THE AGA KHAN UNIVERSITY

THE CENTRE FOR COMMONWEALTH EDUCATION

Centre for Commonwealth Education &

Aga Khan University Institute for Educational Development – Eastern Africa

Research Report No. 1

Developing the Use of Information and Communication Technology to Enhance Teaching and Learning in East African Schools: Review of the Literature

Sara Hennessy, Brown Onguko, David Harrison, Enos Kiforo Ang'ondi, Susan Namalefe, Azra Naseem and Leonard Wamakote

May 2010

UNIVERSITY OF CAMBRIDGE
Faculty of Education

DFID Department for International Development

Developing use of ICT to enhance teaching and learning in East African schools: a review of the literature

Review coordinators: Sara Hennessy and Brown Onguko

OVERVIEW OF CONTENTS

Introduction
Sara Hennessy (University of Cambridge)

1. **National policy for using ICT to support teaching and learning in primary and secondary schools in East Africa**
   Enos Kiforo Ang'ondi (IED-EA)

2. **National government investment in ICT initiatives in primary and secondary schools in East Africa**
   Leonard Wamakote (IED-EA)

3. **Key past and current initiatives supporting the use of ICT in schools in African Commonwealth countries**
   Brown Onguko (IED-EA) and Sara Hennessy (University of Cambridge)

4. **Physical and other related external factors affecting the use of ICT in primary and secondary schools in Sub-Saharan Africa**
   Azra Naseem (IED-Pakistan)

5. **Curriculum and school-related factors influencing integration of ICT in primary and secondary classrooms: evidence from Uganda, Kenya and Tanzania**
   Susan Namalefe (IED-EA)

6. **Teacher factors influencing classroom ICT use**
   David Harrison (University of Cambridge)

7. **Implications for developing educational uses of ICT in East Africa**
   Sara Hennessy (University of Cambridge) and Brown Onguko (IED-EA)

References

DETAILED TABLE OF CONTENTS

Introduction **4**
- **Focus** **4**
- **Scope** **4**

Section 1: National policy for using ICT to support teaching and learning in primary and secondary schools in East Africa **6**
- **Introduction** **6**
- **1.1 Background to the emergence of ICT policies in East Africa** **7**
- **1.2 Overview of East African ICT in education policies: Rationales** **9**
- **1.3 Overview of East African ICT in education policies: Content** **10**
- **Conclusion** **16**

Section 2: National government investment in ICT initiatives in primary and secondary schools in East Africa **18**
- **Introduction** **18**
- **2.1 Uganda** **18**
- **2.2 Kenya** **20**
- **2.3 Tanzania** **23**
- **2.4 Rwanda** **24**
- **2.5 Burundi** **26**
- **Conclusion: An overall picture of government investment in ICT in East Africa** **27**

Section 3: Key past and current initiatives supporting the use of ICT in schools in Sub-Saharan African countries **28**
- **Introduction** **28**
- **3.1 ICT initiatives** **28**
- **3.2 Public-private partnerships in SSA** **33**
- **3.3 Public-private partnerships in East Africa** **41**
- **3.4 Private sector / NGO initiatives in East Africa** **43**
- **3.5 Government-funded academic research programmes in SSA** **44**
- **Conclusions** **46**

Section 4: Physical and other related external factors affecting the use of ICT in primary and secondary schools in Sub-Saharan Africa **48**
- **Introduction** **48**
- **4.1 Infrastructure** **48**
- **4.2 Affordability of technology** **53**
- **4.3 Community facilities** **53**
- **4.4 School policy on ICT use** **54**
- **4.5 Sociocultural and linguistic factors** **54**
- **4.6 Economic and political factors** **55**
- **Conclusion** **56**

Section 5: Curriculum and school-related factors influencing integration of ICT in primary and secondary classrooms: evidence from Uganda, Kenya and Tanzania **57**
- **Introduction** **57**
- **5.1. National curriculum and assessment** **57**

5.2 Language of instruction and of ICTs in education in Tanzania 61
5.3 ICT literacy among students 62
5.4 School leaders as agents of change in ICT integration 63
5.5 Change facilitators and ICT champions/pioneers 64
Conclusion 65

Section 6: Teacher factors influencing classroom ICT use 67
Introduction 67
6.1 ICT in and for Education 68
6.2 Why teachers use ICT 68
6.3 The demands on teachers of using ICT 71
6.4 How ICT is used in the classroom 75
6.5 Initial teacher education (ITE) and continuing professional development (CPD) policies and practices 79
Conclusions 93

Section 7: Implications for developing educational uses of ICT in East Africa 96
Introduction 96
7.1 Policy, investment and partnership initiatives for integrating ICT into schooling: Rhetoric and reality 96
7.2 Barriers to developing ICT use in the East African context 98
7.3 Teacher education and development 99
Overall Conclusions 100

ACKNOWLEDGEMENTS 101
BIBLIOGRAPHY 101

Appendix A: Key ICT initiatives in education in Uganda 117
Appendix B: Key ICT initiatives in education in Kenya 119
Appendix C: Key ICT initiatives in education in Tanzania 120

Introduction

Sara Hennessy

This review was carried out by a team of collaborators based at the Aga Khan University Institute for Educational Development – Eastern Africa (AKU IED-EA), AKU IED-Pakistan and Faculty of Education, University of Cambridge. The work was funded by a DelPHE grant from the UK Department for International Development (DFID) supporting the partnership, by IED-EA and by the Centre for Commonwealth Education (funded by the Commonwealth Education Trust) at Cambridge.

Focus

This review synthesises the literature on uses of information and communications technology (ICT) in primary and secondary schools in Sub-Saharan Africa (SSA), with a particular focus on Commonwealth countries and on East Africa. It focuses on the role of ICT in improving the quality of learning and teaching in schools (Grades K-12) with reference to technologies appropriate for this context. In so doing, the review casts new light on the supporting and constraining factors that influence ICT integration in education in the region.

In more detail we set the scene by auditing and evaluating both provision of ICT in schools and policy initiatives related to its use in supporting school learning and teacher education in East Africa. These include both national and school-level policies, financial investments and interventions. We delve below the surface to examine issues arising regarding access to and actual levels and types of use of digital technologies in East African schools. Key stakeholders and agents of change in ICT integration are identified, including national policymakers, school leaders and academics. Related to this we document and assess the impact of prominent past and current international and local initiatives to use ICT in widening access and participation, and in improving quality of teaching and learning in SSA schools. We explore the pedagogical, social, logistical and technical issues arising as we move on to characterise local needs and the facilitating factors and constraints on technology use in this developing context. Emerging issues include pedagogical awareness, approaches and skills as well as technical expertise, technology infrastructure (especially internet access, bandwidth, hardware and software provision), electricity supply and the potential of portable and alternative energy technologies, geographical dispersion and the role of community telecentres.

Teacher factors influencing classroom ICT use, such as their ICT literacy and confidence levels, are also identified, focusing on impacts of teacher training and continuing professional development, and on teacher beliefs and cultures of teaching. We conclude by drawing from the review a number of implications for further development of educational uses of ICT in East Africa and some suggestions for future research and professional development initiatives.

Scope

All types of digital technology are included in the term “ICT”, not only computers. Note that the term “public schools” refers to state-funded schools (unlike in the UK). We focus on the five countries belonging to the East African Community (Burundi, Kenya, Rwanda, Tanzania and Uganda) in terms of documenting policy and provision of ICT resources in Sections 1-2 and in drawing out implications and a research agenda in Section 7. However Sections 3-6 include some messages learned from

initiatives in other developing Commonwealth countries within SSA, where these are particularly informative, since the conditions and issues arising there are often similar. In the penultimate Section 6 we again focus on SSA but widen our net a little further to consider what we might learn from the widespread integration of ICT into schools and teacher education in European and other developed country contexts, and the extensive associated research literature.

The review covers relevant literature published since 1990 but focuses primarily on more recent work carried out since 2000. We draw heavily on the series of informative surveys of ICT use in African countries carried out by Farrell, Isaacs, Hare and colleagues in 2007, and update the picture using some more recent material too. Printed and electronic sources include:

- Published research studies (peer-reviewed wherever available) and surveys;
- Evaluation reports;
- Government policy documents;
- Donor policy documents and project reports;
- International/local nongovernmental organisation (NGO) policy documents and project reports.

Section 1

National policy for using ICT to support teaching and learning in primary and secondary schools in East Africa

Enos Kiforo Ang'ondi

Key words: information and communication technology, integration, education, policy formulation, East Africa, equity, e-content, teacher education

Introduction

This section presents an overview of the national policies for using ICT to support teaching and learning in primary and secondary schools in Kenya, Tanzania, Uganda, Rwanda and Burundi. It begins by presenting a historical perspective of the ICT policies in education and the rationale for the formation of these ICT policies. It then discusses the policy framework for each country, specific reasons for policy formation, policy objectives and strategies. The review pays close attention to the stakeholders while providing details on what steps individual countries have taken in the formulation of the ICT curriculum as stated in the various policies. It also looks at how the various policies address continuing professional development (CPD) for teachers and how these have been implemented in the various countries. It is noted that although the East African countries have historical backgrounds that are almost similar, they all are at different levels of development. This could be attributed to how the individual countries have adopted the use of ICT, which has become associated with current and future educational, social and organisational development as noted by Minishi-Majanja (2007). Implementation of the policies outlined and some constraining factors are mentioned briefly below but more details are presented in Sections 2 and 4-6.

Although ICT has several definitions depending on the nature of its use, for this review ICT (information and communication technology) is used as an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems, as well as the various services and applications associated with them, such as videoconferencing and distance learning. We refer to ICT in the particular context of ICT provision, policy and teacher factors that variously support teaching, learning and a range of activities in education.[1]

It has been argued that ICT is a principal driver of economic development and social change worldwide (Kozma, 2005; Leech, 2008). In many countries, the need for economic and social development is used to justify investments in educational reform and in educational ICT. Another notable argument to this effect is by Kelles-Viitanen (2003) who referring to developing countries in general, commented that ICT plays a major role in all aspects of national life: in politics, in economic life, as well as in social and cultural development. She further argued that ICT is rapidly transforming the way people do business, access information and services, communicate with each other and even entertain themselves. The UN ECOSOC Ministerial Declaration (2000) provided special attention to the application of ICT for development, for which urgent and concerted actions at the national, regional and international

[1] http://searchcio-midmarket.techtarget.com/sDefinition/0,,sid183_gci928405,00.html

levels have been suggested. A Microsoft Corporation (2007) report on its ICT initiatives in Africa acknowledged that technology alone does not drive development but enables it. In the report, while noting that 300 million Africans live on less than $1 per day, it is asserted that:

> ICTs offer special opportunities to stimulate growth and increase innovation in every local setting, thereby enabling individuals and institutions to interact more productively with the global economy and the wider world. . . But to realize their potential, technologies must be part of a mix of productive changes and supporting capabilities. Resources must be matched by resourcefulness – combined with other initiatives by local leaders, educators and entrepreneurs to achieve individual and institutional objectives. "ICT4Development" is therefore an effort to distinguish the most constructive opportunities to apply technologies for growth and poverty reduction. (p. 4)

This calls for a well-formulated and implemented national strategy and policy to avail the necessary resources. Such strategy would match ICT opportunities with resourcefulness of different players and stakeholders into meaningful national and social development. The five countries comprising the East African Community, namely Burundi, Kenya, Rwanda, Tanzania and Uganda, have each formulated national policies to guide such implementation. This section traces the ICT in education policy via its formulation process in East Africa by fleshing out the main milestones and highlighting key thrusts of the policies as they relate to ICT use for teaching and learning in primary and secondary schools, for each of the countries.

1.1 Background to the emergence of ICT policies in East Africa

Although several countries make up this region, East Africa as it is known today comprises Kenya, Tanzania, and Uganda and in a wider sense Burundi and Rwanda as these five countries constitute the East African Community (EAC)[2]. Between the nineteenth and twentieth century, East Africa was torn apart by the competition between colonial nations of the time and to a certain degree became part of the European colonial empire. However, after the colonial rulers gave power back to the locals, the subsequent independent states became illiberal and corrupt and experienced political coups, civil strife, ethnic violence, oppressive dictators and bad administration - factors that have stagnated the national and regional development of the East African countries.[3]

The political crises and the long drawn-out conflicts in the EAC have had devastating effects on education as observed by Hare (2007). In addition, the archaic modes of operation used in this region have adversely affected different sectors which have led to low levels of development. Education is one such sector which has been affected by dwindling economies and subsequent poverty. Faced with these and many other challenges, the East African countries were keen to embrace technology which can potentially be an important agent of development. This is because the positive effects of ICT use in the developed countries had continually been noted, and it became critically important for developing countries of Africa to embrace technology. The role of technology in national development was undeniably significant as Minishi-Majanja (2007) rightly puts it. What followed then was a proliferation of ICT use which Ochuodho and Matunga (2004) refer to as "electronics burst". However, this emergence and use of ICTs were rather hasty and haphazard as noted by Waema (2005), and thus necessitated streamlining. At the turn of the millennium, most of the East African countries, with the aid of donor agencies, formulated ICT policies to curb the anomalies. The earliest of these reforms was referred to as the "Draft National Informatics Policy" in Kenya (Ochuodho and Matuga, 2004).

[2] http://www.eac.int/about-eac.html
[3] http://en.wikipedia.org/wiki/East_Africa

Rationale for the formation of the ICT policies

It has been noted by Jones and Kozma (2003) that national ICT policies can serve several important functions. Firstly, ICT policies provide a rationale, a set of goals, and a vision of how education systems work if ICT is introduced into teaching and learning, and they can benefit students, teachers, parents and the general population of a given country. Secondly, ICT policies are expected to provide guidance, and failure to do so means that individual school and classroom innovations would be unlikely to be sustained. Additionally, individual efforts are less likely to be felt across the country unless there is a shared vision clearly laid out in the policy (ibid).

Education has been identified as one of the public sectors most influenced by technological developments (Kozma, 2005). The improvement of educational systems and increased educational attainment are primary to countries' preparation for global, technology-based changes in all sectors (OECD, 1999). The formation of ICT policies in education, although embedded in the national ICT policies of the East African countries, is seen to be crucial as ICT plays an important role in preparing individuals in school for the workplace (Were, Rubagiza, Denley and Sutherland, 2007). ICT, if carefully integrated in education, has a potential to facilitate the acquisition of relevant life skills that buttress the development process in the prevailing economic and information order (ibid).

ICT policies in the East African Community began taking shape in the early 2000s. As noted before, there had been an increase in unregulated use of ICTs that prompted the need for governments to offer direction in the use of these technologies. According to the infoDev report, quoted in Farrell and Isaacs (2007), the initial ICT policies were comprehensive and included all sub-sectors of the education system. However, the formation of the policies has been a long and complicated process. In Kenya, for example, the earliest known ICT policy dates back to the 1980s and by 2000 it had not been completed as noted by Nduati and Bowman (2005). These ICT policies, nonetheless, were and still are comprehensive and stress access to ICT tools and internet connectivity (Hare, 2007; Farrell, 2007).

Influence of donor agencies

The development of ICT policies has not always equated to implementation and results on the ground, but to some extent has set up mechanisms to specifically attract donors (Farrell and Isaacs, 2007). For instance, the Kenya ICT trust and the Tanzanian and Rwandan ICT policies specified ICT regulations in order to attract donors. Donors have, indeed, played a crucial role in the development of the ICT policies in the region, and the impact of this is seen in the purposes, outcomes, performance indicators, monitoring, evaluation and implementation strategies that are set out (ibid). To elaborate this point further it is necessary to mention some of the donor agencies that have played a crucial role in influencing the ICT policy making. According to Etta and Parvyn-Wamahiu (2003), resourceful donor partners such as USAID, the Carnegie Corporation and the International Telecommunications Union (ITU) supported the Africa Information Society Initiative (AISI) which was concerned with promoting ICT policy formation in Africa. AISI, an action framework to build Africa's information and communications infrastructure, was adopted by Ministers of Economic and Social Development and Planning and endorsed by the then Organisation of African Unity (OAU) in 1996. This initiative has helped many countries, not just in East Africa, but Africa as a whole to complete elaborate national information and communication infrastructure plans. We now briefly discuss the policy formulation process and the key aspects of ICT in education policies for each of the EAC countries.

1.2 Overview of East African ICT in education policies: Rationales

Kenya

The earliest attempt at ICT policy formulation in Kenya dates back to the 1980s, but the process remained incomplete by 2000 (Nduati & Bowman, 2005). The formation of ICT policy in Kenyan education has its roots in the Ministry of Research of the time. The motivation was to develop national policy guidelines for the development of ICTs in the country in order to address the then prevailing haphazard growth of the sector. This was complemented by the readiness of donor agencies including UNESCO, in funding the current policy-making process. Reports by both Waema (2005) and Farrell (2007) seem to agree with the idea that fast and haphazard growth of information technology lacking direction and regulation provided an impetus for ICT policies as mentioned earlier. The second reason reported was a desire by the then Permanent Secretary (PS) in the then Ministry of Research, Technical Training and Technology (MRTTT) to develop national policy guidelines. This, as the Ministry expected, would steer the development of ICTs in the country in order to address the haphazard growth that was taking shape. The third factor was the readiness by the donor agency and in this case UNESCO to fund the policy making process.

Tanzania

This final reason for policy formation in Kenya could be equated to Tanzania's where the need to develop an ICT policy led to the formation of a grouping called the eThinkTank, a forum supported by the United Nations Development Program (UNDP). As reported in the ICT survey report by Twaakyondo et al. (2002, p. 5), the eThinkTank's stated objective was to "present the public and Government with ideas and suggestions to help the transition of the country into the information age". According to the report, one important objective of the eThinkTank was to help harmonise the current ICT Policy and regulatory environment with that of neighbouring states and partner countries. The consultative process culminated in the formulation of the national ICT policy in 2003. The policy aims at expanding and developing the teaching of ICT at all formal and informal levels of the national education system and using ICT to improve the quality of education and training in all areas including distance learning. The policy proposes to develop and deploy a nationwide e-education system that interconnects schools and higher education/training facilities across the country with each other. (Tanzania Ministry of Communications and Transport, 2003, pp.13-14).

Uganda

In Uganda, the national ICT policy development process was initiated in 1998 by the Uganda National Council of Science and Technology (UNCST) (Torach, Okello and Amuriach, 2006). Five years later in 2002 the UNCST submitted a draft national ICT policy framework to the cabinet which was approved the following year. The policy framework document recognised that Uganda would need to embrace the goal of lifelong education for all (Farrell, 2007).

Burundi

While Burundi's 1993 crisis[4] had a devastating effect on education and greatly exacerbated the underlying problems that existed before, an update of the 2004 ICT policy was adopted in 2007 by the Burundi government (Hare, 2007) specifically to promote the connection of ICT in the rural areas of the country (Novatech, Burundi Country Profile 2008). The national ICT for development policy was expected to focus on the adoption and use of ICT by the country to achieve its six strategic objectives (Hare, 2007), namely (1) capacity building; (2) enhancement of a legal and regulatory environment; (3) promotion of a base infrastructure; (4) promotion of good governance; (5) promotion and encouragement of private investment, and (6) promotion of the development of content and applications. However, the country has no specific policy for ICT use within the education sector, despite recognising it as an enabler of education. This means that ICT initiatives are not a core part of the government development plans, and therefore lack focus, resources and a nationalistic outlook (Hare, 2007b; Novatech, 2008).

Rwanda

Rwanda is a landlocked country with a painful history of conflict and one of the poorest nations of the world. The country accepted ICT as central to its Vision 2020 (Farrell, 2007) and is one of the core pillars of the country's National Information and Communications Infrastructure Policy and Plan, adopted in 2000. It is expected that the country will achieve middle-income status by 2020 based on an information-rich, knowledge-based society and economy, achieved by modernising its key sectors using ICT. This vision, developed through a national consultative process begun in 1998, was the reason for Rwanda's formulation of the ICT policy (Were, Rubagiza, Denley and Sutherland, 2007).

In summary, several commonalities can be deduced from the formation of these ICT policies in East Africa. First, the policies were formed at the turn of the millennium or the year 2000. Around this time, many countries were formulating ways in which to try and achieve the Millennium Development Goals (MDG). Secondly, although the reasons for the formation of these policies varied from one country to another, the bottom line was the intended eradication of poverty through the training of skilled manpower and provision of education in line with the Education for All (EFA) agenda. Thirdly, although the various governments were at the forefront in formation of these policies, the presence of donor agencies was strong, and was felt through their funding of these processes. Finally, although the formulation of these policies was comprehensive and articulate, the implementation, as reported elsewhere in this review, may not have been as impressive.

1.3 Overview of East African ICT in education policies: Content

Kenya

The Kenya National ICT policy was adopted in 2006 after several years of effort in trying to put it in place. The aim of the policy was to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services as reported in the ICT in Education options

[4] In 1993, Burundi's first democratically elected head of state was assassinated setting the scene for years of Hutu-Tutsi ethnic violence in which an estimated 300,000 people, most of them civilians, were killed. (BBC News: http://news.bbc.co.uk/2/hi/africa/country_profiles/1068873.stm#facts).

paper (Kenya. MoEST, 2005). Although the national ICT policy has several sections, objectives and strategies regarding ICT in education are spelt out in the information technology section. In this section, the objective regarding the use of ICT in schools, colleges, universities and other educational institutions to improve the quality of teaching and learning is spelt out as documented by Farrell in the *Survey of ICT in Africa Report* (2007). One important strategy outlined in this report is the promotion and development of specific e-learning resources that would address the educational needs of primary, secondary and tertiary institutions. A significant step in this direction is the digitisation of the curriculum which is ongoing at the Kenya Institute of Education (Ratemo, 2009). Under the subtitle 'E-learning', the ICT policy goes on to outline the strategies that will be used in the promotion and development of ICT in teaching and learning. Other strategies outlined in *The National Information & Communications Technology Strategy for Education and Training* (Kenya. MoE, 2006) include:

- Promote the development of e-learning resources;
- Facilitate public-private partnerships to mobilise resources in order to support e-learning initiatives;
- Promote the development of an integrated e-learning curriculum to support ICT in education;
- Promote distance education and virtual institutions, particularly in higher education and training;
- Promote the establishment of a national ICT centre of excellence;
- Provide affordable infrastructure to facilitate dissemination of knowledge and skills through e-learning platforms;
- Promote the development of content to address the educational needs of primary, secondary, and tertiary institutions;
- Create awareness of the opportunities offered by ICT as an educational tool to the education sector;
- Facilitate sharing of e-learning resources between institutions;
- Exploit e-learning opportunities to offer Kenyan education programmes for export
- Integrate e-learning resources with other existing resource.

These strategies seem to be dependent upon each other. For instance, whereas it was important to develop e-learning resources, it would be meaningless if there was lack of awareness, skilled personnel, facilities and public-private partnerships to support the e-learning initiatives.

Also, the development of the curriculum and training of teachers both at in-service and pre-service level may be central to the government's efforts of achieving the policy objectives. In an effort to promote the development of content that will address the educational needs of primary, secondary, and tertiary institutions, the government came up with two ways in which the curriculum will be developed (Kenya. MoEST ICT in Education options paper, 2005). One, by adapting existing educational materials and distributing them to the schools; and the second, by beginning the process of having schools create their own e-content. Besides, building capacity in Kenya to create instructional material for an increasing digital world is noted as an important aspect of the curriculum that is expected to pay dividends in improving the quality of education (ibid). In order to achieve this policy objective, the

Kenya Institute of Education (KIE) has been singled out as the sole government body charged with the responsibility of developing the ICT curriculum as well as distributing the educational material. KIE would also be in charge of overseeing other institutions that develop appropriate e-content (Farrell, 2007). Objective number 10 of the MoEST strategic plan (running from 2006 to 2011) targets strengthening the capacity of KIE to execute this mandate among others (Kenya. MoEST, 2006). This is a strong commitment in support of the National ICT policy.

