to government expertise is needed.

ix. Support the adaption of learning materials imported from different settings to local contexts.

x. Support acquisition and implementation of EMIS with a focus on open source platforms which focus on data collection and use at school and college levels with integration at district and national levels.
xi. Support the revamping of the EMIS Units to play a key integration role using modern web, GIS and distributed database tools. In addition there is a need to build the capacity of Ministries of education in developing EMIS policy and standards and using the web for dissemination of educational information.

6.3 Initiatives that can be handled by institutions or organizations of institutions

i. Support EMIS development at school level, possibly through piloting with a selection of core schools with a programme of rollout to other schools as capacity grows. Development Partner investment should target supporting standardised EMIS that are developed using open standards and capable of interfacing with, GIS, social networks and mobile and low cost computing; and building the capacity of data providers and users in schools.

ii. Support districts to enhance the decentralisation of EMIS and increase the capacity to use multiple channels to carry out decentralised planning at that level. Donor support to districts needs to encompass the installation of web-based distributed databases and information systems using open standards capable of integrating school information resources. Capacity is also needed to improve data verification and usage at the district levels.

iii. At the higher levels of education, support:

   a) Content networks: Library; e-learning; grid-computing; agriculture; medicine and e-health are some of the sectors where there already exist established or emerging content networks.

   b) National Research and Education Networks

   c) Regional Research and Education Networks

   d) Support NRENs in extending connectivity through long term (IRU) leases, backbone connectivity and last mile access to educational institutions