Farrell (2007) asserts that while technicians can be employed to fix and maintain computers, teachers and educators must know how to exploit ICT for what it does best – opening learners up to the world of knowledge. The author also noted that investment into upgrading computer labs and building ICT capacity at the Teacher Training Colleges (TTCs) is an intervention which can quickly yield high returns. By providing adequate access to ICT, the TTCs can use it to achieve learning objectives at various levels. This point is also noted in the ICT in Education Options Paper (Kenya. MoEST, 2005) in which large-scale capacity building workshops for teachers have been suggested. The paper observes that teacher training should be built on existing structures that support quality ongoing professional development for teachers. The programme should be consistent with the workshops for lecturers and pre-service teachers at teacher training colleges. The paper further notes that the training of teachers should focus on increasing efficiency in the teachers' workload and integrating ICT to improve teaching and learning objectives.

Tanzania

The Tanzanian overall ICT policy mission is to enhance national economic growth and social progress through ICT in all sectors as seen in the National ICT Policy (Tanzania. Ministry of Communications and Transport, 2003). This policy recognised the potential for ICT to offer new opportunities to enhance education and to improve the quality of education in all areas. The Tanzania Ministry of Education having acknowledged this importance of ICT, presided over the formulation of a more specific policy to guide the integration of ICT in basic education (MoEVT, 2007). This policy was directed at achieving those aims of Tanzania's education policies and education development programmes which emphasise the acquisition and appropriate use of literary, social, scientific, vocational, technological, professional and other forms of knowledge, skills and understanding for the development and improvement of society.

In this policy basic education includes teacher education, secondary, primary and pre-primary, as well as non-formal and adult education. The policy, whose vision is to have "a well educated and learning knowledge society" [sic], hopes to achieve this by integrating ICT to enhance access, equity, quality and relevance of basic education, while stimulating and improving teaching and lifelong learning. The policy sets out eleven objectives:

- Promote the harmonisation of activities, approaches and standards in the educational uses of ICT;
- Ensure that there exists equitable access to ICT resources by students, teachers and administrators in all regions and types of educational institutions and offices;
- Ensure the proper management and maintenance of ICT resources and tools;
- Ensure the organised provision of ICT training to students, teachers and educational administrators;

- Facilitate the implementation of communication and information systems for the effective management of the education sector;
- Facilitate the use of ICT as a tool for assessment and evaluation of education, as well as administration and management;
- Encourage partnerships between the various stakeholders in the education sector;
- Facilitate the use of ICT resources in schools and colleges by the neighbouring community;
- Facilitate the development and use of ICT as a pedagogical tool for teaching and learning, and for the professional development of teachers, administrators and managers; and
- Promote development of local instructional content for basic education and other stakeholders that is closely aligned with curricular goals and objectives.

The comprehensibility of the policy is evident in the stated objectives in which it considers issues of infrastructure, curriculum and content, training and capacity development, planning procurement and administration, management, support and sustainability, and monitoring and evaluation (Hare, 2007). The Tanzania ICT Policy for Basic Education (Tanzania MoEVT, 2007) acknowledged that very few schools had access to ICT infrastructure, and those that did were primarily urban. The aim was to ensure the establishment of the necessary infrastructure to facilitate the adoption of ICT within the education system. This infrastructure includes access to computers and the Internet, digital equipment, telecommunications, radio and television. National coverage is envisaged by 2015. Implementation will involve a public-private partnership approach to the financing of ICT in education. Notable in the framework is the inclusion of an ICT curriculum for both primary and secondary schools. The Tanzania Institute of Education (TIE) is the body charged with the development of the ICT curriculum. The importance of ICT in assisting pedagogy is thus emphasised as the government of Tanzania grapples with infrastructure and ICT use.

Uganda

The birth of ICT policies in Uganda was thought to be in 1998 when a number of international organisations from USA, Norway, Germany, Ireland and Sweden approached the Uganda National Council for Science and Technology (UNCST) were given an opportunity to develop ICT policies based on different sectors (Uganda. MoES 2005: Draft Policy for ICT). According to the draft policy, the UNCST was a council mandated by the government of Uganda to coordinate, formulate and manage explicit national policies in respect to science and technology. The council was thus commissioned to oversee the integration of technology in the socioeconomic process and provide the government with appropriate technical advice. Makerere University was identified by the Swedish and Norwegian organisations to support the use of ICT in infrastructures and for human development. In 1999, UNESCO and UNCST agreed to initiate a process that would lead to the development of sectoral policies. The policy is based on the premise that ICT use is a key skill required for a rapidly increasing range of jobs, and developing good ICT skills in young people can help them find employment. Furthermore, the presence of a workforce with good ICT skills can help in attracting a growing industry and increasing employment. In other words, the policy states that the absence of ICT skills can be a barrier to development, and recognises that Uganda would need to embrace the goal of lifelong education for all (Farrell, 2007).

The ICT policy is based on four stated principles. First, it sets a framework of curriculum and teacher training that will facilitate and guide the development of ICT with the view to gaining the best advantage to the country as a whole. This is from the view that ICT policy cannot be implemented in one full swoop due to the financial constraints related to it. A step-by-step approach is thus implied in this principle. The second principle is the balancing of ICT applications and computer science. This suggests the provision of opportunities for the development of computer application skills to many people while at the same time providing ways of developing more technical skills to a smaller number of people who have a specific interest in the area. These people will be the personnel required to install and maintain equipment and networks. The third principle proposes that the key focus should not be on the provision of equipment but on the teachers, trainers, lecturers and on the curriculum that they are expected to follow. The final principle focuses on equity where the Ministry believes that access to ICT should be spread as equitably as possible: ICT should be equally accessible not only in urban and rural Uganda, but in private and public institutions as well.

Critical to the success of the ICT policy as mentioned in the draft policy is the co-ordination between the different strands outlined in the policy and cooperation between all the implementing bodies. For example, teachers have to be given training that matches the curriculum and should be offered before the ICTs are provided to schools and colleges. In addition, the training of trainers should also be carefully undertaken and should be of high quality. The trainers should, for example, be given opportunity to develop sufficient ICT skills themselves and appropriate methods for teaching ICT and should develop an awareness of the roles of ICT in their areas of specialisation to avoid focusing on generic skills. Moreover, the ICT curriculum design has been singled out as an important factor and should be made practical in providing relevant ICT skills and experiences. The draft policy also suggests a constant update to the curriculum design to keep up with rapidly changing technology and a periodic monitoring and evaluation of the ICT in education policy. Monitoring and evaluation will make sure that the policy remains responsive to the needs, aspirations and the dynamics of the global trends in ICT.

Notable debates and arguments have been made about whether students learn about, with or through ICT. The Uganda ICT policy, for example, recognises that the issues are not so much issues of having ICT as issues of what is done with ICT (Uganda. MoES Draft Policy, 2005). It further notes that strategies driven by equipment provision may easily result in underused technology. The draft policy thus suggests that the Ministry of Education should encourage the use of technology to support teaching either by production of teaching materials or by use of technology with students. The paper goes on to say that guidelines should be produced for schools to show how this can be done. The draft policy further observes that computer awareness should be introduced into the training of primary teachers on a phased basis, so that newly qualified teachers are equipped to make use of ICT as it becomes available. Besides, having acquired some ICT skills at the primary school level through pedagogy, the focus of ICT in the secondary sector for students centres on the provision of computer applications skills at ordinary level. This is expected to be executed through a subject called Computer Studies, taught in the schools that have sufficient equipment, and assessed at O level. The paper seems to suggest that the teacher training colleges should provide as many teachers as possible with computer awareness, basic skills, and enough experience to make use of ICT in lesson preparation and in making teaching materials. This will help improve the quality of secondary education, and also lay the foundations for future use of ICT within primary and secondary classrooms.

Rwanda

The Rwanda government identifies ICT as central to its achievement of Vision 2020 which looks towards the building of a modern and prosperous nation, strong and united, worthy and proud of fundamental principles as noted by its Minister for Education, Murenzi (2009). The Government of Rwanda in 2001 released the first National Information and Communications Infrastructure (NICI) plan which was an Integrated ICT-led Socio-Economic Development Policy and Plan for Rwanda aimed at development of ICT in the nation between 2001 and 2005 (Harrison, 2005). This phase of the NICI plan was completed in 2005, paving way for Phase 2 of the plan expected to end in 2010. The development of the plan for Phase 2 (NICI-2010) built on the achievements of Phase 1 and has ICT in education as one of its pillars among the ten sub-plans (ibid). The other nine sub-plans are: (1) human capacity development; (2) infrastructure, equipment and content; (3) economic development; (4) social development; (5) e-government and e-governance; (6) private sector development; (7) rural and community access; (8) legal, regulatory, and institutional provisions and standards; and (9) national security, law, and order (Farrell, 2007).

A number of action items or strategies have been identified by Farrell (2007) as set out in the education sub-plan of the NICI 2010. These are associated planned actions that include time frames, budget estimates, and expected benefits which are assigned to the Ministry of Education in collaboration with other agencies. Whereas some of these planned actions are new, others the author notes, are related to planned actions in the NICI 2005 and have been updated and revised. In the strategies, training is mentioned in two ways; that of primary and secondary school teachers on ICT in education, as well as training of a critical mass of computer literate teachers to oversee the implementation of ICT. To support this training, the policy sets out the establishment of a national library network and a regional information training and research institute to serve Rwanda and the sub-region. Also suggested is the development of a national computer curriculum for primary and secondary schools and coordination of its implementation.

Another strategy is the development of e-learning content; however, the policy suggests a translation of educational software into the local Kinyarwanda language so that it is appropriate for Rwanda. It suggests converting the existing computer-based training and e-learning content to Kinyarwanda too. Mentioned also is the development of programmes to promote the acquisition of computer equipment by educational institutions and a National SchoolNet that will help provide access to the internet for schools, facilitate sharing and learning resources and a comprehensive policy to regulate computer education. In addition, the SchoolNet programme is expected to link Rwandan schools with other schools internationally. Implementation of the Education Management Information System (EMIS) is also suggested for the purpose of enhancing the use of ICT in schools and colleges. To speed up the deployment and use of ICTs is the development of a national electronic distance education and training programme that will supplement and complement campus-based education at all levels. This should also facilitate lifelong learning and encourage in-service training both in public and private sectors. According to Farrell and Isaacs (2008), Rwanda is among few African countries to have developed a comprehensive ICT policy which is based on ten pillars aforementioned as subplans to the NICI plan. Finally, the policy sets out the development of special ICT-in-education initiatives for academic exchanges and twinning, implementation of the SMART schools concept where technology platforms are used for distance education, and penetration of ICT into rural schools (Farrell, 2007).

According to Were, Rubagiza, Denley and Sutherland (2007), the dearth in supply of computer equipment and accessories in many developing countries and in this case Rwanda, means there is a tendency of schools limiting themselves to teaching about ICT rather than teaching with or through it.

Indeed this assertion was earlier noted in the Kenya MoEST (2005) optional paper which observed that paramount to any discussions on technology should be improvement in educational outcomes, and this could be attained if ICT would be consciously used as a tool of instruction in schools. In their paper, Were et al. (2007) highlighted the use of ICT to support basic education in disadvantaged schools and communities. They noted that the Ministry of Education in Rwanda has a vision of fully integrating ICT within the curriculum, teaching it as a key subject that would also cut across mainstream subjects such as mathematics, science and history among others. Specific ICT applications would therefore have to be availed in the form of CD-ROMs, which could be used to teach and learn topics in the mainstream subjects.

Burundi

As quoted in the Burundi Country Profile 2008 (Novatech, 2008), infrastructure – particularly electricity and roads – have been the major threat to growth of the country's ICT sector. However, the report indicates that both bilateral and multilateral rehabilitation of the country's infrastructure are underway and that close cooperation between public and private sectors has been encouraged while identifying potential donor support for capacity building. Another notable point highlighted in the reports of Novatech (2008) and infoDev (Hare, 2007), is the country's lack of a specific policy for ICT use within the education sector despite recognising ICT as an enabler in increasing access and quality of education. According to the infoDev report, there is no documentation to indicate ICT use in public secondary schools. The infoDev report highlights several factors that hinder ICT use in Burundi; chief among them is the lack of an ICT in education policy which means that ICT initiatives are not mainstreamed in the government development plans and therefore lack focus, resources and a nationalistic outlook. The report also observes that availability and access to ICT is still a mirage due to the fact that a large percentage of the population live in the rural areas yet most of the infrastructure is based around the capital Bujumbura. Ironically, this available ICT is still elitist and hence costly to most people. In addition, there are the post war effects. During the war, families were displaced and children did not attend school. Indeed, schools were destroyed along with most of the infrastructure that would support ICT such as electricity and telephone. Therefore there was a need for the reconstruction of this infrastructure. According to the report, there is also lack of awareness, coupled with lack of trained teachers with ICT knowledge, which has contributed to the lack of interest and seeming lethargy related to adopting ICT in the classroom. In addition to these, ICT has not been identified as a priority area in education; hence the resources available are channelled towards the sector development programme, a large project dealing with more basic issues, such as the construction of classrooms and buying of textbooks (Hare, 2007).

Conclusion

Although there are several strategies outlined in the East African ICT policies, those touching on the curriculum and training of teachers in ICT skills and pedagogical application of ICT seem to have been singled out as basic to the implementation of ICT. It is interesting and encouraging to note how the governments of East Africa place emphasis on the teachers and on enhancement of their pedagogical skills. There is some recognition that merely providing equipment is insufficient to promote educational change and the policies point to a desire for a nationally coordinated effort in the creation, dissemination and sharing of e-learning content to improve the quality of teaching and learning in schools. Management and maintenance of the ICT infrastructure as well as use of ICT in school management (business processes) are also catered for in the policies. Teachers are expected to be the curriculum implementers in the classroom and it is expected that their sound knowledge on ICT and

how to use it in teaching and learning will not only go a long way in achieving this goal, but also improve the standards of education. However, while the ICT policies are indeed comprehensive statements of intention, the implementation of such ambitious intentions is a cause for concern. The following sections discuss the implementation strategies of ICT policies in East Africa.

Section 2

National government investment in ICT initiatives in primary and secondary schools in East Africa

Leonard Wamakote

Key words: *ICT, investment, policy implementation, East Africa, equity, infrastructure, human resource*

Introduction

This section presents an overview of national investment in ICT initiatives to support teaching and learning in primary and secondary schools in the five East African countries i.e. Uganda, Tanzania, Kenya, Rwanda and Burundi. For each of the countries, the review sets out the rationale before delineating the major investments recorded so far. An analysis is provided of the reported impact of these initiatives in each of the countries. At the end of the section, the review attempts to tie up the salient and common issues reviewed that are applicable to all five countries and also sets out the striking differences therein.

2.1 Uganda

Rationale

Before 2003, ICT investments in education were not guided by any agreed framework. Instead different schools led their own initiatives mainly funded on bilateral terms between the school and their donor(s). In 2003, a national ICT policy framework was put in place. Strategic Objective no.2 of this policy highlighted the need for literacy improvement and human resource capacity building. Among the strategies for attaining this objective was to integrate ICT in mainstream educational curricula as well as other literacy programmes and provide for equitable access by pupils and/or students at all levels (Uganda. Ministry of Works, 2003). Retrieved from this, an educational sector ICT policy was formulated in 2005 aimed at rationalising and harmonising ICT-related activities/programmes within the educational sector which were uncoordinated and fragmented (Uganda. MoES Draft ICT Policy, 2005). The policy also underscored investing in ICT in education right from primary to tertiary levels. ICT programmes had been initiated at secondary and tertiary institution level, though on a much-limited scale compared to the demand for such services. The role of government in partnership with the private providers of ICT is mentioned as being crucial in narrowing student/computer ratio deficiency (Uganda. MoES ESSPR, 2007).

In summary, government investment in ICT in primary and secondary schools in Uganda has been guided by a policy that defines variable focus at different levels. At primary school level, the policy aims at encouraging those schools that have acquired the technology to use it to support teaching, either by producing teaching materials or by use of the technology with students. This is in addition to introduction of computer awareness programmes at primary teacher-training level to enable newly

qualified teachers to get equipped to make use of ICT as it becomes available. At secondary level, the policy advocates for a more direct government role aimed at ensuring that teachers are equipped to make use of ICT in their lesson preparation and to use it in their teaching. Additionally, a specific subject based on ICT applications has been provided for schools that have sufficient equipment. The policy recognises the need to mitigate the likely expansion of a digital divide between wealthy urban schools and poor rural schools. To this effect, the strategy proposes the provision of a limited amount of equipment targeted at a small number of poor rural schools depending on resource availability (Uganda MoES, 2005).

Level of investment

The Ugandan government's most significant ICT investment in the educational sector is the Education Management Information System (EMIS) which aims at providing quality education statistics in a timely, cost-effective and sustainable manner. This is done through data capture on school facilities and pupil details which is coordinated at the district level and uploaded to the system for national compilation and processing. Districts have been equipped with internet-connected computers and associated peripherals and officials trained in their use (Uganda. MoES Draft ICT Policy, 2005). Unfortunately, the Ministry suspended plans to network all districts and the centre to enable real-time information flow from districts to the Ministry of Education and Sports headquarters and vice versa. Districts are therefore unable to make real-time comparative analysis among them (Uganda. MoES Revised Draft ICT Policy, 2006).

The MoES has also supported other ICT initiatives in partnership with other agencies. Notable among these are SchoolNet, the Microsoft Partners in Learning Program, Connect-ED, Curriculum Net, NEPAD e-schools initiative, Cyber-schools technology solutions (CSTS) program and Computers for Schools – Uganda. The Easy learning project has reportedly stalled (Uganda. MoES Internal Report on ICT, 2009). These initiatives have focused on equipping of schools with computers and associated hardware / software, provision of internet connectivity, training of teachers and teacher educators in ICT, and the development / selection of digitised pedagogical content. A description of the scope and targets of each of these initiatives is given in Appendix A. Some such as the Microsoft Partners in Learning Program are quite ambitious; this initiative has already equipped 100 schools with donated PCs and the plan is to have all (8000) secondary schools equipped with computers and training modules by the end of 2015.

Information on the actual impact of these initiatives is scanty though. A 2002 preliminary baseline study on the status of ICT in Uganda (UNCST, 2002) indicated computer availability in the education sector in sampled districts in Uganda to have ranged from 0 to 27 in number per (entire) district. When compared against the reported supply by MoES in the subsequent years, one notices a remarkable leap. In the financial year 2007/08 alone, more than 2800 computers, both new and refurbished, were supplied to (mainly) secondary schools in the country under different funding arrangements[5] (Uganda. MoES ESSPR, 2008). This has clearly improved the student: computer ratios dramatically, although no

[5] 800 computers to 80 secondary schools (Uganda Communications Communication support); 220 computers to 100 secondary schools (through Cyber School technology Solutions); 100 computers to 10 rural schools (Uganda Communications Commission – Rural Communications Development Fund); 24 computers to 2 schools including digital satellite television connectivity to each (NEPAD). 281 refurbished computers to 57 primary schools, 922 computers to 124 secondary schools and 257 computers to 39 vocational training institutions (Uganda Connect Program). 200 refurbished computers to selected secondary schools (under Computer for Schools Uganda). Source: ESSPR (2008).

actual national statistic on this was found. A recent study of selected schools in the country showed student:computer ratios ranging from 40:1 to 160:1 in primary schools and 20-30:1 in secondary schools (Ndidde et al., 2009). This is far from representative, however, because only a few schools (5 primary and 4 secondary), all located in or near the capital city, were used in the study. In the same study, it was found that the availability of ICT had impacted on educators in a limited though notable way. This was recorded in the areas of lesson planning, in class teaching, evaluation methods, teacher/learner communication and reflection on teaching (ibid).

No data was found to establish the extent to which the noble objective by the MoES of reducing the digital divide between urban-rich and rural-poor schools had been achieved. Likewise, the issue of equitable access to ICT especially for both girls and boys and for learners with disabilities could not be verified.

To conclude, it is important to appreciate that the Government of Uganda through the Ministry of Education and Sports has in place an ICT in education policy which guides the implementation of programmes in schools. Most investments in ICT in schools are implemented by local and international NGOs with funding from a wide range of development partners. The MoES plays a coordinating role in all these projects. There is evidence of improved supply of ICT equipment to schools although no national figures were available to gauge the actual impact of these initiatives in terms of student-computer ratios and application of ICT to teaching and learning. Although equitable access is mentioned as a guiding principle in the draft ICT policy, this reviewer found no data to confirm the reduction of the digital divide between rich-urban and poor-rural schools, nor were specific investments in ICT for pupils with disabilities documented. The Ugandan situation is aptly summarised in a status report on ICTs in higher education in Uganda:

> To many teachers and students in Uganda, the computer and the Internet are still a mystery. This situation is even worse in the rural areas, where the majority of Ugandans (about 80 per cent) live without electricity and connectivity to the global information network. These communities are unable to reap the numerous benefits of ICT – (CET, 2007, p.150).

2.2 Kenya

Rationale

A national ICT policy for Kenya was adopted in January 2006 after many failed attempts in preceding years (Waema, 2005; Kariuki, 2009) as noted in Section 1. The policy is based on four guiding principles: infrastructure development, human resource development, stakeholder participation and appropriate policy and regulatory framework. On human resource development, the policy underscores the need to strengthen and streamline ICT training through (among others):

- Promoting ICT in education at primary, secondary, tertiary and community levels by developing ICT curricula and ensuring that teachers/trainers possess the requisite skills;
- Setting up a framework for evaluating and certifying ICT training programmes. (Kenya. Ministry of Information and Communications, 2006).

The policy further lays the framework for e-learning considered crucial to its development and utilisation. Need is expressed to provide affordable infrastructure to facilitate dissemination of knowledge and skill through e-learning platforms; and to promote the development of content to

address the educational needs of primary, secondary and tertiary institutions. The e-learning framework further seeks to facilitate sharing of e-learning resources between institutions and to exploit e-learning opportunities to offer Kenyan education programmes for export (ibid., 2006). The realisation of these intentions is expressed in the national ICT strategy for education and training, the policy document for ICT in education (Kenya. MoE, 2006). These include, among others, (1) equipping education institutions with digital equipment to stimulate integration of ICT in education and (2) supporting initiatives that provide digital equipment to educational institutions, with priority to secondary and primary schools. The expected outcome of these measures was to improve equipping of educational institutions with digital infrastructure up to 80% in secondary schools and up to at least 10% in primary schools. The average access was expected to improve from the prevailing one computer for 150 students to one computer for at least 50 students in secondary schools. The strategy also underscored the need for access and equity by establishing mechanisms to support infrastructural development in remote areas, implementation of policy provisions that are favorable to special needs groups, and making budgetary provisions for adequate supply of ICT equipment and facilities (Kenya. MoE, 2006).

Level of investment

The level of investment in ICT in education in Kenya reflects the recognition in the national ICT policy of the need for Public-Private Partnership (PPP) in addressing key development challenges in the country. An ICT unit has been established at the Ministry's Head office to ensure systematic efforts are made towards strengthening adoption and use of ICT in the education sector in general (Wambui and Barasa, 2007). In this respect, the Government of Kenya, through the Ministry of Education, Science and Technology (MoEST) plays a coordinating, overseer and mobilisation role in bringing together key stakeholders in the ICT in education sector (Farrell, 2007).

A main component of this implementation strategy is achieved through the Kenya ICT Trust Fund. Kenya ICT Trust Fund is a registered consortium in the form of an NGO in Kenya that brings together many partners from the public, private and civil society sectors. It is chaired by the Permanent Secretary of the Ministry of Education. Its main objective is to mobilise funds for the sole purpose of setting up computer laboratories in all Kenyan secondary schools in 4-5 years (CCK, 2005). Information on achievements of the fund so far was not readily available (the link to its website is non-functional). However, one of the partners – Microsoft Partners in Learning – reported having delivered a 5-day training course to over 500 secondary school teachers, and also helped organise and direct over $80,000 worth of contributions from Trust Fund members, including donated computers (Microsoft, 2006). It must be noted here that coordination efforts should be widely publicised for intending partners to see what has been achieved and what remains. This is necessary for improving transparency to encourage future participation, sharing of experiences learnt and best practices and for minimising likely duplication of efforts.

A number of initiatives have delivered ICT infrastructure to schools, mainly at secondary level. (Not much is documented about ICT infrastructure in primary schools.) These include initiatives supported by parents, the government, NGOs, or other development agencies and the private sector (Farrel, 2007). Notable among these are EMIS, Computers for schools – Kenya, NEPAD e-schools initiative, and the Microsoft Partners in Learning program (Microsoft, 2007). A description of the scope and targets of these initiatives is given in Appendix B and some further information appears in Section 3. Other initiatives worth noting include Network Initiative for Computers in Schools (NICE) which coordinates member activities related to computer equipment sourcing, refurbishment, distribution,

installation, training, maintenance, networking, connectivity and use of ICT as a tool within the formal and informal sectors (Wambui and Barasa, 2007).

A recent survey of 56 nationally spread (but purposefully selected) schools in Kenya having computers showed that 59% of the schools had received the computers through government and NGO donations, while 54% and 18% had been acquired from school funds or received from the CFSK (Computers for Schools- Kenya) initiative respectively. The Parent-Teacher Associations and individual students had contributed to 16% and 7% respectively[6] (Oloo, 2009). This provides evidence of the public-private-partnership in investment in the ICT sector in education.

This reviewer did not find sources with sufficient current statistics depicting the national impact of these initiatives so far. A few studies found in the literature were referring to the pre-2005 period which could be misleading; especially since the guiding national policies were formulated after then (see Obura, Musili & Etta (2005), Wafula & Wanjohi (2005), Farrell (2007) for examples). A recent study on the pedagogical integration of ICTs in education in Kenya (PanAf, 2009) reported a computer: student ratio of 1:24 with only 38% of these having internet connectivity. This figure cannot be taken to be representative of the situation in the entire country, though, because the study included just a few selected schools, all of which were already utilising computers.

A quarterly financial monitoring report of the Kenya Education Sector Support Programme for the period April – June 2008 (Kenya. MoE, 2008) reported achievements in establishment of the EMIS but mentioned that it was not yet web-based, leading to limitations in access and updating. As an example of this limitation, data from districts obtained two years earlier had not been migrated to the national platform in all except two of over 70 districts. This is far behind the initial objective of EMIS which was to "harmonise and integrate information systems to support timely collection, processing, dissemination, and use of education data for management to identify necessary interventions to achieve relevant and quality education" (Kenya. Ministry of Education Science and Technology, 2005, p. 75). On ICT infrastructure and software development, the Kenya Education Sector Support Programme (Kenya, MoE, 2008) report mentioned the acquisition of Microsoft software licenses for schools but indicated that funds were not available for renewal of these licenses. The survey reported by Oloo (op. cit.) found an average of 21 computers per school in the 56 purposefully sampled[7] schools; giving an average of 1 PC to 21 students[8]. 20 of these schools, however, were still using some old models which had been received as donations more than 5 years earlier and were evidently obsolete. This is an indication that a share of the 50 million metric tones of e-waste estimated by the United Nations Environmental program (UNEP) to be generated globally every year, could be ending up in schools. Moreover, a majority of the surveyed schools (59%) did not have internet connection. These statistics point to low access to ICT facilities in schools in Kenya and low utility of the equipment for educational purposes where available.

However, Kenya government efforts towards improving access to ICT have not been without hitches. A Sh1.3 billion plan to introduce mobile computer laboratories in public schools is yet to take off even after a budgetary allocation due to what the Permanent Secretary in the Ministry of Information and

[6] The total percentage as reported exceeds 100%, probably because one school could have computers from more than one source.

[7] The school had to have some computers to qualify for this sample.

[8] The ratio was calculated basing on a presumed pupil enrolment of 500 per school, even though the report acknowledges that the typical enrolment ranged from 400 to 1200.

Technology has termed as interference by the politicians (Ayodo, 2009). The move was meant to provide one mobile digital laboratory – for use by secondary schools – per constituency represented in parliament. Currently Kenya has 210 constituencies (Kenya. Ministry of Finance, 2009). This was part of a larger Economic Stimulus Programme (ESP) under the 2009/2010 budget which is geared towards supporting the country's Vision 2030 plan.

In conclusion, it is clear that investments in ICT in education in Kenya are guided by a National ICT Strategy for Education and Training document which is derived from the national policy. Although it took a long time (until 2006) for Kenya to adopt these policies, investments in ICT in education have been in existence since the early 1990s, led by NGOs and individual schools. The Ministry of Education (formerly with Science and Technology) co-ordinates all these initiatives mainly through headship of participating consortia. There is clear evidence of public-private partnership in ICT investments in education, especially in the delivery of computer hardware and software to schools, but no clear national statistics of the impact of these initiatives was found. A statement from a recent survey report aptly summarises this situation:

> During this survey it was clear that majority of teachers where ill equipped to effectively integrate ICT in classroom. The main challenge for teachers interviewed was lack of adequate number of computers, educational applications, training, policy and strategy on how integration should be done. (Oloo, 2009, p. 3)

2.3 Tanzania

Rationale

The Tanzanian Government National ICT Policy published in 2003 details a set of objectives related to the development and application of ICT in education and training. Among these and of direct bearing to primary and secondary education are to:

- Expand and develop the teaching of ICT at all levels of the national system of formal and informal education and training;
- Use ICT to improve the quality of education and training in all areas including distance learning, as well as to enhance the learning experience itself;
- Develop and deploy a nationwide e-education system that supports schools, higher education/training facilities across the country by interconnecting them with each other and with relevant knowledge centres, providing curriculum integration while also generating information to better shape policies, strategic plans and tactical decisions for developing education and vocational training in Tanzania. (Tanzania. Ministry of Communications and Transport, 2003, pp. 13-14).

Based partly on the above national policy and after a series of national consultative sessions, the Ministry of Education and Vocational Training (MoEVT) came up with the ICT policy for Basic Education (Tanzania. MoEVT, 2007). This policy acknowledged that very few (mainly urban) schools had access to ICT infrastructure and set out to ensure the establishment of the necessary infrastructure to facilitate the adoption of ICT within the education system (from computers, digital equipment, telecommunications, and internet access to radio and TV) in a phased rollout targeting national coverage by 2015. This is to be implemented by adoption of a partnership approach to the financing of

ICT in education. Notable in the ICT in education implementation framework is the inclusion of an ICT curriculum for both primary and secondary schools.

Level of investment

Similar to the other East African countries, the investment landscape of ICT in Tanzania is best viewed through the different ICT initiatives that have been introduced in the country. Notable among these are the Education Management Information System (EMIS), e-schools program, ICT implementation in teachers' colleges, and the Computers for Schools project (Hare, 2007). A description of the scope and targets of each of these initiatives is given in Appendix C. Only those initiatives with direct linkage to primary or secondary school education are included.

The EMIS is a national project planned to provide educational data in six categories: 1) baseline education statistics and demographics, 2) human resource information, 3) infrastructure and assets, 4) school performance, 5) financial management information, and 6) documents such as research and field reports, policies etc. (Tanzania. MoEC, 2004). If the data available from links on the MoEVT website[9] are used as an assessment of the achievement of the above intentions, it is evident that numbers 1, 4, and 6 have been achieved to a large extent, while evidence for the other three remains thin. In particular, it is not possible to obtain data from the site on the current portifolio of ICT infrastructure in schools in the country.

Distinct from its other East African neighbours, the government of Tanzania has invested in the development of a curriculum for ICT in primary schools although its diffusion is still very limited to a few urban schools. To support this program, the MoEVT has partnered with donor agencies to support an ICT programme in teacher training colleges. All the 32 colleges were equipped with computers and the tutors in the colleges given ICT training leading to the International Computer Driving Licence (ICDL) qualification (Tanzania. MoEVT, 2007). Whether this strategy will have the desired multiplier impact on the adoption of ICTs in primary schools remains to be seen.

In conclusion, there is a direct involvement of the government in Tanzania through a consortium of stakeholders to ensure placement of ICT infrastructure in secondary schools. This is being augmented by efforts from the private sector and NGOs. At the primary school level, other than development of the curriculum (which has witnessed very limited adoption), there is not much documented government investment. The main investment here is targeted at teacher training colleges, where it is hoped the trainees can later use their acquired skills in ICT to implement the ICT curriculum in primary schools. Although an EMIS is in place and so a lot of current school demographical data is available, it is still not possible to obtain data on ICT infrastructure levels in schools. This, coupled with the lack of recent studies to assess the impact of ICT investment to the quality of teaching in schools, makes it difficult to draw an accurate picture of ICT use in the schools of Tanzania.

2.4 Rwanda

Rationale

As noted in Section 1 of this review, the government of Rwanda adopted a national ICT policy in 2000, much earlier than any of the other East African countries. The policy is being implemented in 5-year planned phases referred to as the National Information and Communications Infrastructure (NICI)

[9] http://www.moe.go.tz/index.html

plans. Phase 1 began in 2001 and concluded in 2005, while Phase 2 covers the period from 2006-2010 (Rwanda. UNECA, 2006). These plans are based on the relevant vision for Rwanda (VfR) mission strategies which in the case of ICT are to:

- Transform Rwanda into an ICT-literate nation;
- Transform the educational system using ICT with the aim of improving accessibility, quality and relevance to the development needs of Rwanda;
- Improve the human resource development capacity of Rwanda to meet the changing demands of the economy.

The NICI plan has clearly elaborated activity plans relating to the integration of ICT in education. In the NICI-2010 plan, seven policy action items relating to ICT in education are elaborated. Three of these have direct bearing on primary and secondary education: (1) use of ICTs for formal education, (2) improvement of formal education in ICT, and (3) helping educational institutions improve their business processes. All the planned actions to achieve these goals are clearly laid out with specific timelines. It is not surprising therefore that Rwanda has recorded a dramatic rise in ICT usage in schools. Farrell (2007) reported a growth rate from only one school with a computer in the whole country in the year 2000 to more than half of the primary and secondary schools being equipped with ICT hardware 6 years later; and the rollout still continuing.

Level of investment

The level of investment in ICT in education is high, reflective of the deliberate prioritisation of the sector by government. The ministry of education (with development partners in some instances) is implementing several initiatives in line with the NICI plans mentioned above. Activities indicated in the NICI–2010 plan (Rwanda. UNECA 2006) are:

- Training of primary and secondary school teachers on teaching with or use of ICT;
- The scholarship management programme;
- The Rwanda national Library network;
- Development of new e-learning content;
- Implementation of the Education Management Information System (EMIS);
- Carrying out a survey of educational software for potential use in formal and informal ICT training programmes;
- Conversion of existing Computer-Based Training and e-Learning Content to Kinyarwanda (NICI, 2010).

Other plans which were rolled over from the previous NICI plan and are of direct relevance to ICT implementation in primary and secondary schools are:

- Program to promote the acquisition of computer equipment by educational institutions - Computers in Schools – “Operation ICT Knowledge for the Youth” program; This has now been absorbed by the “one laptop per child” (OLPC) programme which aims at

- The National SchoolNet Project;
- National public awareness program targeted at promoting the vision for Rwanda (VfR) to transform Rwanda into a middle-income, information-rich and knowledge-based society and economy;
- An initiative to develop a national computer curriculum for primary and secondary schools and coordinate computer education in Rwandan schools;
- Program to train a critical mass of computer literacy teachers;
- Special ICT in education programs and initiatives.

In conclusion, Rwanda has a well laid out and detailed plan for the integration of ICT in education whose implementation has caused a dramatic increment in the availability of ICT in secondary and primary schools. There is evidence of increased direct government investments in ICTs in education to complement donor programmes. If the accelerated rollout of ICT in Rwandan schools continues unabated, the problem of access to ICT in schools will soon be forgotten. What is needed is to continuously monitor the pedagogical impact of these investments.

2.5 Burundi

Rationale

The effect of civil strife has had its toll on the development of Burundi as a whole and the ICT in education sector has not been spared either. A national ICT policy was adopted in February 2007, in order to especially promote the connection in rural areas of the country, but its implementation is still hampered by war and post-war resettlement issues (Hare, 2007). There is no specific policy in place to guide the development of ICT in education.

Level of investment

This reviewer did not come across any sources documenting public investment in ICT in education in Burundi. It is highly probable that the situation described by Hare (2007) still prevails:

> There is no documentation indicating that there is any use of ICT in the national public school system currently. However, there are a number of privately owned secondary schools that teach basic computer lessons for productivity applications such as word processing and spreadsheets. Computers are also used for administrative purposes, but not for learning and teaching. (Hare, 2007, p. 5).

In 2007 there were an estimated 14,000 internet users in Burundi and over 80,000 mobile phones among its 7 million inhabitants, however by 2009 there were 65,000 internet users.[10]

In conclusion, it is not possible to draw up an accurate picture about government investments in education in Burundi in the absence of published documentation. (The official government website[11] [in French] had no information.) It is evident that the country is still struggling with post-war re-settlement effort and efforts in education are still being directed at building basic infrastructure like classrooms and teacher accommodation (World Bank, 2007).

Conclusion: An overall picture of government investment in ICT in East Africa

This section has summarised the investments made by the governments in East Africa in ICT within the education sector, with a focus on primary and secondary education. All of the five countries have developed a national ICT strategy at different times, ranging from the year 2000 (Rwanda) to 2007 (Burundi). With the exception of Burundi, the countries have developed an educational ICT policy which is guiding the investments in ICT in education. It is evident that levels of government investment have increased after the adoption of the specific ICT in education policies.

In the three countries forming the initial East African Community (EAC), the role of government is mainly a coordinating one – bringing together different donors under consortia directed by the government. Rwanda, which joined the EAC later, has seen much more direct government investment in ICT in education from the national budget. Burundi, also a later member of EAC, did not have evidence of direct government investment. The other four countries all have operational education management information systems (EMIS), from which basic biographical school data (at least) can be obtained. However, currency of the data is still hampered by the non-connectivity of the districts which serve as the primary data collection centres. The EMISs are currently being used for collection and analysis of predominantly demographic school data in ways that limit application. Information on the levels of investments in ICT in schools, for example, was not readily available from the respective education ministries. Such information is useful in monitoring the progress of ICT integration in schools. There is need for research on the optimal use of EMISs for prompt provision of such information. It would be a useful addition if these systems were used to collect data on ICT infrastructure and usage as well as the integration of ICT in the school systems, a key objective in the national policies.

In the absence of such data, it is not possible to establish accurate trends depicting the impact of government investment in ICT in education; reducing pupil-computer ratios for example. It is also difficult to draw a clear distinction between government and donor investments in the education sector as donor support has taken various forms ranging from budgetary support at macro level to direct provision of ICT equipment and infrastructure in schools. Whichever the case, it can be concluded that the elaboration of clear policies and strategies on the integration of ICT in education has led to increased government investments in all but one of the EAC countries. However, it is immensely important to have efficient mechanisms to monitor such actions to ensure that the high cost of educational ICT investments pays off in the form of improved and increased educational opportunities for the citizens.

[10] http://www.internetworldstats.com/stats1.htm
[11] http://www.burundi-gov.bi/

Section 3

Key past and current initiatives supporting the use of ICT in schools in Sub-Saharan African countries

Brown Onguko and Sara Hennessy

Key words: *ICT, education, integration, policy initiatives, implementation, public-private, access, e-learning, teacher professional development, monitoring and evaluation*

Introduction

This section presents a review of some of the initiatives on the use of ICTs in schools in East Africa (see further details of these in Appendices), including lessons learned and issues raised by wider "ICT4Development" initiatives implemented in African Commonwealth countries more generally. The aim is to understand the basis of the initiatives, the nature of their providers, and their outcomes where information is available. Assessment of the long-term impact of ICT initiatives on the teaching/learning process and outcomes requires longitudinal study design (Farrell et al., 2007) that is often not possible within funding constraints. Moreover, we acknowledge the futility of trying to isolate and measure the "impact" of ICT use on learning; the primary educational aim is instead to embed ICT use in the learning environment as a medium or form of support.

3.1 ICT initiatives

3.1.1 Government-led initiatives in some SSA countries

Most Sub-Saharan African (SSA) countries of the Commonwealth have to some extent developed their national ICT policies. These policies provide the foundation upon which ICT both at the national level and at the educational sector level is set. Before focusing on East Africa we raise some pertinent issues derived from initiatives implemented in SSA countries. There is an overarching problem of variable education across different sectors of schooling within a country (and sometimes between urban/rural areas) and the need to ensure that this is consistent. A survey supported by infoDev as reported by Isaacs (2007) reveals for instance that, within the education sector in Botswana all junior and senior secondary schools have fully equipped computer laboratories. However, many schools are struggling with their effective use, and government-led initiatives (see Appendices for details of initiatives in three East African countries, for example) seem to mainly emphasise capacity building for teachers – both in initial and in-service teacher education pertaining to ICT use. There is therefore a clear gap in the primary school sector in terms of both provision of ICT resources and teacher development.

One initiative of interest is the Botswana College of Distance and Open Learning (BOCODOL). This college provides a unique blend of e-learning programmes for students at the level of secondary schools. The curriculum is the same as that offered in secondary schools and is examined by the same examinations body. The college justifies the need for e-learning by stating that it can be carried out anywhere a learner has a computer or any communication-enabled electronic device, an internet connection (physical or wireless) and can address needs that occur anytime. The college uses the open

source software, Moodle, as its content management system while incorporating a wide variety of formats including text, graphics, quizzes, audio and video components communicated via the internet, CD Rom or other electronic forms of communication including mobile phones (BOCODOL, 2009). It is not, however, clear from the college website why it was found necessary to deliver school equivalency programmes at the college.

Another challenge arises in the context of projects to provide computer equipment in schools without paying heed to infrastructure and other constraints operating against its use. In the Gambia, for example, the Ministry of Education in conjunction with the World Bank equipped half of the state secondary schools with state-of-the art networked computer labs, but internet access remained a major obstacle to using these to their full potential (Mangesi, 2007). Similar challenges in terms of inconsistent connectivity, high costs and low connectivity speed are Africa-wide problems, as we elaborate in Section 4. Mangesi further argues that where ICTs and internet access do exist in schools, a number of teachers use the internet for research, so the benefits for classroom teaching and learning are increased.

Mangesi describes a large number of other, wide-ranging and innovative ICT initiatives in Ghana (see Appendix 1), including equipping schools with ICT, networking amongst schools, schemes awarding teachers who excel in using ICT, capacity building for teachers, and e-mail communication between students and teachers. If sustained these could lead to advanced use of ICT in schools. There is also a Computer Literacy Programme for training school teachers and principals on keyboarding, word processing, basic troubleshooting and maintenance. Similarly, the forward-thinking Gambia HELP Computer Project focused on not only building computer labs but also teaching a key group of students and staff at each school the skills necessary to keep the labs up and running. However, many initiatives in other countries have failed owing to a more short-sighted planning as equipment is rapidly abandoned when it breaks down and there is a lack of funds and expertise to repair it.

In Ghana, there is a policy and plan to put the school curriculum onto CD in order to facilitate access to it across the country without having to distribute it as a bulky printed document, although it was not yet on CD by the time the survey supported by infoDev was done (Mangesi, 2007). (By the time of compiling this review, it was not possible to confirm whether the curriculum was finally released on CD as the official Ministry of Education and Sports website consistently returned a message informing visitors that the account domain had been suspended). The Presidential Special Initiative on Distance Learning in Ghana has been more successful, however, in broadcasting nationwide educational television programmes in Mathematics, Science and English and marketing them in CD format. This strategy could be very effective in overcoming internet access difficulties in other developing contexts as the materials can be reproduced at low cost and accessed on stand-alone computers.

Mauritius is another country at the forefront of digital development and is worth a mention. ICT initiatives there are modelled on the Singaporean experience as a “cyber island” and focus on becoming a hub within the Southern Africa region with a substantial segment of its ICT policy being dedicated to education. In 2006, Mauritius approved the Universal ICT Education Programme (UIEP) which aimed at providing hardware, internet connectivity and computer proficiency skills to students and other target groups through ICT skills courses in 59 training centres located within schools across the country (Isaacs, 2007). Significantly, the programme target was to train all the 5400 primary school teachers to be able to use ICT as a pedagogical tool by 2006. The need for this kind of training in order to make classroom use of new technologies effective is often unrecognised in both developed and developing countries, as we explore further in Section 6.

Namibia's policy on ICT in education is fairly well developed as well. Its implementation in all Namibian educational institutions is coordinated by the Global eSchools and Communities Initiative (GeSCI) formed by a UN task force on ICT, and by the National Educational Technology Services and Support Centre (NETSS) set up to oversee the sourcing, refurbishment, installation and support of ICT (Isaacs, 2007).

By contrast, Sierra Leone, a country still recovering from civil war of the 1990s (Mangesi, 2007) and Swaziland, a small landlocked, drought stricken and deeply impoverished country (Isaacs, 2007) do not have strong ICT initiatives or policies for schools. It would, however, be of interest to establish the current situation since the surveys were carried out 2 years ago. Likewise the penetration level of ICT in Zambia's education institutions remains low with schools that are mostly using secondhand and refurbished computers (Isaacs, 2007). The integration of ICT into learning and teaching has been limited although the introduction of computer studies as a subject has somewhat changed the scenario here. (Further information about Zambia is offered in the next section, as public-private partnerships have been stronger there than government-funded initiatives.)

Further insights can be derived from prominent academic research programmes, such as the Digital Education Enhancement Programme (DEEP) Project, carried out by the Open University and commissioned by the UK Department for International Development (DFID), and the ongoing PanAfrican Research Agenda on the Pedagogical Integration of ICTs[12], known as PanAf, funded by a Canadian government organisation, the International Development Research Centre (IDRC). These are discussed later in the section.

3.1.2 Government-led initiatives in East Africa

Kenya

Turning to the East African countries now, the ICT survey reported by Farrell (2007) revealed that Kenya recognises the importance of ICT in education which is manifested through the promulgation of the national ICT strategy in education and training. Farrell further pointed out that the Ministry of Education supports the implementation of the strategy either directly or through various institutions involved. Among a series of ICT initiatives identified in the survey for Kenya (apart from the NEPAD e-Schools Initiative already mentioned) were the following:

- Establishment of the learning resource centre that offers training in educational management and integration of ICT for school managers, lecturers, and students at the Kenya Technical Teachers College;
- An MoE project "ICT equipment for schools" purchased computers for 142 schools in support of the ICT in Education Strategy;
- Development of learning content focusing on digitisation of curriculum content for schools at the Kenya Institute of Education;
- Central and Regional Support Centres provide immediate solutions on ICT issues to schools via telephone or online inquiries;
- Kenya Education Network Trust (KENET), currently funded by the Kenyan Ministry of Education and the ICT Trust, established permanent high-speed internet infrastructure in 22

[12] http://www.idrc.ca/en/ev-116195-201-1-DO_TOPIC.html

- School Broadcasting - following a successful one-year pilot, there was a plan to revive Kenya's nationwide school broadcast service, using WorldSpace technology to broadcast educational content to 11 million students in 18,000 primary and 3,000 secondary schools by the end of 2006;
- Free Software Licenses providing free access to Microsoft Corporation's operating software for schools and higher education institutions in order to reduce the cost of buying and using computers. The company was to work with the organisations involved in supplying computers to the institutions to install the software on the machines (Farrell, 2007).
- Efforts have been made in integrating ICT (and EMIS) in educational managers' training which is offered by the Kenya Educational Staff Institute (KESI). This effort seems to augment the NEPAD e-school initiative which also targets providing school managers with ICT skills so as to facilitate efficient management and administration in the schools.

Kenya, like Ghana, presents a large number of diverse kinds of ICT initiatives in schools. The involvement of different players under the umbrella of the Ministry of Education, if well implemented, could lead to more sustained use of ICT in schools in the long run. The financial monitoring report of the Kenya Education Sector Support programme for the period April to August 2008 included reports on ongoing initiatives in Kenya indicating that a stocktaking process of ICT initiatives on ICT integration in schools and e-readiness was ongoing and would culminate in a report and development of a website. The other outcome was preparation for standards and guidelines for ICT in education (Kenya. MoE, 2008). The reports of these initiatives could not however be accessed and not much could be found on the Ministry's website which appeared to be under construction.

In the *Survey of ICT and Education in Africa: Kenya Country Report* (Farrell, 2007) it has been observed that high levels of poverty, limited rural electrification, and frequent power disruptions result in limited access to ICT in secondary schools. This could also be said of primary schools where the large number of students enrolled poses an additional challenge to ICT access. As observed from the survey, some secondary schools have computers but these are only limited to administrative purposes and only few ICT tools are availed for teachers and students. However, the Interactive Radio Instruction has proved to be the most widely used form of ICT, which provides an intensive half hour each day of high quality instruction of a kind that teachers by themselves simply cannot offer (Kenya. MoE, 2005). These obstacles to policy implementation are further explored in Section 4.

Rwanda

Rwanda has strong government support for ICT development, and this has increased dramatically over the last decade as pointed out in Section 2. In 2000, only one school had a computer, while 6 years later, as the infoDev survey on ICT reported, over half of the country's primary and secondary schools had been equipped with computers. At the same time, over 2000 teachers had been trained in ICT (Farrell, 2007). A number of other projects have been reported in Rwanda such as:

- ICT training in basic skills for 3,000 secondary school teachers carried out in partnership with Microsoft Partners in Learning (PIL) using a trainer-of-trainers model. This project is funded by the Ministry of Education;
- Further, in-depth ICT training for 1,000 secondary school teachers. The objective was to follow on from the basic skills training to train two teachers per school with higher-level skills such as troubleshooting and fault finding. These teachers are expected to train other teachers in the schools. This project was again funded by the Ministry of Education (Farrell, 2007).

The above initiatives indicate that Rwanda could be one of the leading countries in Africa in adopting ICT in education. The fact that about 9 years ago there was only one school with a computer compared to the current ratio is evidence of the commitment of the political leadership in Rwanda, a key factor in its impressive development of ICT integration in education.

Uganda

In Uganda, Farrell (2007) reported that the Ministry of Education and Sports had become much more proactive over the period 2005/06 as a result of the policy emphasis on ICT. For example, in its Review for 2005-2006, the Ministry listed the following achievements:

- Over 300 teachers have been trained;
- Three generators and 300 computers have been provided to NEPAD e-schools;
- Software and upgrades for 6,000 desktop computers already in schools have been procured;
- Preferential rate agreements with Uganda Telecom for voice and data connectivity have been secured;
- Work has started on introducing ICT into the teaching and learning process in primary and secondary schools.

Farrell observed that computers are typically set up in a one-room lab with 10 to 20 machines. A television receiver with a VCR may also be included depending on reception capability. Classes generally have scheduled use of the lab two or three times per week. Overcrowding is common because of large class sizes. However, it is important to note that most of the ICT initiatives have been funded by NGOs, international donors and religious organisations as Farrell (2007) reported in the ICT survey for Uganda.

Tanzania

Tanzania's Ministry of Education and Vocational Training (MoEVT) has been working in cooperation with international bodies such as SIDA, IICD and UNESCO on the potentials of applying ICT in the education sector by deploying and developing a countrywide e-learning system, as mentioned in earlier sections. As part of the government policy for introducing ICT into basic education (MoEVT, 2007), the Commission for Science and Technology (COSTECH) and IICD implement rural ICT access initiatives which aim to bring to the community affordable technologies for good governance and transparency and as part of assisting national institutions in establishing computer-mediated

communication.[13] Another initiative by the MoEVT and SIDA concentrates on teacher e-training through introducing ICT in all government teachers' colleges (ibid; Tanzania. MoEVT, 2007). In particular, the project expects principals, teachers and students to be able to use ICT as a tool for teaching and learning as well as for management and administration. ICT activities within the projects (such as hardware and software procurement and installation in all 32 colleges, internet connectivity, training of 80 IT tutor technicians and 16 trainers, training of all college students and tutors in ICT basic skills, implementation on curriculum in ICT in teacher's colleges) are carried out with the Volunteer Services Overseas and United States Peace Corps.

The ICT initiatives reported above are mainly government-initiated and/or government-led in the different countries of the Commonwealth in Africa. In addition, there are various other initiatives involving public-private partnerships between government and private organisations as outlined in the next section.

3.2 Public-private partnerships in SSA

African governments are generally lacking in resources due to the prevailing poverty across the continent. They therefore need the support of other organisations including private sector and NGOs to provide services for the people. The education sectors provide a valid case for public-private partnerships since education is considered one of the key pillars of human development. Some of the key partnerships in ICT for schools in African Commonwealth countries are reviewed generally in this section, beginning with prominent multi-country initiatives before exploring countrywise initiatives. The next section focuses particularly on East Africa.

3.2.1 NEPAD

The NEPAD (New Partnership for African Development) e-schools initiative, the Commonwealth of Learning[14]and infoDev run in close partnership with a consortium of private sector institutions (AMD, Cisco, HP, Microsoft, Oracle) and Ministries of Education. It is a highly ambitious multi-country, multi-stakeholder initiative aiming to:

- equip more than 550,000 African schools with state-of-the-art computers and curriculum-relevant learning materials;
- connect the schools to the internet by 2020;
- teach ICT skills to young Africans in primary and secondary schools;
- provide teachers with ICT skills to enable them to use ICT as tools to enhance teaching and learning. (Farrell et al., 2007)

Farrell et al. (2007, p.1) assert that "the project is without precedent in terms of its international scope, socio-economic diversity and the comprehensiveness of the partnerships it comprises." NEPAD was implemented as a pilot scheme (called "Demo") in 2005-07 to start with, involving 16 African

[13] http://www.costech.or.tz and http://eonyango.blogspot.com/2008/08/implementing-ict-policy-for-education.html

[14] Commonwealth of Learning (http://www.col.org/) is an intergovernmental organisation created by Commonwealth Heads of Government to encourage the development and sharing of open learning/distance education knowledge, resources and technologies.

countries, including Kenya, Rwanda and Uganda in East Africa, plus Algeria, Burkina Faso, Cameroon, Egypt, Gabon, Ghana, Lesotho, Mali, Mauritius, Mozambique, Nigeria, Senegal and South Africa. Phase 1 entailed identifying six demonstration schools spread across the regions of each participating country; the consortia supported the operation of the e-school activities for 1 year following implementation in each country. For example, the e-schools project provided end-to-end solutions to connect schools across Kenya. This was done through provision of internet solutions including components of digital content.

The Demo includes a comprehensive monitoring and evaluation component. The interim report by Farrell et al. (2007) identifies a number of problems that hindered or delayed implementation, including a lack of both human and fiscal resources, a consequent lack of effective communication among project partners, inaccurate assumptions about ICT use in education in Africa owing to failure to conduct a review of existing and "best practices" gleaned from similar projects in Africa and elsewhere, and lack of preparedness of some countries to participate. Nevertheless:

> The Demo is having a major impact on governments in terms of their awareness of the importance of adopting ICT in their strategic educational plans. This may be the greatest achievement to date in those countries that did not have an ICT in education policy already in place. . . .The use of local partners is proving to have a major effect on the ease and efficacy in the implementation of the project and in providing support to teachers. . . .The impact of the Demo school in local communities has also been much more comprehensive than was anticipated. Teachers from neighbouring schools that have no ICT facilities are being trained to use the Internet at the Demo school. (ibid., pp. 2-3)

The report concludes that the operating models that the consortia have put in place in collaboration with the host countries are a tangible legacy from the Demo and that they can provide a "continental platform for ongoing demonstration and research" (p. 21) if they are maintained and kept current with developing technology. Moreover, teachers and school heads welcomed the training and learning software supplied by the various consortia, and importantly, many teachers realised that they could produce their own learning materials. Both students and teachers reported significant increases in their technical abilities and confidence levels, although technical support, repair and maintenance funding were sometimes problematic. There was little evidence of integrated use of the technologies to enhance pedagogy across the curriculum or of a shift toward a more student-centred learning environment. Farrell et al. (2007, p. 17) point out that the integrated use of ICT needs much more incubation time, better access for individual learners, more operational reliability and much more training and support before this outcome can be achieved. Lack of impact may also be due to the initial focus of the programme primarily on the importance of getting schools connected and giving pupils and teachers ICT skills, rather than on using ICT to enhance their wider learning experiences (Unwin, 2005). Despite the rhetoric about teacher training, no comprehensive frameworks were developed at national level to train teachers in the appropriate use of the technology.

There are rollout plans for further schools in each participating country. Suitability of Demo models for future wide-scale rollout has been questioned by several Ministry of Education officials because the capital and maintenance costs are a constraint. It is also not yet clear what impact the NEPAD e-schools Demo will have on participating schools in the longer term although the interim findings of this fairly large-scale project already offer some clear messages for other planned initiatives. Lessons learned (derived from questionnaire and interview data) include the importance of partnership with other ICT-in-schools initiatives in Africa, and of involving local companies / civil society organisations in order to make implementation and follow-up support more effective. Farrell et al. (2007) point out that local support infrastructure must be developed and available to schools if they are to continue after

the Demo project period. The commitment of senior leadership to the project is another major determinant of success, along with assessment and re-assessment of readiness of educational systems to facilitate interventions of this kind. Clear communication of plans and obstacles, and realistic expectations of scope and timescale for implementation are also essential. Finally, an "e-school model" has to be flexible and adaptable to local context.

3.2.2 OLPC

The most well-known portable computing initiative for developing countries globally is the One Laptop per Child (OLPC) scheme initiated by Nicholas Negroponte at the MIT Media Lab in 2005, whose mission statement is

> To create educational opportunities for the world's poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning.

The "US$100 laptop" actually now costs US $200 according to a 2009 OLPC update on the public forum OLPC News site. The XO is "a flexible, ultra-low-cost, power-efficient, responsive, and durable machine with which nations of the emerging world can leapfrog decades of development—immediately transforming the content and quality of their children's learning." It needs no external power but can be hand cranked for primary school children. It comes with tools such as a Web browser, rich media player, and e-book reader but has no hard drive. Many consider that the mobile phone would be a better tool to work with, but the debate continues. Anecdotal evidence indicates that software resources for these machines are limited and in some cases teachers have banned students from bringing them to school owing to perceived disruption to classroom activity.

The scheme has to be adopted wholesale by a country's government and so far Rwanda, Nigeria, Ethiopia and Ghana have done so (although with varied long-term commitment). The infoDev-supported ICT survey indicated that Nigeria initially embraced the OLPC project for its 24 million public primary school children. This was a political commitment taken at the presidential level (Agyeman, 2007). The government ordered 1 million laptops, however, the OLPC News (2009) reported that with the change of president in Nigeria, the order was cancelled and the new government distanced itself from the project. This is a common practice in Africa that is counterproductive because it leads to wastage of human, financial and time resources. When new political leadership takes over through elections or other means, then previous commitments tend to be thrown out of the agenda. However, a rather critical July 2008 news report[15] of the Nigerian pilot scheme highlights a number of other problems that reportedly prompted the country's withdrawal. These include pupils freely browsing adult sites with explicit sexual content and high costs of electricity and diesel generators to power XOs and internet routers. The Education Minister explained: "We discovered that the scheme is a conduit pipe to siphon public funds."

The OLPC programme has, however, been embraced by Rwanda, to the extent that the country is seen as among the three countries to have made substantial commitment to the project. After an initial trial in October/November 2007 in which 106 laptops were deployed in one primary class, a pilot project involving 5000 laptops was commissioned a year later (Nugroho & Lonsdale, 2009). The OLPC News (2009) clearly identified that Rwanda has deployed 110,000 laptops (worth more than US$18 million) for primary schools, far surpassing orders by other African countries including Ethiopia (5000), South

[15] http://www.olpcnews.com/countries/nigeria/olpc_nigeria_one_year_later.html

Africa (100 laptops), Ghana (100). It is hence placed alongside Uruguay's deployment of 300,000 and Peru's 260,000 as one of the three leading countries committed to the initiative. More than 2,000 teachers have completed training in use of the laptops and the Rwandan government is trying to convince parents to buy the laptops for their children, claiming they are vital tools for education. This commitment to the OLPC is taken at the highest political level – the presidency –and so it would be of interest for other countries in Africa to track the progress of this, among other ICT initiatives in Rwanda. Indeed the country's progress in promoting the use of computers in schools means it is now the focal point for the OLPC project within Africa and is set to host a pilot learning outreach centre (Malakata, 2009).

The OLPC project is being piloted in two schools in Ghana; one urban school in Accra and a rural school in Ashanti (eLearning Africa News 2008). Both schools are public and the project pilot is being implemented in grade 4 with 40 learners each. According to one member of the implementation team, Mr. Kwesi Smith, by the time of the interview in May 2008, it was too early to give a general evaluative report on the project. However, he was able to point out that the students and teachers in the two pilot projects were enthusiastic about the project. Updated information was not available at the time of writing.

There is a general lack of systematic research studies on the merit of the laptops. Buchele & Owusu-Aning (2007) thus refer to the initial reports of the OLPC projects in various countries, which suggest increased attendance and participation, and more engaged learning, in schools in which the laptops have been piloted. A recent and comprehensive review of the OLPC scheme by Nugroho & Lonsdale (2009) for the Australian Council for Educational Research confirms that most feedback from the OLPC programs has been anecdotal in nature, and highlights the need for embedding an evaluation framework at the very beginning of a deployment. Other key findings include reports on general change in behaviour of the learners, for instance decline in absenteeism; exhibition of a positive attitude towards class activities; students taking on more responsibility on the XOs; teachers and parents developing keen interest in computers and even registering for computer classes. However, several issues were raised such as: inadequate technical support; financial concern as the actual cost of an XO (originally billed as the "$100 laptop") is now US $500; difficulties in sourcing parts; students learning faster than their teachers (ibid).

An OLPC News entry in July 2009 (posted by a first-hand observer and initiator of OLPC in Ethiopia back in 2006) directed us to reportedly the first serious independent academic research on the OLPC Ethiopia project conducted by the University of Groningen as a 2-year on-site monitoring and evaluation project. The first of four reports was recently presented by Hansen et al. (2009)[16] and this compares two samples of about 600 children aged 12-14, one group with laptops and one without, after 6 months of usage. Some of the findings are:

Children regard the OLPC as a learning device;

OLPC increases the children's total time spent on learning (mainly at home);

Children's logical reasoning and spatial awareness increase dramatically;

Using the laptop increases motivation to go to school, especially in rural areas;

[16] olpc-ethiopia-groningen.pdf

After 4 months academic performance increases by 3% on average in all schools that use the laptop as a learning device and 13% in schools that extensively use the laptop as a learning device.

The OLPC Ghana website[17] informs us that following the pilot of 100 laptops, the government signed an agreement with OLPC to purchase 10,000 laptops, the deployment of which was to be coordinated by Baah-Wiredu Laptop per Child Foundation in Ghana. However, an OPLC news entry from 29 June 2009[18] suggested that this large-scale deployment was jeopardised by the newly-elected government. Specifically, having paid the cost of 1,000 laptops, the Ministry of Finance and Economic Planning issued a statement in which it wishes to withhold the purchase of the further 9,000 laptops. Since these laptops had originally been seen as the solution for Africa's varied problems in education including poverty alleviation and access, it would be interesting to find out more about the impact of the project in other countries where the pilot project has been implemented (although not always widely), including Mozambique, Senegal, South Africa, and Rwanda.

3.2.3 SchoolNet Africa

SchoolNet Africa[19] supports a network of practitioners, policymakers, teachers and learners in 31 African countries and works towards affordable and sustainable ICT access in schools plus the creation of locally developed, digitised education content. SchoolNet is a non-governmental organisation working in partnership with private companies and other organisations such as Commonwealth of learning. The SchoolNet Nigeria initiative, for instance, involves several government ministries and among other functions aims at mobilising human and financial resources for the purpose of using ICT in education (Agyeman, 2007). It creates learning communities of educators and learners to use ICT by:

- Coordinating, implementing and supporting ICT development projects in education;
- Providing and supporting lower cost, scalable technology solutions and internet for schools;
- Providing support mechanisms for schools for technical infrastructure and connectivity.

SchoolNet Nigeria activities are mainly concentrated in secondary schools (Agyeman, 2007). By focusing on secondary schools, SchoolNet Nigeria has reasonably considered the contextual realities since Nigeria is the leading country in terms of human population in Africa and hence there are bound to be many primary schools operating on scarce resources. This is a common phenomenon in Africa generally, and there is need to begin with what is manageable and achievable within the resource base. SchoolNet programmes in Malawi, Namibia, Mozambique and Zambia are outlined later in the section.

3.2.4 Intel World Ahead Program

The Intel World Ahead Program[20] aims to integrate and extend Intel's efforts to advance progress in four key areas: accessibility, connectivity, education and content. In the area of education Intel has supported a number of projects in South Africa, Ghana and Nigeria, as the Intel News Release (2007)[21] describes:

[17] http://wiki.laptop.org/go/OLPC_Ghana
[18] http://www.olpcnews.com/countries/ghana/
[19] http://www.schoolnetafrica.org/english/index.htm
[20] http://www.intel.com/intel/worldahead/
[21] http://www.elearning-africa.com/pdf/press/press_kit/intel.pdf

- 52,000 South African educators from 820 schools took part in the Intel® Teach Program between 2003 and 2007 designed to train teachers to incorporate the use of IT in their teaching, and 783 facilitators have been trained to deliver the program curriculum.
- In Ghana, Intel implemented Africa's first WiMAX connected school Accra Girls Secondary School in collaboration with Zipnet, TechnoNet Ghana, the Ghanaian Ministry of Education and the Kofi Annan Centre of Excellence. A full eLearning centre with hardware, software, internet connectivity and teacher training was setup and WiMAX technology provided high-speed internet access to the school.
- Intel in conjunction with Microsoft supported the Ghanaian Government with the launch of **'**iADVANCE-Computer for All**',** Sub-Saharan Africa's first digital inclusion program. The program is designed to improve the access of ordinary Ghanaians to PCs and the internet by providing financial support for purchases.
- Intel and Ghana Telecom signed a Memorandum of Understanding in which Intel commits to donating equipment and digital education content towards the enablement of eLearning, and Ghana Telecom promises to install WiMAX equipment and provide broadband connectivity.
- In September 2006, Intel launched the Proof of Concept Pilot Project at the Jabi School in Abuja, Nigeria. This was aimed at researching students' reactions and susceptibility to one-on-one experiences with the Classmate Personal Computer, and how effectively this new technology integrates within existing teaching methods. Teachers used the Classmate PC along with Intel mathematical software (SKOOOL) to help students with various subjects including English, Mathematics, Applied Sciences and Introductory Technology. The results were impressive, with the students taking part in the pilot scoring an average of 66% across seven subjects in comparison with students in regular teaching classrooms scoring an average of 49%.

According to Intel News Release (2008)[22], Intel signed an agreement with Alcatel-Lucent and Kenya Data Networks (KDN) to set up a mobile WiMAX trial in Kenya, paving the way for a much larger-scale WiMAX network in the future[23]. Also, Kenya's Ministry of Education (MoE) signed agreements with Intel to provide training to primary school teachers through the Intel Teach program, and collaborate on developing localised content for the Intel skoool™ Learning and Teaching Technology.

3.2.5 Solar powered e-learning

A number of initiatives for applying renewable energy technology in East African countries have been planned in recent years especially in remote locations. Maendeleo Foundation initiated a project in 2008 in Uganda called the Mobile Solar Computer Classroom (MSCC), which introduced computers to local schools, many of which have no electricity.[24] MSCC is a solar-powered, mobile computer classroom consisting of a modified SUV, three solar panels and a battery, a tent with folding tables and chairs and 15 Intel-powered Classmate PCs. The MSCC taught about 1,300 students and 100 teachers in 2008.[25] In Kenya, photovoltaic equipment maker Go-solar Systems has teamed with renewable energy builder Power Options to bring solar power in far-flung areas of the country where electrical infrastructure remains underdeveloped. This solar pilot project, costing an estimated $3.6 million, will

[22] http://www.intel.com/pressroom/.../releases/2008/20081204corp_c.htm
[23] http://www.webwire.com/ViewPressRel.asp?aId=81694
[24] http://download.intel.com/pressroom/kits/events/idfspr_2009/Inspire-Empower_FactSheet.pdf
[25] http://www.maendeleofoundation.org/MSCC_case_study.pdf

set up rooftop solar panels to supply electricity to 117 schools and health clinics in rural Kenya.[26] In Ethiopia, two versions of a portable solar powered educational DVD player are being used by SafeHands for Mothers, a charity dedicated to reducing maternal mortality, in partnership with the Ethiopian Ministry of Health. The solar powered DVD player with 17-inch LCD screen was developed by Welsh company Dulas Ltd. to enable high-quality training in remote areas where there is no electricity supply. The portable DVD pack minimises costs of training and maximises the number of people reached by one extension worker.[27] This technology has evident implications for other educational purposes, including within schools.

3.2.6 Local Initiatives

Ghana

The Ghanaian Ministry of Education, Science and Sports has teamed up with the Ministry of Communication and the Intel World Ahead Programme to set up the local Ghanaian version of the Intel worldwide digital education content platform[28] (currently operating in South Africa and Nigeria too). The objective of this initiative is to provide an integrated platform for science and mathematics education. The platform also aids students with curriculum-focused multimedia learning, offering open-ended learning tools to help them explore wider concepts and providing valuable exam-focused resources for their preparation for state examinations (eLearning Africa Newsportal, 2009). The Computers for Africa Schools Project[29] has equipped two schools in Ghana[30] with networked labs containing a total of 50 refurbished PCs and internet connectivity. The facility has enabled primary through junior secondary school children to learn basic computer hardware and software technologies, keyboarding, internet browsing and e-mail usage.

Malawi

Although highly impoverished Malawi has a dedicated ICT policy which includes promotion of ICT in education including enabling ICT access to schools and an integrated library and information systems and networks. Malawi has a Computers for Schools initiative which is jointly administered by the British Council and SchoolNet Malawi. This programme provides refurbished computers which are shipped in from the UK for schools, trains teachers, and provides a mechanism for sustainability of the programme through raising funds internally (Isaacs 2007). SchoolNet Malawi itself was set up to provide and facilitate access to ICT in schools according to Isaacs (2007). It was funded by the International Development Research Centre (IDRC) and SchoolNet South Africa although at the time of the survey it was still at the stage of conception. Unfortunately there is no information available on the Malawi Ministry of Education website on its implementation while a SchoolNet Malawi website could not be found on the web.

Mozambique

[26] http://green.venturebeat.com/2010/01/05/solar-panel-project-to-bring-affordable-power-to-african-schools-clinics/
[27] http://www.peopleandplanet.net/doc.php?id=3338
[28] http://www.skool.com
[29] http://www.casproject.org/Projects.htmb
[30] http://www.casproject.org/Our%20Objectives.htm

In Mozambique, the ICT initiatives in schools include SchoolNet Mozambique which was established in 1997 as a project called internet for Schools. The aims were to introduce computer literacy into 10 secondary schools, to explore the introduction of ICT into the teaching process, and to encourage schools to become centres of information sharing and communication, among others. Among the key achievements of SchoolNet Mozambique was the facilitation of establishment of PC labs in 75 schools out of the 280 secondary schools by July 2006 with an estimated 25 schools connected to the internet. Mozambique was also recorded as one of the 16 countries in Africa implementing the NEPAD e-Schools demo (Isaacs, 2007). The situation of Mozambique presented above leaves out primary schools and hence highlights the need for more initiatives to address ICT use at that level.

Namibia

Namibia has also established a SchoolNet that provides sustainable, affordable open source technology solutions, internet access as well as technical support and training to schools. This initiative is reported by Isaacs (2007) as part of the findings of the survey done on ICT in Namibia supported by infoDev.

Zambia

In Zambia, according to Isaacs (2007), the Computers for Zambian Schools Trust (a partnership between the Ministry of Education, Zamnet, SchoolNet Zambia, the Beit Trust, The British High Commission, HSBC, The British Council and Computers for Africa Schools project) has provided 4,500 computers to 300 schools. This project is co-ordinated from a boys' school in Lusaka where computers are received, refurbished and distributed to schools and used in support of computer studies. Computers for Zambian schools also train ICT teachers, distribute hardware to schools, provide technical support to schools and recycle computers in partnership with a South African company.

The AfriConnect iSchool Project is in the process of creating a National iSchool Network in Zambia by connecting schools across the country via internet and by accessible iSchool website learning content (Bennett, 2009). The key objectives of the iSchool Project are to teach children to "learn 2 learn", to create a workforce capable of operating in a knowledge economy (driven by ICT), and to create a population of self-motivated and life-long learners. By March 2009 iSchool facilities had been trialled in 16 schools in different locations across Zambia. These facilities were funded by AfriConnect and included computers, broadband internet connection, upgrade of school infrastructure (including buildings, electricity, and security), school websites, and school internet café websites. Basic teacher training on internet use and IT support were also provided. The envisaged Phase 2 of this project (up to 3 years) will be based in 100 schools, will fully test the concept of e-learning within the Zambian context and determine the parameters needed for a wider rollout. The outcomes may be applicable to the rest of SSA. AfriConnect will continue to provide teacher training and support, internet connectivity, computer equipment, physical plant, 24 hour technical support, and support in developing online learning materials for school websites. Importantly, funding is being sought for Phase 2 of iSchool which will start to develop sustainability models for the project, enhance monitoring and evaluation of the implementation process, and address the policy level.

In parallel, a consortium of North-South partners including Africonnect and iSchool, Centre for Commonwealth Education at University of Cambridge (UK), University of Zambia, Participatory Culture Foundation (US) and Ministry of Education, Zambia is currently conducting a small-scale pilot project assessing the feasibility of introducing open educational resources (OER) into Zambian primary schools. OER are learning and teaching materials (including lesson plans) that are not just free to

download, but are available under a Creative Commons license that allows adaptation and re-use. OER allow students and teachers to contribute innovation and educational materials at low cost and with a low bar to contribution. Most OER at the moment are tailored towards Northern education systems. The OER4Schools project[31] seeks to leverage contemporary pedagogies for improving teaching and learning in SSA countries and to overcome resource shortages by appropriately drawing on OER and ICT.

Isaacs (2007) pointed out the involvement of OneWorld Africa[32] too, an NGO which has a network of Education Support projects that involves volunteers in the development of teacher support materials for nine schools in Zambia. OneWorld Africa has a children's channel that provides a host of information and learning opportunities for children. The overarching OneWorld network operates in five continents and produces content in 11 different languages. In Zambia, OneWorld Africa has trained 35 secondary school teachers in basic computer skills including using the internet. In addition 6 volunteer editors were trained in basic skills. The schools involved all received 9 computers and 8 colour printers each. This is an example of small but important initiatives that can really make a difference in supporting access to education in Africa. It is even more interesting that one of the schools follows a fragmented syllabus based on American, British and Kenyan ICT curricula which are easily downloadable from the internet.

Seychelles

Seychelles provides an interesting scenario according to Isaacs (2007). It is among the countries in Southern Africa with the most developed ICT infrastructure including being the highest in fixed line density, mobile phone penetration, electricity penetration, PC penetration, internet access and number of households with television and radio. However, it should be noted that the total population of the Seychelles was only 87,476 in 2009 and thus there are very few schools. Isaacs (2007) only identified one project on ICT for schools, which is a partnership between Microsoft and the Ministry of Education to train 166 master teacher trainers. This initiative provides a 5-day training programme focusing on basic ICT skills development and application to support learning and teaching. The agreement between the two partners also included provision of software to schools.

3.3 Public-private partnerships in East Africa

Rwanda

Apart from the take-up of OLPC in Rwanda as mentioned above, WorldLinks in collaboration with the Rwandan Ministry of Education has been providing training of primary school teachers in computer skills. Two teachers in each of the schools equipped with a computer were trained in basic computer literacy who then trained their colleagues. A total of 2,216 teachers were trained.

In Rwanda there are a number of public-private initiatives in provision of ICT opportunities including:

- Over 2000 teachers have so far received training in the use of ICT in their teaching;
- All the public schools were expected to join the information superhighway by the end of 2008;

[31] http://www.educ.cam.ac.uk/centres/cce/projects/ictzambia/
[32] http://africa.oneworld.net/

- Rollout of computers to secondary schools whereby 2,100 computers have already been distributed to secondary schools. The target was to continue distribution at 300 computers per month funded by Ministry of Education and Rwanda Network Computer;
- Rollout of computers to primary schools whereby two desktop computers were provided to 98 primary schools with power, and one laptop plus solar supply provided to another 1,018 primary schools without power. A rollout of up to five computers in each of the 2,200 primary schools in Rwanda was planned over a 3-year period beginning in 2007. Programme funding was initially from WorldLinks in Phase 1 then later funding was being supported by UNESCO, World Bank, and the African Development Bank (Farrell 2007).

According to the survey of ICT and Education in Africa reported by Farrell (2007), Rwanda has over 400 schools that have been fully equipped with ICT facilities which include wireless internet access for some. This has been made possible following an agreement by Microsoft to significantly reduce the annual fee to manageable amounts.

Tanzania

The Tanzanian scenario as reported by Hare (2007) on the ICT in Education survey revealed that the e-Schools Forum for education stakeholders formulated a 5-year ICT in education programme. This programme's aim was to equip schools with ICT equipment in a phased approach beginning with 200 schools in Phase 1 leading to a large-scale rollout to 2000 schools in Phase 2. The Survey of 2007 indicated that at that time only a few private secondary schools around urban settings especially in Dar es Salaam had access to ICT or the internet. In public primary and secondary schools exposure to ICT was negligible. By the time of compiling this review it was not possible to establish whether the 5-year ICT in education programme was implemented as the Ministry of Education and Vocational Training (MoEVT) website had no information on this initiative. However, since the 2007 ICT policy for basic education had focused on phased implementation of ICT initiatives beginning with teacher training colleges, it is possible that the implementation of the ICT programme for secondary schools has not yet rolled out.

The MoEVT (2007, p. 9) acknowledged ongoing support (since 1998) of the International Institute for Communication and Development of the Netherlands for various initiatives in the sphere of ICT, including: Tanzania Computer Literacy for Secondary Schools, education and information services through Web sites (TanEdu, Wanafunzi) and ICT training for teachers (TC-CONNECT-TED).

Uganda

Uganda's ICT initiatives according to Farrell (2007) include the involvement of Uconnect and SchoolNet Uganda NGOs in getting 106 schools out of 13,353 primary and 2,070 schools connected to the internet by the time of the ICT survey in 53 African countries. The other point raised in the survey implied that many schools had computers provided through the involvement of NGOs, religious organisations and international donors. Farrell (2007) further pointed out that due to recent policy emphasis on ICT, the Ministry of Education and Sports had become more proactive in the preceding 3 to 4 years by providing training for 300 teachers, providing generators and 300 computers to NEPAD e-schools, among other self-reported achievements. Some challenges in the use of computers in the schools have been outlined in the survey report including the need to alternate use of the computer labs that typically have between 10 and 20 computers and cannot accommodate a whole large class without overcrowding (Farrell, 2007).

According to a survey report by Farrell (2007), only few secondary and primary schools have access to ICT. The survey reports that most of the schools connected to the internet are in the urban centres hence creating the rural – urban divide. As noted for Kenya and Tanzania, the constraining factors faced in technology connectivity include poor infrastructure, low electrification and high costs of acquiring ICT. However, many initiatives by NGOs, religious organisations, international donors and the government of Uganda are reported to have helped in equipping schools with ICT infrastructure. Interestingly, though, the survey notes that most of these have been used for administration purposes rather than instructional purposes.

The Ministry of Education and Sports ICT Review (2006-2007) lists some achievements made so far. Notable among them is the training of over 300 teachers who are expected to help in the implementation of ICT in the classroom. In addition to this training of teachers, work is also reported to have started on the introduction of ICT into the teaching and learning process of primary and secondary schools. This has been facilitated by yet another achievement: provision of hardware and software upgrades. To enable easy connectivity the review reveals that preferential rate agreements with Uganda Telecom for voice and data connectivity have been secured.

Kenya

The Intel Corporation supports Kenya's transition from traditional teaching methods to e-learning through the integration of ICT in education for primary and secondary school pupils (Panafrican Research Agenda on the Pedagogical Integration of ICTs: Karsenti, 2009). The focus of the Intel Teach[33] Program is on educating teachers about e-learning teaching methods with the view of incorporating e-learning into school curricular to improve the academic performance of students. The 25 selected Kenyan teachers from teacher training colleges, Centre for Maths and Science and Technology Education in Africa, Kenya Institute of Education and Kenya Education Staff Institute are to work on the development of online material to then orient 250,000 teachers nationwide. This project builds on a number of policy initiatives by the Kenyan government on the adoption and integration of ICT in education.

Kenya was also one of the first EAC countries (in addition to South Africa, Nigeria and Ghana in SSA) to join the Intel World Ahead Program in 2007 as described earlier (Intel News Release, 2007; 2008). According to the Information Assistant Minister, Kenya's participation in the Intel-supported eLearning Africa conference will assist in fulfilling "a plan to set up Digital Villages in all 210 constituencies in Kenya and boost the number of people who have access to the internet from the current 2.7 million to six million" (ibid).

3.4 Private sector / NGO initiatives in East Africa

The Scientific Advisory and Information Network (SAIN) established in 2001 as a non-profit organisation is involved in the Chemistry initiative project. The aim of this project is to introduce multimedia educational resources into the classroom hence enabling students to "see" live chemical reactions and carry out practical hands-on chemistry. According to Ogunde, the chief executive officer of SAIN, during the course of the project, both students and teachers make extensive use of online

[33] http://www.intel.com/education/teach/

resources offered by the Royal Society of Chemistry (RSC) and the Chemistry Video Consortium (CVC). These projects are ongoing in Kenyan schools (eLearning Africa Newsportal, 2008).

Hare (2007) reporting on the infoDev-supported ICT survey for Tanzania indicated that most private schools in the country were already users of ICT despite the lack of a formal setting or policy framework then. It was reported that the push was provided by the parents and students desiring to achieve high national grades. This report further indicated that the use of the ICTs was confined to administrative work and not really evident in the classrooms; it was mainly concentrated in secondary schools.

There are a number of private sector initiatives providing for ICTs in schools in Burundi and in the process contributing to an otherwise uncoordinated effort due to lack of a policy for ICT in education. The ICT survey for Africa report on Burundi (Hare, 2007) observed that there are a number of privately owned secondary schools that teach basic computer lessons for applications such as word processing and spreadsheets. The report however, pointed to a few initiatives to equip public schools. These include The World Instituto Tecnico Alessandro Rossi, which is a small Italian NGO that has helped raise money for the LTAR (Lycée Technique Alessandro Rossi) school. As a result the school is equipped with desktop computers and laptops for its students. The school is also connected to the internet via VSAT technology. Another initiative is the Computer Trailer, which was a campaign by volunteer youth from the Burundi Youth Training Center to introduce ICTs in secondary schools by creating awareness among the school teachers, administrators, and pupils. As a result of this initiative two schools have each been equipped with 20 computers and a printer.

In Uganda, Uconnect, a non-profit NGO, is working to advance public education by using ICT to improve the quality and efficiency of communications. Activities focus on providing computer connectivity and training for schools and ICT training to officials of 22 mostly rural districts. More than 225 schools have benefited to date (Farrell, 2007). Besides, the spread of mobile phones and FM radio stations has enabled the development of an interactive public discussion forum in local languages on topics such as politics, health issues, agriculture, education, gender issues, and the environment in Uganda.[34]

3.5 Government-funded academic research programmes in SSA

Most of the above initiatives are concerned with provision of ICT to schools, support and training for its effective use. Further insight into "what works" in the context of SSA and into how the schools with technology at their disposal are capitalising on it can be derived from the prominent academic research programmes. They are:

(1) The Digital Education Enhancement Programme (DEEP) Project, carried out by the Open University and commissioned by the UK government Department for International Development (DFID) with the aim of investigating how using information communications technology effectively could significantly improve the teaching and learning of literacy, numeracy and science in primary schools in South Africa. The study has suggested that the forms of ICT, software and associated training should be primarily determined by the purposes and context of use (Leach, 2005). They should therefore be focused on schools, and classroom practice. The research further pointed to the fact that

[34] http://researchictafrica.net/index.php?catid=18

school-based professional development uniquely permits ICT to simultaneously provide the medium, context and content for:

- Teachers' personal and professional development;
- New and improved curriculum, school and classroom practice;
- Student learning and activity.

The findings provide a key insight into how implementation of innovative ICT use in education could begin with consideration of the contextual factors and needs of the users. (We return to the DEEP work in looking at teacher development in Section 6.)

(2) According to SAIDE (South African Institute for Distance Learning) (2008), there are a number of projects, both institutional and virtual, that use mobile technology for learner support. Mostly based in South Africa, these initiatives include SEMA and DEEP aiming at teacher development; MELFA and MobiDic for language learning; MOOP and MobilEd for biology; Dr Maths on MXit and MLearner Mobile for mathematics; initiatives at Makerere University MRSI, University of Pretoria and the Dunia Moja project on student administration and academic support and The One World M4G project on health education and jobs in Kenya (pp. 10-11).

(3) Another major ongoing programme is the PanAfrican Research Agenda on the Pedagogical Integration of ICTs[35], known as PanAf and funded by a Canadian government organisation, the International Development Research Centre (IDRC). The programme began in 2007 and Phase 1 involves 12 HEI partners in countries throughout SSA: Cameroon, Central African Republic, Congo, Côte d'Ivoire, Ghana, the Gambia, Kenya, Mali, Mozambique, the Republic of South Africa, Senegal and Uganda. The research partners share their data collected from a total of 117 schools (42% are secondary level) openly via an online "Observatory". The general objective of the project is to provide practical support for an effective and substantial pedagogical integration of ICTs for the improvement of the quality and efficiency of teaching and learning at all levels of African education systems. Secondary aims include evaluation of the impacts of an ICT-inclusive pedagogy on student and teacher knowledge, skills, attitudes and performances, and extension of the pilot scheme to new member countries. The objective of the forthcoming Phase 2 is to develop and communicate recommendations and solutions for education policymakers and practitioners.

It must be acknowledged that with only about 10 schools involved in each country, and their selection because they all make some use of ICT, the sample is neither representative (only 71% are state funded) nor large and thus the findings should not be overgeneralised. Nevertheless, some consistent trends emerge across the different SSA countries that offer some insights for researchers and developers interested in ICT use in this context. A key finding emerging from Phase 1 is that ICT is predominantly used to teach computing itself rather than to teach other subjects (as is often the case in Northern countries too when they first introduce ICT), yet, as the authors point out, current literature argues that subject teaching is where usage should be concentrated. Moreover teaching "of" ICT is mainly limited to demonstration and learning is through passive absorption, whereas the literature suggests that approaches offering more active learner participation and ownership are more effective. While some learners in the pilot schools enjoy this increased involvement, an obstacle is teachers' perception of ICT as a threat and their fear of losing class control.

[35] http://www.idrc.ca/en/ev-116195-201-1-DO_TOPIC.html

> In this context, ICTs are not used as a "way" to learn, they are "what" is taught – educators focus on initiating new users to the basic functions of the machine. . . . Though the teaching of computers may have its place in numerous regions of Africa where schools are the only venue for accessing and learning ICTs, it is paradoxical that in cities where 75% of learners report frequent use of cybercafés – and are comfortable with at least the basic functions of computers – the approach to computers in schools would be so limited. (Karsenti, 2009, pp. 9-10).

Country reports of Phase 1 findings from Kenya and Uganda (the only EAC countries participating) offer some further information about policy, curriculum, resourcing and other obstacles to ICT integration which are reported in Sections 4-6.

Conclusions

The review in this section has identified a variety of ICT initiatives to support teaching and learning in schools in African countries of the Commonwealth. These are generally recent projects initiated in the last few years and many are still ongoing or planned. While their objectives and operations have been documented, especially through the infoDev-supported Africa-wide survey of 53 countries (Farrell & Isaacs, 2007), it still remains difficult to establish their outcomes. Extensive research findings were not readily available to the authors although some outcomes have been identified above, but in many cases evaluations have simply not taken place. We have identified a clear gap for research which pays more attention than in the past to evaluating the aims and outcomes of current initiatives. It is increasingly becoming apparent too that pilot schemes are only effective if further support is then provided over the longer term, or more helpfully, if local capacity to sustain them is developed or if they are rolled out to more schools.

Some additional general issues arise across the initiatives reviewed in this section. First, many schemes include provision of refurbished computers for schools. These computers are in most cases acquired from the developed countries of Europe and America. However, it should be emphasised that their use such as in the case of Zambia as reported by Isaacs (2007) does not provide the best solution in provision of ICT to schools. These refurbished computers become a burden to the institutions within a short time as they often have a very short working life remaining. They are in most cases outdated technology that is best for dumping.

Secondly, it is important to note that most of the countries discussed in this section have a common feature in their ICT initiatives in schools in the form of promotion of computer science or information technology as a school-based subject in addition to access, use and integration of ICTs within the subject curriculum (Farrell & Isaacs, 2007). Of course integration is slower to catch up especially considering the fact that:

> the dominant access model in [African] schools is the computer lab involving between 1 and 40 computers, most of which are networked either by thin client or fat client, although some are stand alone PCs like in Mali and Cameroon. These computers are used both for administration as well as support tools to aid teaching. (Farrell & Isaacs, 2007)

By locating the computers in a lab, it follows that the teachers and students have to keep moving from their regular classrooms to the lab whenever they want to use the computers. This movement can be a hindrance to integration of ICTs in subjects hence in most cases only a few teachers who teach computer science will have access to the computer lab.

Finally, on teacher professional development, the findings of the survey done in 53 countries reveal that most of them have invested in developing the capacity of teachers to use ICT for teaching and learning through both in-service and pre-service programmes (Farrell & Isaacs, 2007). Most of the programmes emphasise the development of basic ICT skills and occasionally included the application of ICT as a teaching and learning tool for teachers. This is an important outcome since having resources without the expertise on how to use them is a sure path towards wastage of investment. It is also clear that there is a need to expand the professional development programmes as the findings do not portray a picture of large-scale professional development but rather smaller proportions of the teaching force are reached by these initiatives. The impacts of initial and continuing teacher education programmes on ICT use in schools and the issues arising, including teacher confidence and beliefs about ICT, are explored at much greater length in Section 6.

Section 4

Physical and other related external factors affecting the use of ICT in primary and secondary schools in Sub-Saharan Africa

Azra Naseem

Key words: *ICT, education, barriers, ICT access, connectivity, affordability, m-learning, socio-cultural, political*

Introduction

This section identifies the physical and other related factors affecting the use of ICT in schools in Sub-Saharan African countries through a review of the available literature. The author acknowledges the complexity of the notion of divide in recognising that physical access to technology does not necessarily mean full and effective use of that technology or equal take-up of opportunities by different groups of children. Inequities can result from various factors such as amount of use, type of use, nature of teachers' attitudes, knowledge and classroom practices, nature and quality of student interactions with technology. In addition, while data presented in this section draw from multiple existing sources which may not relate to schools directly, many of the issues raised in this section, including high cost of connectivity, lack of computers and internet in schools/classrooms, lack of or poorly trained teachers, and absence of ICT integration with curriculum, are important concerns for the schools in Africa (Trotter, 1999). Note that curriculum factors and teacher factors in take-up and integration of ICT use are dealt with in Sections 5 and 6 respectively; here we concentrate mainly on physical factors.

4.1 Infrastructure

Physical access to ICT is the first step towards making technology accessible to the local people. Referring to Butcher (2001) cited in Were et al. (2007) it can be noted that at that time, out of the 818 (increased to 991 in 2009) million people in Africa:

- 1 in every 4 people had a radio
- 1 in every 13 had a television
- 1 in every 35 had a mobile phone
- 1 in every 40 had a fixed line telephone
- 1 in every 130 had a personal computer
- 1 in every 160 used the internet
- 1 in every 400 had a pay TV

The above statistics include countries such as South Africa, the richest country in the continent, yet present an overall dismal picture of computer and internet access in Africa. In most countries of Sub-Saharan Africa, inadequate technological infrastructure, such as lack of hardware and software, and internet, limit individual and community access to ICT and also pose a barrier to its integration with the curriculum in schools (Menda, 2006; Janczewski, 1992). In addition to the commonly listed issues of infrastructure, the African region faces "many external systemic factors such as electricity, transport

networks, import duties" (Jensen, 2005), technical faults and network configuration problems (Minishi-Majanja, 2007).

The available literature confirms the well-known fact that the East African countries face a shortage of electrical energy supply. In Tanzania, the national electricity grid is limited to commercially viable areas missing out most of the schools in the rural areas. This, together with frequent power breakdowns and power cuts, has increased the cost of owning ICT infrastructure (Farrel, 2007) and made it almost impossible for schools in the rural areas to access and use ICT in education. Kenya and Uganda too face similar electrification challenges. In these countries, hydro-power constitutes the bulk of energy supply. Other major sources of commercial energy include petroleum and biomass energy resource such as fuel-wood and charcoal, causing a sharp rise in deforestation in the region. Alternate sources such as wind and solar energy options have not been exploited to their full capacity[36]. However, small-scale funded projects are currently exploring alternate power supply options for the schools in East African countries[37] as elaborated in Section 3. Erratic electricity supply with occasionally lengthy blackouts limits the use of ICT in schools.

Moreover "the digital divide is very much expressing itself across Africa as a bandwidth divide" (Unwin, 2005, p. 123). Parts of South Africa and capital cities elsewhere have much better provision than that across much of the continent. While good broadband connectivity, for example, is now taken for granted in many of the richer countries of the world, and educational software is increasingly being developed to take advantage of this, such access to the internet is rare and expensive in Africa due to dependence on expensive satellite (VSAT) connections. Eastern Africa has no submarine connectivity at present, while some West and Southern African countries benefit from the SAT-2 and SAT-3 cables[38]. Two-way satellite connectivity is now widely available, but the costs of using this for educational purposes remain prohibitively high to be a sustainable choice for classroom use or for teacher education in the short- to medium-term (Unwin, 2005). For instance, internet was first introduced in Tanzania in 1989 when a "store-and-forward" email system was used (Sheriff, 2007). In 1995, a network of users in Tanzania was built without any link with the global internet. The first live internet connection was available in 1996. The cost of connectivity remained high with a mere 32kbps link costing an internet provider about US$ 16,000 in 1999. While over the years, the cost of connectivity has reduced, it still remains high as compared to the other parts of the world. Hence, use of ICT in education is hampered by the cost of bandwidth which is unaffordable for many schools. Many rural schools located outside the national telecommunications network have to use expensive satellite technologies. However, a number of new large-scale submarine cable projects are underway which are expected to establish better links between other parts of the continent and European and Asian networks, and improve data communication for research and education. Figure 4.1 below shows envisaged cable connections by 2011. Eastern and Southern African coastal states were reported to

---

[36] http://www.areed.org/country/tanzania/energy.pdf and http://www.mbendi.com/indy/powr/af/ke/p0005.htm.

http://www.itsabouttimebpp.com/BPP_Africa/Solar_Power_to_the_People.html

[37] http://www.allbusiness.com/energy-utilities/utilities-industry-electric-powerity/11393696-1.html

http://www.german-renewable-energy.com/Renewables/Navigation/Englisch/Biomasse/case-studies,did=183292.html?view=renderPrint

http://www.egr.msu.edu/classes/ece480/goodman/spring09/group02/files/PreProposal.doc

http://www.solarserver.de/solarmagazin/anlage_0207_e.html

http://www.tz.undp.org/news_170608.html

[38] http://www.scidev.net/en/news/africa-still-dependent-on-satellite-net-access.html

have been connected to the SEACOM cable, which links to India and Europe in mid 2009[39]. A second cable project EASSy (The Eastern Africa Submarine Cable System) which links between Eastern and Southern Africa but does not itself make a connection outside of the continent, is expected to be completed during 2010. The greatest connection capacity currently projected will be that of the WACS (West Africa Cable System) project which is envisaged to be completed by 2011.

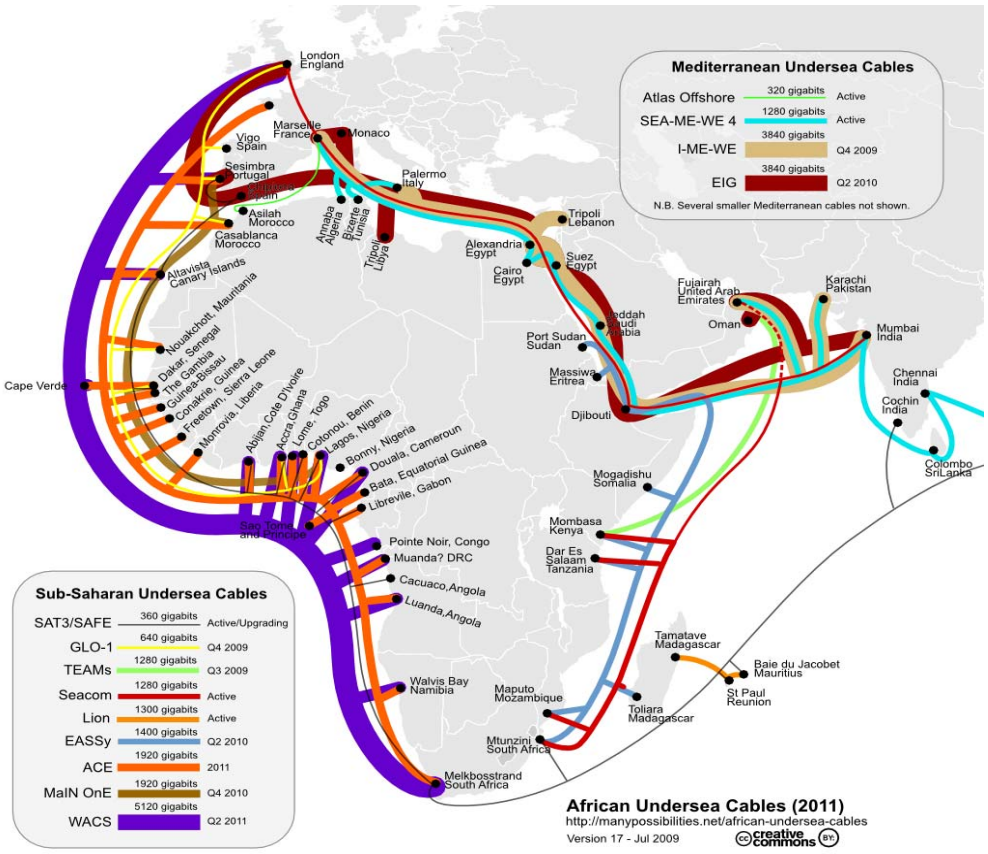

Figure 4.1: Map of Existing or Planned African Submarine Cables (as of June 2009)

Source: Steve Song (http://manypossibilities.net/african-undersea-cables).

Since its availability in 1996, there have been several initiatives, funded by international organisations, for enhancing the ICT infrastructure in Africa. The key projects related to internet access include United Nations Development Programme's (UNDP) IT for Development, the World Bank's WorldLink, and the International Development Research Centre's (IDRC) Acacia Project. Another project aimed at developing internet connectivity and improvement in national ICT capacity in Africa was the Internet Initiative for Africa (IIA) funded by the UNDP. Nevertheless, access to computers and internet remains a challenge for the African region.

[39] http://www.seacom.mu/news/news_details.asp?iID=100

It is noted that the majority of the schools in East Africa are without internet and computer access[40]. In Kenya, some schools have computers but this could be limited to one computer in the office of the school head. Very few secondary schools have sufficient ICT tools for teaching and learning. Even in schools with computers, the student-computer ratio is high. The schools with ICT infrastructure have acquired it through initiatives supported by parents, the government, NGOs, or other development agencies and the private sector, including the New Partnership for African Development (NEPAD) e-Schools programme. There have been minimal attempts to set up basic ICT infrastructures in primary schools (Farrell, 2007).

Various small-scale funded projects have been set up to provide internet and computer access for schools in the region. For instance, through a project funded by the Swedish International Development Agency (SIDA) internet connectivity is being provided to the schools, health centres, hospitals and council offices in remote rural locations in Tanzania. The project aims to explore low cost and sustainable solutions for providing connectivity to rural Tanzania so as to replicate the model to the rest of the country[41]. SchoolNet Africa is another project aimed at connecting schools in Africa[42]. This and other projects aimed at connecting or equipping schools in Africa have already been elaborated in Section 3.

In Uganda, a number of schools have computers and internet access; though some are not connected to the internet and some schools lack electricity. "The computers are normally set up in one-room laboratories with 10 to 20 machines. A television receiver with a VCR may be included depending on reception capability. Use of the facilities is scheduled two or three times per week per class but congestion is frequent because of large class sizes" (Farrell, 2007, pp.7-8). Following the policy emphasis on ICT, the Ministry of Education and Sports became more proactive, for instance; generators and computers were provided to NEPAD e-schools, software and upgrades for the computers already in schools were procured, agreements with Uganda Telecom for voice and data connectivity were secured, and work has started on introducing ICT into the teaching and learning process in primary and secondary schools (ibid).

One of the important means of connectivity in other locations, i.e. fixed lines, is largely unavailable in Sub-Saharan Africa. Most fixed phone lines are available in the cities and have a high access cost (Gillwald & Stork, 2008). As a result, the number of people with internet access through fixed phone lines remains quite low, although internet cafes and Web-enabled mobile phones are becoming more prevalent. Table 4.1 presents the statistics on the numbers of internet users in various Sub-Saharan African countries. Users in Africa (almost 66 million) make up about 4% of internet users globally, yet Africa has 14.6% of the world's population.

Table 4.1: Internet Penetration in June 2009

Country	% Population
Tanzania	1.3
Kenya	8.6

[40] http://www.egr.msu.edu/classes/ece480/goodman/spring09/group02/files/PreProposal.doc

[41] http://www.tzaffairs.org/2009/01/connectivity-for-remote-schools/

[42] http://www.schoolnetafrica.org/english/index.htm

Uganda	7.7
Rwanda	2.8
Burundi	0.7
Zambia	5.9
Malawi	0.9
Mozambique	1.6
South Africa	9.4
Ghana	4.2
Ethiopia	0.4
AFRICA	**6.8**
WORLD	**24.7**

Source: Internet World Stats[43]

In the absence of widespread fixed phone line access, mobile connectivity is emerging as a powerful means of providing connectivity in Africa and over 90% of phones are now digital. Van der Merwe (2003), the CEO of Wireless G observed that in Africa "the [wireless] technology lends itself to the rapid, low-cost rollout of a new wave of connectivity into rural areas not currently served by telecoms. It's a paradigm shift, a leapfrogging of earlier technologies".[44] According to Peña-López (2009), the number of mobile phone connections in Africa increased sevenfold between 2002 and 2007 and the percentage of cellphones per inhabitant was 28% (compared to 110% in Europe and 38% in Asia). At the same time, it is noted that the mobile market is concentrated in urban areas and its cost of access is high (Were et al., 2007).

With the rapidly increasing access to mobile technologies in Africa, mLearning appears as a viable alternative to traditional learning, especially for rural areas (and for increasing participation of learners with disabilities). During the eLearning Africa conference, Traxler (2009b) argued that

> In Africa, mobile learning is partly a way of dealing with the challenges of poor connectivity, mains electricity, and PC availability on the one hand, and on the other hand, has been stimulated by the enormous spread of mobile phones and by the vigour and talent of the mobile phone networks.

He also spoke about several mobile learning pilot projects taking place in Kenya, one of which was the use of SMS to support in-service teachers' training.[45] Similarly, Brown (2005) identified mLearning as "the gateway to e-learning for most learners in Africa". Amongst the promising developments comes a word of caution from Kukulska-Hulme (2005) who suggests that along with benefits, potential pitfalls need to be considered. Use of mLearning is associated with a shift in pedagogical approach and learning styles. Adopting tasks which have worked well with other forms of technology to mLearning contexts could be detrimental and could well be an overwhelming experience for the learners using an unfamiliar mode of learning (ibid., p. 192). Also, mobile technologies used for communication purposes are often less powerful (with short battery life, small screen, and so on) support for learning activities, and the cost of good quality mobile devices could be far more than an average person could

[43] http://www.internetworldstats.com/stats1.htm. Percentage of population is defined by those who went online on the last 30 days.
[44] http://www.acacia.org.za/WEBTIMES/news_releases.htm
[45] http://www.elearning-africa.com/newsportal/english/news70.php

afford (ibid). Other issues arising include security of handheld devices and safety of unsupervised use of the internet. Further research is required to understand the pedagogical design and challenges associated with the use of mLearning.

4.2 Affordability of technology

Available technology needs to be affordable by schools if it is to be adopted. At the national level, affordability could be limited by the high cost of putting infrastructure in place, and is linked with the issue of poverty. At the individual or organisational level, expensive hardware and software as well as high costs of communication and services restrict access to ICT. Most schools in Africa do not have the means to purchase expensive computers and hardware, and provide training for their staff. Schools could adopt cost-cutting measures such as those suggested by James (2001) cited in Minishi-Majanja (2007, pp.11-12):

- the use of open source software or cheaper versions of software which can operate on older hardware;
- procurement of refurbished computers;
- redesigning of hardware so as to lower the cost of internet access, including using hardware that does not have hard drive or disc drive but has internet software;
- merging internet technology to use television connection with modifications; and
- using community wireless LANs (local area networks) e.g. Air Port [46] and Residential Gateway.

However, Wells and Wells (2007) caution against adopting technology for which local expertise is not available, as it would result in high maintenance costs for the user.

4.3 Community facilities

The idea of shared computer access emerged in Europe, Canada and the US during the 1980s and 90s, and emerged as a global movement through the establishment of telecentres around the globe through funding from development agencies (Fillip & Foote, 2007). In Africa, community technology centres where access to computers, the internet, and more importantly, training to use the technology was provided to the local communities, were set up by funding agencies (such as IDRC, the International Telecommunications Union (ITU) and UNESCO) during the mid 1990s. These telecentres typically housed a few computers with internet connections and skilled staff to train people in the use of computers. The centres were set up in schools, hospital or other facilities in rural areas. The community surrounding the telecentre was encouraged to use the computers or to register for regular training programmes in the use of computers.

In 2001, a project of setting up school-based telecentres started in Uganda and Zimbabwe, with support from IDRC/ITU and UNESCO. Cost was shared amongst the participating schools where the schools paid US $200 per month and World Links matched the contribution over a 2-year period. The schools raised funds from charging students where each student paid an average of US $18 per year. In this

[46] http://www.freebase.sourceforge.net

project of strategic importance, the challenges were related to lack of reliable electric power, adequate time (teacher workload) and identifying community needs (Minishi-Majanja, 2002).

Public access to internet and computers, through public schools, libraries and community centres, is also seen as a way to make technology affordable and accessible to local communities. A project by Carnegie Corporation of New York is working towards making technology more accessible and affordable for the local communities. The programme aims to support the "creation of model libraries by updating and digitising key public and university libraries in Sub-Saharan Africa and Development of innovative technology and processes that offer access to information to public and university libraries"[47].

Despite their promise, there have been issues related to the sustainability and success of telecentres. Benjamin (2001) identified good management, developing new services, external linkages, networking, finances, and top-down programmes as important factors for the success of telecentres in South Africa. A recent review of literature on impact of public access to ICT revealed limited "conclusive evidence on downstream impacts of public access to ICTs" (Sey and Fellows, 2009). In this review, four main types of evidence were identified, i.e. evidence on venue performance and sustainability, users, usage patterns and downstream impacts, where the evidence of downstream impact remained difficult to gauge. Also, sustainability of telecentres in low resourced areas, their impact on economic uplift of the community and gender were identified as critical challenges. A need for further research in this area was also highlighted.

4.4 School policy on ICT use

It has been noted that within a school different students may have different levels of access based on the subjects they opt for. In Uganda, students taking computer studies as a subject have greater access to computers and in schools that have cyber schooling and computer clubs, science students and club members often enjoy greater access to the computer rooms (Ndidde, Lubega, Babikwa & Baguma, 2009). Access to ICT facilities therefore varies with school and students. For instance a study by Ndidde et al. (2009) revealed variations in ICT use for learning by students, depending on access to computers, institutional rules and regulations and the level of ICT skills by the learners. Primary school pupils may use the computer laboratory only once a week for about 30 minutes at secondary level, students' use of computers for learning varied according to school and instruction by teachers, class level and whether they belonged to the computer club or not. Only students taking computer studies as an examinable subject at 'O' level have regular access to the computer-based library (p. 13). Lack of proper integration of ICT with the school curriculum is thus a problem, as we have flagged up in earlier sections. These issues are further explored in Section 5.

4.5 Sociocultural and linguistic factors

Sociocultural factors such as age, gender, social class, physical mobility, HIV status, geographical location, religion, language, literacy and certain cultural practices are all potential barriers to access and use of ICT; these factors affect people in many Northern and Southern countries although they are highlighted in the SSA context by Mutula (2004) and in other contexts by many researchers of the "digital divide" (e.g. Becta 2001; Kozma et al. 2004). There is not scope here to examine them in detail

[47] http://www.carnegie.org/sub/program/international_program.html

but we do extract from that body of work the key argument that physical access and connectivity are not the only kind of divide operating as other such factors come into play. In particular, local cultures and traditions influence the ways in which knowledge is created and interpreted. Hence, understanding the local means of generating and interpreting knowledge is important for ICT integration. Ryckeghem (1995) highlighted the importance of understanding the local culture in selecting appropriate technology and pedagogical approach, especially where many Africans prefer to consult colleagues or friends rather than to visit a library to find information. Gender is another key area of divide and there is evidence that gender inequities observed in relation to school students' use of computers are being transferred onto new media such as the internet, and that positive strategies to include girls are needed (e.g. Sunley 2007). Indeed Olatokun (2008) argues that ICT has widened the digital divide gaps between Africa and the rest of the world, and between males and females. These are complex issues that we can really only flag up here.

In the discourse on access to technology in the African continent, Osborn (2006) brought in the linguistic dimension. The dominant language of technology is English and those with limited understanding of English language are marginalised. Also, it is argued that the urban bias of internet penetration (and electricity supply) disadvantages people from the villages. Since city dwellers typically have better English language skills, it is not considered financially viable to invest in content and applications in local languages, which further disadvantages the poor.

4.6 Economic and political factors

Chege (2003) cites lack of acceptance of ICT as an urgent national need as a reason for slow penetration of ICTs in the Africa. Technology is still considered a luxury by many within the region and extreme poverty necessitates countries to choose between feeding the hungry and sheltering the homeless over investing in enhancing technological infrastructure and thereby improving access. Schools themselves are under-funded and have little resource to spend on technology.

Absence of policies to regulate the growth and use of ICT in the country creates a barrier. Minishi-Majanja (2007) mentioned that computers and related items are often treated as luxury items and heavy government taxes are imposed which increases the cost of such equipments. Deregulation of polices related to satellite communication and other telecommunication links, and regulating ISPs, government and cross-border data flows is needed. Mutula (2004) has argued for government subsidy on technology to educational institutions.

Minishi-Majanja (2004) identifies *financial sustainability* as one of the major constraints for ICT use in schools. According to Sheriff (2007), internet was first introduced in Tanzania in 1989 when a "store-and-forward" email system was used. In 1995, a network of users in Tanzania was built without any link with the global internet. The first live internet connection (via satellite) was available in 1996. The cost of connectivity was high with a mere 32kbps link costing an ISP about US$ 16,000 in 1999. Over the years, while the cost of connectivity has reduced, it still remains high as compared to other parts of the world. It is expected that the arrival of the undersea fibre optic cable network during 2009-10 will reduce the cost of connectivity substantially[48]. Also, most infrastructure and access-related projects have relied heavily on donor funding and in the absence of plans for financial sustainability, issues surface when donor aid ceases.

[48] http://allafrica.com/stories/200903021720.html

Conclusion

In this section, factors affecting the use of ICT by schools, teachers and students in Sub-Saharan Africa have been identified. Significant issues related to lack of electricity, poor technology infrastructure and high cost of access have been highlighted along with geographic factors such as size, terrain and communications, demographic factors such as population size, density and dispersion (e.g. Anderson 1997), and deeper concerns related to socio-cultural, linguistic, and political factors. Additionally, sustainability of donor-funded projects and acceptance of ICT as a priority area for integration into African life pose significant challenges for access. The issues of access are further exacerbated by low levels of literacy, extreme poverty, growing instances of HIV, and a lack of political will to alleviate the situation through proper planning. Without an integrated framework for improving the poverty situation, and educational and health provision, along with ICT infrastructure enhancement, the desired results might not be achieved. Although the questions regarding the availability of ICT for all in Sub-Saharan Africa prevail, amongst these are avenues for future inquiry into the role of ICT towards educational development.

Section 5

Curriculum and school-related factors influencing integration of ICT in primary and secondary classrooms: evidence from Uganda, Kenya and Tanzania

Susan Namalefe

Key words: *ICT, curriculum, assessment, integration, discrete subject, ICT literacy, leadership, pedagogy*

Introduction

This section deals with curriculum and school-related factors that influence the introduction of ICTs in schools with specific references to Uganda, Kenya and Tanzania (the three original EAC countries). The national curricula and assessment patterns in the three countries are discussed and more specifically, the curricula for teaching ICT as a discrete subject in these countries are presented, including evidence of ICT applications. Additionally, school-related factors such as physical access to ICT facilities and internet connection (see Section 4 for more details), language of instruction and software availability, school leadership as agents of change and the compulsory/optional status of the subject are identified. By so doing, patterns of integration of computers as teaching/learning tools across the curricula are explored.

5.1. National curriculum and assessment

One key theme that emerged from evidence is that, except Tanzania, no other East African country has a curriculum for the teaching of ICT as a discrete subject in primary schools. The subject may be offered by some schools but it is not examined by the national examination boards in these countries. ICT is, however, taught as a discrete subject at the secondary school level and is examined. Besides, language of instruction and availability of software, especially in Tanzania, are further key factors influencing the integration of ICT in education in the countries of this region. These issues are discussed in greater detail below. For the purpose of clarity, curriculum planning and assessment practices are elaborated in a countrywise manner.

5.1.1 Uganda

The Ugandan national primary curriculum emphasises the development of functional literacy and numeracy, effective communication skills in local languages, appreciation of diversity in cultural practices, traditions and social organisation, acceptance of variety in beliefs and social values, and a sense of national identity. The curriculum is planned with the view that the mother tongue will be the medium of instruction from Primary 1 (6-year-olds) to Primary 4 (10-year-olds) for the proper development of the above attributes, while English will be used as the medium of instruction after Primary 4. However, evidence suggests that in reality the medium of instruction is English throughout primary education (Uganda. Ministry of Education and Sports, 2007).

The primary school curriculum comprises eleven subjects namely Basic Primary Technology including Art and Craft; Mathematics; Language and Literature, Mother Tongue/pre-language, English and Kiswahili; Social Studies, Religious Education, Music, Dance and Drama; Agriculture and Home Economics; Business and Commercial Education; Science, Health, Environment and Population Education; Physical Education and Community Service Scheme. Basic Primary Technology is a new inclusion in the curriculum aimed at developing the necessary knowledge, attitudes and skills of the pupils by means of hands-on activities (Uganda. Ministry of Education and Sports, 1999).

There is integration both within individual subjects and across the curriculum aimed at developing integrated learning and application of knowledge and skills. Emphasis is on experiential learning with a view to developing responsible citizens. Science, therefore, incorporates Basic Science, Health, Environment Education and Family Life Education. Social Studies include aspects of Environmental Education, Family Life Education and Community Service so as to promote a sense of community and good citizenry. Mathematics and English similarly draw on the rich environment within the context of family life in various sections of Ugandan communities (Uganda. Ministry of Education and Sports, 1999).

The assessment of pupils is undertaken annually by the Uganda National Examinations Board (UNEB) which sets and administers the Primary Leaving Examination (PLE). The examination comprises four subjects; English Language, Science and Health Education, Mathematics and Social Studies including Religious Education. Scores range from 1 (the best) to 9 (the worst), the results in the whole Primary Leaving Examination range from aggregate 4 (the best) to aggregate, 36 (failure). The candidates are then graded into about five grades. First grade ranges from aggregates 4 to 12. Each subject in the curriculum has a set of objectives. Although objectives concern cognitive aspects (knowledge, comprehension and application of facts, concepts, and principles), developing manipulative skills, positive attitudes, behaviour and values, the examinations always give written tasks, and can only determine cognitive aspects indirectly (Uganda. Ministry of Education and Sports, 1999).

Curriculum for teaching ICT as a discrete subject

In Uganda, Computer Studies (CS) is taught as a separate subject in secondary schools, and it is examined by the Uganda National Examinations Board (UNEB) at the end of the 4 years of lower secondary. The aim is to equip learners with "computer information and communication technology in order to enhance one's productivity and development of creative skills for problem solving and efficiency" (UNEB, 2005, p. 270). The subject objectives include; equipping learners with knowledge and skills in the use of ICT, which they can apply in other subjects. Learners should be able to use different computer technologies to access, analyse, interpret, process and disseminate information. They should additionally understand how to live in a technological society and exhibit ethical behavior in the use of ICT, and use knowledge acquired at the secondary level as a foundation for further studies in computer technology (UNEB, 2005).

Topics covered in the four years of lower secondary include; The computer: history and present uses, Components, categories, classification and functions of computers; Computer hardware, Computer software, Introduction to computer word processing, Introduction to spreadsheets, Introduction to computer communication, internet and intranet, Introduction to databases, Introduction to presentation software, Introduction to web publishing and The future of computers and the internet (UNEB, 2005, p.271-274).

5.1.2 Kenya

Primary education in Kenya is the first phase of the formal educational system. The starting age is 6 years and primary school takes 8 years. The objectives of primary education are:

> To promote growth of the whole person through developing the mental, physical and emotive abilities and attitudes; to impart literacy and numeracy and nurture scientific and social skills; promote social equity and lay a foundation for further education (Kenya Government 1998, p.55).

The primary school curriculum is therefore designed to provide "a functional and practical education that caters both to the needs of children who finish their education at the primary school level, and to those who wish to continue with secondary education" (State University.com, 2009).[49] The subjects taught in primary schools include English, Kiswahili, mathematics, science, music, history, civics, geography, and religious education.

Secondary school education in Kenya starts at the age of 14 years and takes 4 years. The aim of secondary school education is "to prepare students to make a positive contribution to the development of society, and to acquire attitudes of national patriotism, self-respect, self-reliance, cooperation, adaptability, and a sense of purpose and self-discipline" (State University.com, 2009).[50] Six major areas covered in secondary education are communication (English, Kiswahili and foreign languages), mathematics, science (physical and biological), humanities (geography, history, government, religious education, social education, and ethics), applied education (agriculture, industrial education, wood technology, metal technology, power mechanics, electrical technology, business education, accounts, commerce, typing and office practice, home science, clothing and textiles, food and nutrition, arts, and music), and physical education. At the end, students are examined in a minimum of eight subjects of which English, Kiswahili, and mathematics are compulsory. This leads to the award of the Kenya Certificate of Secondary Education (KCSE). Computer Studies is a recent appendage to the curriculum. So, it is clear that in Kenya, like Uganda, emphasis on ICT has been introduced in the secondary school.

ICT as a discrete subject

In Kenya Computer Studies (CS) is offered as an optional subject in secondary schools. The subject is aimed at enabling the learners to; "appreciate the computer system and the development of computers, safely use computers, understand the role of ICTs, interact with the global society, and acquire basic knowledge, skills and attitudes to help them live in a fast changing technological world" (Kenya. MoEST, 2002, p. 30).

Topics covered in the 4 years of secondary education include Introduction to computers, Computer systems, Operating systems, Application packages: word processing, spreadsheets, databases, desktop publishing, internet and Email. Data security and controls, Elementary programming principles, Application areas of ICTs, Impact of ICT on society and Career opportunities in ICT (MoEST, 2002, p. 31-44, Kenya).

[49] http://education.stateuniversity.com/pages/773/Kenya-PREPRIMARY-PRIMARY-EDUCATION.html
[50] http://education.stateuniversity.com/pages/774/Kenya-SECONDARY-EDUCATION.html

5.1.3 Tanzania

Primary Education in Tanzania is universal and compulsory for all children aged 7 onwards. Primary education aims to equip pupils with "permanent literacy and numeracy, basic life skills and values to enable them function productively in the socio-economic setting of Tanzania and pursue further education and training" (Tanzania. MoEC, 2001). At the basic education level, examinations are administered at Standard (Grade) 4 (age 10-11) and at the end of the primary cycle at Standard 7 at age 13-14. Both examinations assess pupils' acquisition of knowledge, abilities and skills in Mathematics, General Knowledge, and languages (Kiswahili and English).

Secondary education refers to post-primary formal education offered after completion of 7 years of primary education. Secondary education aims to

> Consolidate and broaden the scope of basic ideas, knowledge, skills and attitudes acquired and developed at the primary educational level; Enhance the development and appreciation of national unity, identity and ethic, personal integrity, respect for human rights, cultural and moral values, customs traditions and civic responsibilities and obligations; Promote linguistic ability and effective use of communication skills in Kiswahili and English; Provide opportunities for the acquisition of knowledge, skills, attitudes and understanding in prescribed or selected fields of study; Prepare students for tertiary and higher education, vocational, technical and professional training; Inculcate a sense and ability for self-study, self-confidence and self-advancement in new frontiers of science and technology, academic and occupational knowledge and skills; and Prepare the students to become responsible members of the society (Tanzania. MoEC, 2001)

Curriculum for teaching ICT as a discrete subject

Tanzania has a curriculum for ICT in primary and pre-primary education; referred to as *Teknolojia ya Habari na Mawasiliano* (TEHAMA). Currently, this subject is only taught in a few schools located at district headquarters, which have ICT facilities. Very few primary schools have computers or internet access. Almost all schools have radios, but only a few have TV, and these are restricted to areas that have electricity (Tanzania. MoEVT, 2007). In primary schools, Information and Communication Technology (ICT) is therefore taught as a discrete subject. The subject aims at enabling primary school pupils to "search, compose, send and receive information from various sources", in order to improve communication in education, economic and political activities using both traditional and modern technologies. ICT is viewed as important in society in aiding the acquisition and dissemination of knowledge, skills and attitudes; facilitating teaching and learning, speeding up the process of economic development and increasing efficiency in various sectors (Tanzania. MoEVT, 2005, p.iii).

The general objectives of ICT use in primary schools are:

> Identifying different strategies of searching and getting information from various sources; building capacity of using traditional and modern technologies in developing knowledge and skills; using information communication technology in the process of teaching and learning; and Applying information and communication technology in economic, political and societal development. (MoEVT, 2005, p.iii)

By the end of Standard 7 (12-13 years) the pupils are expected to have developed competencies such as, using various multimedia and ICTs to process and share information. Pupils' age and class levels are the key determinants of content. The topics are arranged logically starting from the simple to the complex and the time allocated to topics also depends on the complexity. Instructional time ranges

from 26 hours a year in Standard one to 52 hours in Standard 6 and 7. Each topic has specific objectives based on the cognitive, psychomotor and affective domains (Tanzania. MoEVT, 2005).

Topics taught in primary schools include:

> Identification and interpreting information from pictures and drawings, attentive listening, Communication methods including, telephone, written and non verbal. Use of library and other information and communication centres and equipment. The computer and its uses, postal services, radio, newspapers, journals, books and television; Word Processing, Spreadsheets, Local area network and internet. (MoEVT, 2005, p. viii, Tanzania)

In secondary schools, Information Computer Studies (ICS) is taught as a separate subject, aimed at developing several competencies. By the end of the 4-year course, the students are expected to be able to: Interpret organize and present information in a variety of forms; use Information and Communication Technologies in data and information processing. Apply principle, knowledge and skills of information technology in daily life; Solve problems using computers and demonstrate willingness to keep abreast with current developments and issues related to everyday use of computers (Tanzania. MoEC, 2005a, p.v).

By the end, the student is further expected to be able to: process and interpret information, explain the role of information technology in socioeconomic and cultural development of the society, apply information technology knowledge and skills in their daily living and understand networks and security issues in a networked environment (MoEC,2005, p.v.). This syllabus is planned to be covered in 40 weeks over the school year. The subject is allocated 2 periods of 40 minutes each per week (Tanzania. MoEC, 2005a).

Topics taught in secondary schools include Information dissemination, Communication media, Significance of computers, The computer, Computer evolution, Word processing, Spreadsheets, Computer networks and communication, Impact of ICT on society, Web development, Management of database information systems, Presentation, Desktop publishing and Multimedia (Tanzania. MoEC, 2005a, pp. 2-62).

5.2 Language of instruction and of ICTs in education in Tanzania

The language of instruction in Tanzania has been significant to the integration of ICT in education. All pupils in primary schools in Tanzania except those in private schools learn all subjects in Kiswahili for the 7 years of basic education. However, in secondary schools and all higher learning institutions, Swahili is treated only as a subject and not a medium of instruction. Conversely, the English language is taught as a subject in all public primary schools but becomes a medium of instruction in all subjects after the 7 years of primary education.

A stakeholders' workshop held in Dar es Salaam on the theme "*The future of ICT in Secondary Schools - Strategizing for implementation***"** raised many issues including the question of adopting ICT in a foreign language (English), while most Tanzanians can only speak, read or write in Kiswahili. Some of the questions raised were:

> How can ICT bring about rapid development in Tanzania by adopting it in our secondary schools, while most of the content is English, a language still considered foreign?" "How can ICT develop Tanzania by

adopting it in English in secondary education when less than 12% of the relevant age group proceeds to secondary schools? (Menda, 2006).

Kiswahili constitutes less than 2% of the internet content. Conversely, over 95% of the Tanzania population can only speak, read and write in either Kiswahili or tribal languages and therefore may not precisely follow most of the internet content even though they have access to it. The challenge therefore is to develop enough ICT-based Kiswahili content before ICTs can fully be integrated in Education (Menda, 2006).

In summary, Eastern African countries have a curriculum for teaching ICT as a discrete subject in secondary schools but only Tanzania has a curriculum for primary schools. Different names are used for the subject including; Information Computer Studies (ICS), Information and Communication Technology (ICT), and Computer Studies (CS). The subject is examined by the national examination boards at the end of the primary and secondary school levels. Besides, Computer Studies is offered as an optional subject therefore not all the students study it in secondary schools. Although secondary school education in Uganda and Tanzania progresses to the advanced level (Form 5 and 6), computer studies is only offered at the lower level (up to Form 4). However, children are being educated to use ICT although there is insufficient access to resources to facilitate subject teaching and learning fully. The trend is that computers are being used to teach basic skills, word processing, spreadsheet, databases, desktop publishing and internet. Universities, however, teach courses in computer sciences. There is limited or no integration of computers as teaching/learning tools in other subjects neither does the curriculum prepare students to use ICT to study other subjects (Tanzania. MoEC, 2001).

On the whole, Eastern Africa countries are still at the initial stage of ICT integration, and yet to shift focus to the primary issue of the role of ICT in education. This poses a challenge for educators and schools to "develop a conceptual basis for applying technology – one that looks at how we think, solve problems, make decisions and interact using computers as tools" (Flanagan, 2003, p. 126). Such a framework would lead to a better understanding of the relationship between technologies, pedagogy and student learning, and hopefully provide answers to questions such as: "What can teachers and learners do differently or better with digital technologies than with present tools? How can computers and networks be used to meet the needs of the diverse learners in our schools? How can teachers be supported in their uses of technology to enrich curriculum in meaningful, integrated ways?" (ibid.).

5.3 ICT literacy among students

Literacy in today's digital age requires more than the ability to read and write. There are differing views or types of literacy including: "computer literacy, digital literacy, hyper-literacy, information technology literacy, interactive literacy, internet literacy, library literacy, media literacy or mediacy, multiple literacy, network literacy, oral literacy, or "oralcy" and visual literacy" (Raseroka, 2003, in Kawooya, 2004, p. 423). These differing perceptions of literacy have emerged partly because contemporary dynamic technologies demand innovative capabilities to access information and interact eloquently in the increasingly electronic communities. Drawing from Kawooya's (2004) definition of information literacy, ICT literacy can be defined as "the ability to realise the need for finding and effectively using" ICTs (p. 423). ICTs are vital in accessing, using and disseminating information hence the relationship between ICT and literacy and the need to review ICT literacy among students in the whole equation of ICT use in schools. (Teacher ICT literacy is dealt with in Section 6.)

Since ICT in education is a recent occurrence in Eastern Africa, not many initiatives have specifically concentrated on ICT literacy among students. Reviewed surveys and reports on ICT in education have mainly concentrated on infrastructure and connectivity; it is therefore hard to gauge the level of ICT literacy among students. While students are taught basic computer skills, given the constraints of access and connectivity, one would hesitate to say that after 4 years of secondary education students can effectively use ICT to interact meaningfully in the increasingly digital world. Moreover the education systems in Eastern Africa are so examination-based that practical subjects like computer science are taught theoretically with students being drilled to pass exams. Research would have to be undertaken to evaluate ICT literacy among students especially after the many initiatives to equip schools with computers. This is crucial because technology presence does not always mean technology use. Most schools are now equipped with computers but there is a dearth of research carried out that would establish whether students actually use these computers and how ICT literate they are as a result.

5.4 School leaders as agents of change in ICT integration

Despite the importance of school leadership in supporting ICT integration, leadership has been overlooked in the many initiatives to integrate ICT in schools in East Africa. Not much literature is available on school leaders' technology leadership capabilities and the part that school leaders play or should play as leaders in ICT integration. This omission is strange given the fact that literature (e.g. Fullan, 2003; Schiller, 2003 cited in Afshari, Bakar, Su Luan, Samah and Fooi, 2008) on school effectiveness, school improvement and change emphasises that leadership is important in achieving successful change (Afshari et al., 2008). Lack of 'technology' leaders could therefore be one of the factors influencing the integration of ICT in education. For instance, in their study of 11 institutions, Ndidde et al. (2009) revealed that the majority (8) did not have well formulated written plans for ICT integration. Only the expressed views and ideas of the educator in charge of ICT were available. The institutions also lacked strategic plans to implement and sustain the ICT infrastructure in place.

Flanagan (2003) observes that principals who are not prepared for technology leadership struggle to develop the resources required for ICT integration. When computers are introduced in schools, very few, if any, school leaders have in fact used computers in meaningful ways with children and therefore lack the necessary academic vision and experience to lead ICT integration. Flanagan (2003) laments the consequence that:

> In many schools, informal leaders have emerged from classrooms, libraries and computer labs to take up the difficult task of planning for technology integration, and supporting distributed and often uncoordinated efforts by enthusiastic teachers. Unfortunately, technology planning has too often been limited to the goal of acquiring hardware and software. Schools have focused on purchasing equipment, setting up labs and wiring their buildings, without considering the substantial organizational and cultural changes that are necessary to support appropriate use of technology to enhance student learning. As a result, many schools have expensive computer labs that are being used for typing, games and drill, if they are being used at all. (p. 127)

Furthermore, when it comes to the difficult task of making decisions and budgeting for equipment purchases, wiring and networking, without an understanding of how hardware choices and deployment scenarios impact student learning, principals have often relied on advice from technicians who often do not have the wide picture in mind.

> The result, in many cases, is a restricted, locked-down approach to school networks that is meant to protect the machines from the teachers and students. Innovative and exciting uses of computers for collaborative projects are impeded or completely blocked by closed network structures. (Flanagan, 2003, p. 127).

Far from creating learning opportunities, such restrictive networks serve as obstacles to computer use by both teachers and students. Therefore in schools where principals are not prepared to handle the complex issues around ICT integration, decision-making is based more on financial and technical considerations than pedagogy.

As key leaders of change in the teaching-learning processes, school leaders can facilitate the decision to integrate ICT into teaching, learning and school administration. To achieve that, school leaders need to understand, support and practice the idea that ICT integration is not about the ICT but about a change in the teaching and learning processes (Afshari et al., 2008).

The demands on schools to integrate ICT into teaching and learning processes should therefore come with a demand for leadership to lead the development. The introduction of any new strategy should also consider the improvement of the capacity of school leaders to lead the change. Head teachers are crucial in leading the integration of ICT into the school curriculum. If school leaders do not apply ICTs in their management practices, they may not be able to lead the integration of ICT in the classroom (Mentz & Mentz, 2003). Therefore education in the information age requires school leaders to not only update their skills and knowledge, but also work towards the transformation of their roles as educational leaders (TTL SA, 2002, in Mentz & Mentz, 2003).

Drawing from several research sources Leng (2008) reiterates that effective leadership is a key element of success in any innovation in education. He contends that leadership is critical for successful Integration of ICT in schools. Effective leadership is needed to take advantage of the potential of ICT in education. This suggests that the success or failure of ICT integration in schools depends on the leadership in the school. This could be because ICT integration involves decision making, influencing others, supporting teachers and being a role model in ICT use. It would therefore be interesting to investigate school leaders' technological leadership in Eastern Africa and ways in which school leaders can be specifically prepared for the integration of ICT in education.

5.5 Change facilitators and ICT champions/pioneers

According to Microsoft (2006, p.1),

> No single stakeholder, not even government, has the resources to plan, fund, implement and control successful, scalable, sustainable ICT deployments across an entire country. Partnerships are vital, and the real key to success is an inclusive partnership that pulls together the visions, resources and experiences of both the public and private sectors.

Generally, the champions in the introduction of ICT in schools in Eastern Africa have been "private companies (usually ICT based), government ministries, educational institutions, donor and development agencies, and civil society organisations working together to garner resources and set priorities for ICT in education projects" (Farrell, & Isaacs. 2007). These include for example

> The Kenya ICT Trust Fund, the Information Society Partnership for Africa's Development (ISPAD) put together by NEPAD through the e-Africa Commission and five major ICT companies in part to implement the NEPAD e-Schools Demonstration project. Schools Program, civil society institutions focused on

> networking African schools such as SchoolNet Africa (SNA), university partnerships such as the African Virtual University (AVU), and collaborative learning projects that directly involve learners and teachers from schools in several African countries such as the Global Teenager Project (GTP), Mtandao Afrika (MAf), World Links, and the International Education Resources Network (iEARN) (Farrell, & Isaacs. 2007, p. 2).

In Uganda, CurriculumNet has developed, tested, and integrated ICT-based instructional materials and teaching into the existing Ugandan curriculum. In addition, the project has explored the viability of using ICTs in education by evaluating their potential for a positive impact on teaching and learning, and testing the economic, technical and operational feasibility of the delivery process. The project was undertaken as a participatory effort, wherein curriculum experts and teachers were trained and supported in the collaborative development of ICT-based curriculum, and in delivering the curriculum electronically in their local classrooms (Institute for the Study of Knowledge Management in Education, 2008).

Conclusion

The review reveals that significant progress is being made in the endeavour to incorporate ICTs in education in the three original EAC countries. This is mainly characterised by the endorsement of computer science, computer studies or information communication technology as a discrete school-based subject examined by the national examination boards in addition to increasing access, use, and integration of ICTs within the school information and management systems. In general, emphasis on ICT has been mainly confined to secondary school education except in Tanzania where ICT has been introduced in the primary sector. However, access to ICTs in schools is commonly associated with having computer labs, which are often single rooms with between 1 and 20 networked computers, although some are standalone PCs (Farrell, 2007).

The countries face several challenges, however, in the attempt to integrate ICT in education. Currently, the curricula across the three countries do not prioritise ICT. It is mainly taught in secondary schools and to just a few students as it is offered as an optional subject. In addition, the ICT curriculum focuses on teaching students *about* technology, not how they can *apply* that technology to enrich learning. Moreover, students are taught basic computer skills and applications – predominantly word processing, spreadsheets, databases, desktop publishing and internet – but are not taught how to use ICT as a tool to facilitate learning in other areas. It is difficult to fully determine students' ICT proficiency from a modest body of published literature but we do know that schools are yet to address the critical question of how ICT can be integrated into other subjects and generally be applied to improve teaching and learning processes.

As reported in Section 3, the introduction of ICT in schools in Eastern Africa has been championed by private ICT-based companies, government ministries, educational institutions, donor and NGO / development agencies (such as World Bank's World Links for Development), civil society organisations and telecommunication companies (e.g. Zain, Vodacom, MTN and Safaricom in Eastern Africa) working together to garner resources and set priorities for ICT in education projects, such as SchoolNet Africa. These stakeholders have equipped schools with computers for teaching, learning and administration purposes; and students are enthusiastic about using computers for learning despite the high student: computer ratio. In Section 4, we saw that access to ICT facilities in schools in Eastern Africa is growing rapidly and connectivity is improving especially in urban areas through

wireless networks. There is also extensive use of mobile phone technology, and some countries are developing digital content for use across the curriculum.

Conversely, ICT use is still constrained by irregular or unavailable electricity supply, inadequate ICT equipment leading to overcrowding of computer labs, insufficient and inappropriate software including software designed for Northern contexts or languages and the highly prohibitive costs of software licenses, slow speed of technological development including unaffordable access to connectivity with adequate bandwidth (e.g. Anderson 1997). In most East African countries this is exacerbated by free primary education and Government policy of charging no fees in primary schools, and not charging exorbitant amounts in secondary schools. State funding to schools is usually consumed by teacher salaries and this makes it difficult for public schools to generate resources to set up the necessary infrastructure. Sometimes school leaders and boards of governors have a negative attitude towards computers and internet and hence do not prioritise access and connectivity (Ndidde et al., 2009). Despite the importance of school leadership in supporting ICT integration, not much literature is available on the specific contribution of school leaders as agents of change. Anecdotal evidence suggests a lack of "technology" leadership to oversee the integration of ICT in education such that access and use of ICT facilities by both students and learners is individual depending on interest and expertise and is thus not institutionalised.

On the whole, there is a need to address the challenges of infrastructure, connectivity and pedagogical integration of ICT into the curriculum. Schools may have to address institutional issues of access and use of facilities and develop capacity especially of the leaders to guide the integration of ICT in education. There is a need for a general paradigm shift from associating ICT with only computers and considering how other technologies can be integrated in education.

Section 6

Teacher factors influencing classroom ICT use

David Harrison

Key words: *ICT, Sub-Saharan Africa, pedagogy, technology, technological literacy, school, teacher education*

Introduction

The earlier sections have looked at, firstly, the importance of availability and accessibility of ICT resources (hardware, software, infrastructure) in terms of physical and other external factors. Secondly, the significance of context, including national policies on ICT use in a range of contexts (economic, educational, etc) and local level policies (school leadership, curriculum, etc), are discussed in the preceding sections. In so doing, the review has also established that Africa suffers from typical infrastructure problems including (1) insufficient numbers of computers and other technologies owing to limited funds; (2) absence of properly developed curricula for teaching ICT skills; (3) lack of subject teachers trained to integrate ICT into learning areas.

Qualified teachers are often seen as a catalyst in the introduction and effective use of technology in schools. Unfortunately, in many African countries, the lack of trained teachers and the low levels of teachers' ICT knowledge and skills have been identified as major impediments to effectively introducing technology into schools. For instance, 80% of the pupils in South Africa (one of the most developed countries in Africa) leave school before being exposed to a computer (Haupt and Mintoor, 1997, in Mentz & Mentz, 2003). This problem is further exacerbated by growing poverty and lack of funding for the teachers' salaries, and the exponential rise in student population in the last two decades (National Universities Commission, 2005) – that ironically relates to the admirable Millenium development goals concerning free universal primary education. The crisis is worsening further as increasing numbers of teachers become afflicted by HIV/AIDS. Indeed it has been observed by many that meeting the desperate need for more qualified, competent teachers is the most persistent and daunting challenge facing the African education system in general, and the integration of ICT in particular (Afe, 2002; Olakulehin, 2007).

There is substantial evidence that, in the right hands and used appropriately for specific purposes in specific contexts, technology can be an effective tool in supporting learning and teaching. However, it is now firmly established that it is critical to understand the ways in which technology is conceptualised to be of use in addressing the challenges of the developing world and the policy environment necessary for this to happen. Overall, this section focuses in more depth on the teacher level factors, in terms of both teachers' skills and experience with using technology, and their personal beliefs and perceptions about ICT gained through training and career development. These factors are considered in relation to classroom practice – how and why teachers use ICT in the classroom and what prevents its use – throughout primary and secondary schooling. While the focus of this review is on Sub-Saharan Africa and East Africa in particular, there are some useful messages to be learned from exploring the widespread integration of ICT into schools and teacher education in European and other developed country contexts. The discussion in this chapter draws upon such insights where relevant.

6.1 ICT in and for Education

The idea that teaching and learning can successfully take place using technology inspires both hope and dismay. There is the hope that more learners can be reached at a more convenient pace than has previously been the case, dismay that the infrastructures necessary for deploying technological resources or constructing an effective ICT platform are lacking in low-income countries. Tella et al. (2007) examined Nigerian secondary school teachers' uses of ICTs and its implications for further development of ICT use in schools through a census of 700 teachers. The results showed that for teachers a lack of technical support in the schools and teachers' lack of expertise in using ICT were the prominent factors hindering teachers' readiness and confidence of using ICT during lessons. Teachers are not always fully aware that pedagogic uses of the computer require the development, among teachers as well as students, of new skills and attitudes for the effective use of ICT. Aside from computer/digital literacy, teachers see ICT as kindling interest in students in the subject and in learning and an attitude towards information technology as a learning tool as an essential part of a lifelong interest in learning. Building on this, it becomes clear that ICT must be linked to the specific needs of developing countries and desist from the 'one size fits all' approach (Leach 2005, p.112) with ICT being used as a learner–centred tool, instead of within the more traditional pedagogy.

The ways ICTs have been used in the education can be clearly divided into two broad categories: (1) ICT for Education and (2) ICT in Education. ICT for education refers to the development of information and communications technology specifically for teaching/learning purposes, while ICT in Education involves the adoption of general components of technologies in the teaching process (more specifically, often for the training of teachers in the use of technology for teaching (Olakulehin, 2007). In a similar vein, UNESCO (2004) classifies ICT in education into three broad categories: (1) pedagogy, (2) training, and (3) continuing education. Pedagogy is focused on the effective learning of subjects with the support of the various components of ICT. Olakulehin (2007) emphasises that the pedagogic application of ICT involves effective learning with the aid of computers and other information technologies as learning aids, which play complementary roles in the classroom, rather than supplementing the teacher. Meanwhile, on the teacher training and continuing development side, one practical and highly significant approach to addressing the challenges has been the development of school networking and the formation of local and national entities such as Schoolnet (described in Section 3), which are less dependent on specific technological innovations and skills, encouraging school-based programmes rather than university or training centre-based initiatives (Hawkins, 2002). We now move to teacher conceptions of technology, and its benefits for schooling.

6.2 Why teachers use ICT

A range of studies have looked at why teachers choose to use ICT. These typically involve conducting case studies of classroom use in a particular setting or from a longitudinal perspective. Tella, Toyobo, Adika & Adeyinka (2007) examined Nigerian secondary school teachers' uses of ICTs and implications for further development of ICT use in schools using a census of 700 teachers. The findings showed that most teachers perceived ICT as very useful and as making teaching and learning easier. It was recommended that professional development policies should support ICT-related teaching models, in particular those that encourage both students and teachers to play an active role in teaching activities. Additionally, emphasis should be placed on the pedagogy underlying the use of ICTs for teaching and learning.

Research and active projects, such as those run by EdQual[51], a Research Consortium of educational institutions in the UK and Africa (Ghana, Rwanda, South Africa, Tanzania) on Educational Quality, typically indicate two main reasons why teachers use ICT: (1) teachers feel that their own use of computers benefits their learners, and (2) teachers feel learners benefit from using computers themselves; they gain confidence, self-esteem and renewed motivation. Haddad and Draxler (2002) categorise the technology use in a classroom into five levels: presentation, demonstration, drill and practice, interaction and collaboration. Building on this, Thijs et al. (2001) argue that technology use creates a learner-centred environment by

- Motivating learners by combining text, sound, colour and moving images that enhance content for easier learning;
- Facilitating acquisition of basic skills through drill and practice (not very learner-centred sounding though). This is better accomplished by education television broadcasts that teach literacy and numeracy at basic education level;
- Enhancing teacher training by improving access to and the quality of teacher training.

The 'educational' ICT literature makes frequent reference, both directly and indirectly, to rationales for the use of ICT in education. A literature review was carried out in 2003 which resulted in 19 distinct rationales for the use of ICT in education being identified by Fox and Twining (2006), as listed overleaf in Table 6.1.

The real challenge for educationists is, therefore, how to harness the potential of ICT to complement the role of a teacher in the teaching and learning process. Teachers who do not have a chance to develop professionally in the use of emerging technologies and acquire modern computer literacy and skills are under threat. The relevance of a teacher in the 21st century is determined by the will to develop professionally and appropriately, while teacher development, according to MacDougall and Squires (1997), should focus on the following aspects in pre-service and in-service training programs:

- ICT skills with particular applications
- Integration of ICT into existing curricula
- Curricular changes related to the use of ICT including changes in instructional design
- Changes in teacher role in the face of ICT
- Underpinning educational theories

These prepare the teacher to handle the learner-centred processes of education and play the role of facilitator, mentor and coach. This experience is also a learning experience for the teacher, as it will involve discovering new ideas alongside the learners. The teacher will have to become less authoritative in class and guide the learners on how to ask questions and pose problems, formulate hypotheses and locate information and then critically assess the information in relation to the problems posed.

[51] See http://www.edqual.org/research/ict.html

Table 6.1 The 19 rationales for 'educational' ICT synthesised from the literature

Rationale	Source
1. In order to learn IT skills	Harris (1999); Twining (2001a; 2002b; 2002c)
2. As a tool to achieve traditional teaching and learning goals across the curriculum	Harris (1999); Pelgrum and Plomp (1991); Twining (2001a; 2002b; 2002c)
3. In order to extend and enrich learning across the curriculum	Cuban (1993); Harris (1999); Hexel, De Marcellus and Bernoulli (1998); Twining (2001a, 2002b; 2002c)
4. In order to motivate learners	Hexel et al. (1998); Twining (2001a; 2002b; 2002c)
5. As a catalyst for educational change	Moseley, et al. (1999); Pelgrum and Plomp (1991); Twining (2001a; 2002b; 2002c)
6. Because of the impact of ICT on the nature of knowledge	Cloke (2000); Twining (2001b)
7. In order to fundamentally change teaching and learning	Dwyer, Ringstaff and Sandholtz (1990); Cuban (2001); Twining (2001a, 2002b; 2002c)
8. As a tool to support learners in thinking about their own learning	Twining (2001a; 2002b; 2002c)
9. In order to provide access to the curriculum for those who might otherwise be excluded from it	Twining (2001a; 2002b; 2002c)
10. In order to increase productivity in education	Cuban 91993)
11. In order to reduce the cost of education	Pelgrum and Plomp (1991)
12. In order to make education more efficient	Moseley et al. (1999); Cuban (2001); Twining (2002b; 2002c)
13. As a substitute for teachers	Harris (1999)
14. In order to reward teachers	Harris (1999); Twining (2002b; 2002c)
15. As preparation for living in a society that is permeated with technology	Pelgrum and Plomp (1991); Cuban (1993)
16. As preparation for work (employment)	Pelgrum and Plomp (1991); Cuban (2001)
17. In order to support and stimulate the country's economic development	Pelgrum and Plomp (1991)
18. In order to impress stakeholders (e.g. inspectors, funders, prospective parents/students)	Pelgrum and Plomp (1991); Twining (2002b; 2002c)
19. In order to reduce inequalities between students/pupils with differential access to ICT outside formal education	Twining (2002b; 2002c)

In summary, ICT enables teachers to demonstrate understanding of the opportunities and implications of the uses for learning and teaching in the curriculum context; plan, implement, and manage learning and teaching in open and flexible learning environments (UNESCO, 2004). ICT also facilitates enhanced learning in subject areas and learning at home on one's own, and these require the use of new tools like modelling, simulation, use of databases, etc. Changes in the teaching strategy, instructional content, role of the teachers and context of the curricula are all seen by teachers as obvious as well as inevitable. Using ICT is also perceived as having the advantage of heightening motivation for the learner; helping recall previous learning; providing new instructional stimuli; activating the learner's response; providing systematic and steady feedback; facilitating appropriate practice; sequencing learning appropriately; and providing a viable source of information for enhanced learning.

The real challenge for educationists is, therefore, how to harness the potential of ICT to complement the role of a teacher in the teaching and learning process. There is an understandable apprehension, even fear, as to the role of a teacher in an ICT-equipped classroom (Futurelab, 2003). Teachers who lack the chance to develop professionally in the use of modern ICT feel under threat. The relevance of a teacher in the 21st century is determined by their willingness to develop in this way, a discussion to which we return later.

6.3 The demands on teachers of using ICT

Based on their review of the policy and research literature, OECD (2002) concluded that there seemed to be a substantial international consensus that ICT was no longer conceived of as an educational goal in itself (for learning about ICT, as it appeared to be the case during the 1980s and early 1990s) but rather as a tool that can help facilitate a reform of education, introducing pedagogical approaches by which students would be stimulated to play a very active role in the learning process. For teachers this reform means they would have to redefine their role in the learning process by stimulating students to work and learn in self-sustained, responsible and autonomous ways. In any educational reforms the teacher is a crucial element. When considering ICT-related innovations in education we cannot see the teachers as isolated actors with no past. Teachers follow routines and implement strategies that they have learnt during pre-service training and in their schools, they are required to implement curricular objectives and contents that quite often are formally established and they work within the constraints of the school organisation. Any innovations that require teachers to change many aspects of their daily routines are very demanding. Complex innovations can only be successful if a number of interacting conditions are met. Therefore, the following questions need to be addressed:

1. What types of ICT skills do teachers need?
2. Which policies and programs are effective to prepare and motivate teachers for their role in education for the information society?
3. What is the impact of ICT on teachers' working conditions?

6.3.1 ICT skills needed by teachers

Many school leaders perceive the lack of ICT-related knowledge of teachers as one of the main impediments to the realisation of their ICT-related goals (Pelgrum, 2002). The literature describes the kind of skills teachers may need when integrating ICT in new student-controlled learning approaches. However, which competencies each teacher needs to acquire very much depend on the specific circumstances of their particular school. Some teachers may be suited for lecturing to large or small groups of students, while others are more confident in coaching or on technical matters. Teachers

themselves need to become lifelong learners, with traditional teacher "training" models perhaps being replaced by models that allow teachers to learn independently, at their own pace and supported by ICT (including teacher educators who are virtually present in addition to physical presence). Important support tools would be tools for self-assessment that direct teachers to relevant knowledge sources. There can also be recognition that substantial learning can take place while teaching and even by learning from students,

The UNESCO ICT competency standards for teachers (UNESCO 2008) describe three approaches: technological literacy; knowledge deepening; knowledge creation. These approaches are seen as part of a development continuum and each approach has different implications for education reform and improvement; each has different implications for changes in the components of the education system: pedagogy, teacher practice and professional development, curriculum and assessment, and school organisation and administration. ICT plays a different, but complementary role in each of these approaches, with new technologies requiring new teacher roles, new pedagogies, and new approaches to teacher education. The successful integration of ICT into the classroom depends on the ability of teachers to structure their learning environments in some non-traditional ways, merging technology with new pedagogies, to develop active classrooms that encourage cooperative interaction, collaborative learning, and group work.

In all, this requires a very different set of classroom management skills to be developed – including the ability to develop innovative ways of using technology to enhance learning and to encourage technology literacy, knowledge deepening and knowledge creation. Teacher professional development is seen as the crucial component of such educational improvements. However, it is warned that teacher professional development has an impact only if it is focused on specific changes in teacher classroom behaviours and particularly if the professional development is ongoing and aligned with other changes in the educational system.

6.3.2 Implications for professional development

The implications for change in teacher professional development and other education system elements differ as a country moves from traditional education to (1) technology literacy, (2) knowledge deepening, and (3) knowledge creation. Of the three approaches, the technology literacy approach involves the most basic policy changes. The policy goal of this approach is to prepare students, citizens, and a workforce that is capable of taking up new technologies so as to support social development and improve economic productivity.

Professional development programmes though have the goal of developing teachers' technological literacy so as to integrate the use of basic ICT tools into the standard school curriculum, pedagogy, and classroom structures. Leach and Moon (2002) describe the concepts underlying the process of teachers coming to know how, where, and when (as well as when not) to use technology for classroom activities, for management tasks, and obtaining extra subject materials and also pedagogical knowledge in support of their own professional development.

According to UNESCO (2009, p.8), educational changes related to the knowledge deepening approach have more impact on learning as they aim to add value to society and the economy by having learners apply the knowledge of school subjects to solve complex problems encountered in real world situations of work and life. Coordinated teacher professional development would provide teachers with the skills to use more sophisticated methodologies and technologies with changes in the curriculum that emphasise depth of understanding and application of knowledge to real world problems and a

pedagogy where the teacher serves as a guide and manager of the learning environment and students are engaged in extended, often collaborative project-based learning activities that can go beyond the classroom.

The most complex of the three approaches to educational improvement, the knowledge creation approach, aims to increase civic participation, cultural creativity and economic productivity by developing a population that is continuously engaged in and benefits from knowledge creation, innovation, and participation in the learning society (ibid., p. 11). Here, the curriculum goes beyond a focus on knowledge of school subjects to explicitly include the 21st century skills that are needed to create new knowledge and engage in life-long learning—the ability to collaborate, communicate, create, innovate, and think critically. Teacher training coordinates the teachers' sophisticated professional skills with the pervasive use of technology to support students who are creating knowledge products and are engaged in planning and managing their own learning goals in a school that is a continuously improving, learning organisation. So, teachers model the learning process for students and serve as model learners through their own ongoing professional development – individually and collaboratively.

6.3.3 The impact of ICT use on classroom teaching and learning

Bringing ICT into the classroom can have a considerable impact on the practice of teachers, in particular when ICT is conceptualised as a tool that supports a real change in the pedagogical approach. Newhouse (2002) points out that the real impact of ICT and the subsequent changes in pedagogy, development and training on teachers is varied and idiosyncratic although some general areas of impact may be identified as:

- the balance of roles they play with a perceived risk of reduced influence,
- providing greater access to information, leading to increased interest in teaching and experimentation (Cradler & Bridgforth, 2002),
- requiring more collaboration and more communication with teachers, administrators and parents *(ibid.)*,
- requiring more planning and energy,
- requiring the development of skills and knowledge of ICT, and
- providing more time to engage with students, leading to greater productivity *(ibid.).*

Not only do the teachers need to change their roles and class organisation, but in particular they need to invest energy in themselves and their students to get ready to introduce and manage new learning arrangements. Some have to start with acquiring basic ICT skills. They also need to determine which applications have added value for learning in their subject area. While doing this they need to be aware that this is not a one-time activity as the information environment is continuously changing. It is challenging for teachers who engage their students in open, flexible, authentic and autonomous learning environments to determine which basic subject, social and management skills students need in order to function in such environments. The change can impact on assessment tasks, with new learning environments moving away from summative methods of assessment to formative approaches and open-ended products (such as reports and research papers that are created by groups of students). These different aspects are time consuming and result in an increased teacher workload. Some things can be done to reduce the workload. To reduce the workload, teachers can be encouraged to share resources

with others and locate good practices on the Web and adapt these to their local circumstances. In a number of cases the high workload is caused by teachers wanting to control all the activities of their students, which means answering many questions and running from one student to the other all the time. Teachers can take time to discover that computers do not mean extra work but that they can actually make their work easier.

The impact on pedagogy can be summarised as being strategies that are (a) more learner-centred, (b) more cooperative and collaborative, (c) more active learning, and (d) based on greater access to information and sources of information. These impacts on pedagogy relate directly to the impacts on teachers, in particular the roles they play, their use of information, and their workload.

There is no doubt that teachers who use ICT in classrooms have to demonstrate high levels of energy, hard work and perseverance, often in the "face of considerable odds" (Lankshear & Snyder, 2000, p. 110). If they are early adopters then they are required to be resourceful and overcome many barriers to "make things work". Planning lessons involving computers can take considerable time and demands complex scheduling and resourcing. Therefore, teachers using computers in the classroom should not act in isolation from each other. They need to have access to resources that will supply ideas and material for different classroom applications, including peers who are also developing their own pedagogies and resources (Leach et al., 2004). While computers may be seen to have great potential in education, they also present teachers with some additional obstacles to overcome. Most of the potential benefits are directed towards the student in improved learning and instruction. Very few of the benefits are directed towards the teacher.

The Dutch ICT monitoring project (Pelgrum & Brummelhuis, 2001), a yearly collection of data from all sectors of primary and secondary education as well as teacher training institutes, includes questions to school administrators and teachers about their expectations for the future of teaching and learning. The teachers saw teacher-controlled education as the main characteristic of current educational settings, but they expected (without any objective evidence) that student-led education would be much more important for the future and would lead to improved outcomes for both students and teachers:

- Self-confidence/self-esteem through peer recognition;
- ICT skills;
- Pedagogical skills and/or other view on pedagogy;
- Collaboration with colleagues.

Less common but still of note were the following teacher outcomes:

- Fewer discipline and management problems;
- The relationships between students and teachers improved;
- Teachers learned from the students;
- Teachers improved their presentation skills.

Table 6.2 The Implications for Teachers in Using Computers in Classrooms

Potential	Implications for Teacher
Dynamic Learning	Students may learn outside the teacher's own area of expertise. More difficult to direct and manage student learning.
Student motivation	Students are easier to manage and direct towards the tasks. Students may be distracted by the computer from the tasks the teacher has intended.
Removing tedious tasks	More satisfying for teacher to direct less tedious tasks. Some teachers may prefer students to complete tedious, routine tasks as "busy" work.
Instruction to fit the learner	Relieves the teacher from needing to spend a lot of time with students who need extra practice, catch-up or extension work.
Independent learning	Learning may not direct itself towards the teacher's objectives. Additional coordination of the classroom, students and materials is required.
Extending student thinking	Student thinking may go beyond the teacher's experience or capabilities which may reduce the confidence of the teacher.

Teachers need to continually work at updating their skills and knowledge in the operation and use of ICT, in addition to their need to be up-to-date with curriculum content and pedagogy. It is therefore vital that they are supported in practical and motivating ways. Not surprisingly a number of studies have found that, "Personal access for teachers to a computer for the purpose of preparation and planning is one of the strongest influences on the success of ICT training and subsequent classroom use" (Office for Standards in Education, 2002, p. 3). Also supportive, enthusiastic and visionary leadership has a positive impact on teachers' attitudes and behaviours (Becta, 2002).

6.4 How ICT is used in the classroom

In the developing world, more often than not, ICTs such as computers are installed into schools without sufficient thought given to how they will be used. In "Ten Lessons for ICT and Education in the Developing World," Robert Hawkins (2002) from World Links[52] discusses his programme's experience in connecting schools to the internet, training teachers, and dealing with curriculum and education reform issues in developing countries citing a practical lesson that: "to take full advantage of new technologies, we need to fundamentally rethink our approaches to learning and education— and our ideas of how new technologies can support them." Yet it is clear that many different types of technology can be used to support and enhance learning. The technologies available in classrooms today range from simple tool-based applications (such as word processors), to online repositories of scientific data and include other forms such as electronic versions of primary historical documents,

[52] a program of the World Bank Institute,

handheld computers, closed-circuit television channels, and two-way distance learning classrooms. Prensky (2005) also strongly asserts that cell phones can be used to learn.

Lei and Zhao (2007) describe how each technology is likely to play a different role in students' learning. Yet, rather than trying to describe the impact of all technologies as if they were the same, it is clear that we need to think about what kind of technologies are being used in the classroom and for what purposes. Two general distinctions are found in the literature. First, students can learn from computers where technology is used essentially as tutors to increase students' basic skills and knowledge, and second, they can learn with computers where technology is used as tools applied to a variety of goals in the learning process and being a resource to help develop higher order thinking, creativity and research skills (Reeves, 1998; Ringstaff and Kelley, 2002).

According to UNESCO (2004), the three main approaches to ICT taken by teachers are:

(1) An Integrated approach: planning the use of ICT within the subject to enhance particular concepts and skills and improve students' attainment.

(2) An Enhancement approach: planning the use of an ICT resource which will enhance the existing topic through some aspect of the lessons and tasks.

(3) A Complementary approach: using an ICT resource to empower the pupils' learning

All three approaches can enhance attainment, but the effects may be different. In the integrated approach, students' learning is enhanced because they are confronted with challenges to their existing knowledge and given deeper insights into the subject being studied. The enhancement approach presents knowledge in new ways, encouraging learners to formulate their own explanations. The complementary approach frees the learner to focus on more challenging and subject-focused tasks (Kemmis et al., 1977 in UNESCO, 2004). These different types of use require the teacher to have an extensive knowledge of ICT and to be able to fit its use either into their existing pedagogy or to extend their pedagogical knowledge so they can accommodate ICT effectively in their teaching.

Finally, ICT initiatives need to be driven by the provision of appropriate technological solutions for the challenges faced by communities rather than by an interest purely in these physical technologies themselves, particularly in countries where resources are limited. Those implementing technological solutions need to ensure that they are sustainable, context-specific and adapted to local needs and conditions. For actual technologies by themselves have little development impact. It is only when potential users have a sound understanding of how they can use new ICTs effectively that they have real influence. Otherwise, ICT becomes just a drain on the organisation or community (Unwin, 2005).

6.4.1 Barriers to ICT use by teachers

Across Africa and most developing countries there are many challenges in bringing ICTs into teacher training and the education process in general. Anderson (1997) identified a range of factors that affect ICT use by teachers, including many of those physical and cultural factors identified in Sections 4 and 5. In addition, educational factors including levels of teachers' own education and literacy rates and access to professional development play an important role. JISC (2004) in their study on developing maturity in learning technology reveal that the most significant barriers identified are linked to staff attitude and training in the use of ICT, access and ICT skill in general. Specifically, attitudes of trainees and teacher trainers indicate a gross lack of independent learning skills and a reluctance to take

responsibility for their own learning. There is also a general inadequacy of learning resources, course curriculum and other learning materials that incorporate ICT use. Consequently teachers' expertise and lack of knowledge to evaluate the use and role of ICT in teaching (or technophobia in teachers and teacher trainers) are prominent factors hindering teacher's readiness and confidence in using ICT support. Moreover, there is a dearth of qualified IT professionals who might work with teachers on ICT-related matters and this is exacerbated by the problem of 'brain drain,' leading the experts to opt for better paying jobs elsewhere (Minishi-Majanja 2007; Alemneh and Hastings 2006).

Marshall, Elgort & Mitchell (2003) reported that staff continue to identify the lack of time as a barrier to the use of technology. While some interpret this to mean that staff have not have had the time to acquire the necessary skills in the use of technology in teaching, it also reflects a sense of priority conveyed by the institution and a desire by academics to see a return on the investment of their time in developing their teaching with technology. Surveys of academic staff attitudes to the use of technology have also repeatedly identified time and an absence of skills and knowledge as significant barriers to technology adoption (Marshall, 2000). The biggest barriers to the use of computers identified by teachers participating in the 1998-1999 survey assessing World Links schools programme (elaborated below) were again the lack of time in classes and daily school activities rather than physical resources (i.e. hardware, software, electricity), and the lack of a national policy on the use of computers in schools (Kozma, McGhee, Quellmalz, & Zalles, 2004, p. 376). As less technologically advanced countries joined the programme in 1999-2000, the major barriers to ICT use in classes became the lack of computer hardware (60%), software (56%), and reliable internet connections (52%), particularly in African countries such as Mauritania, Ghana, and Zimbabwe. Importantly, few of the World Links schools' teachers in both surveys named (or were concerned about) the following barriers: computers did not match instructional goals or methods (as contrasted to curricular goals); the use of computers would have no value for students; and the introduction of computers in schools would affect teachers' jobs status or stability.

6.4.2 Factors contributing to using ICT in the classroom

Cox et al. (1999) identify a number of factors that contribute to the continuous use of ICT by teachers, such as ICT helps making the lessons more interesting, easier, more diverse, more motivating for the pupils and more enjoyable. Further studies (e.g. Tella, 2007) found that computer use was predicted by intentions to use it and that perceived usefulness was also strongly linked to these intentions. Generally, if the ICTs are available, this will motivate the teachers to access them more than when they are not available or available but not in sufficient quantity and quality.

McCarney (2004) reports on an investigation into effective staff development in ICT for teachers where a sample of Scottish primary school teachers has been surveyed to investigate the impact of different models of staff development in ICT on the teacher. The study explored the knowledge and skills gained by teachers from staff development and indicated the need for a much greater emphasis to be placed on the pedagogy underlying ICT use. Moseley et al. (1999 in UNESCO, 2004), in a study of primary school teachers known to be achieving either average or above average gains on measures of relative attainment by pupils also focused on pedagogy for using ICT. Observations showed that the most successful teachers were those who used examples and counterexamples and involved students in explaining and modelling in the class. Teachers who favoured ICT were likely to have well-developed ICT skills and to see ICT as an important tool for learning and instruction. They were also likely to value collaborative working, enquiry and decision making by students.

There also clear differences between teachers who choose ICT resources to fit within a particular topic and those who choose resources merely to present pupils' work in a new way, without any direct application to the topic. The evidence shows that when teachers use their knowledge both of the subject and also of how students understand the subject, then they can ensure that their use of ICT has a direct effect on students' attainment. Overall, it is clear that the psychological factors of the teacher's own beliefs and attitudes to ICT and pedagogic innovation are identified as the primary facilitators and barriers to teacher use of ICT in the classroom.

6.4.3 Teacher beliefs, ICT and pedagogy

Moon (2000), Leach and Moon (2002), Dladla and Moon (2002) and Leach (2003) have all pointed to the potential of communication technologies for transforming the models and processes of teacher development in the less developed countries (LDCs), as well as for enabling access to quality resources and professional support. Leach, Moon and Power (2002) suggest that ICT offers:

- scaffolding tools, that support teachers' construction and understanding of new professional knowledge;
- environments and new contexts for learning, enabling teachers to experience new situations, practices and people;
- communicative tools, facilitating social participation structures between teachers and other educators (e.g. collaborative tasks);
- metacognitive tools, enabling teachers to reflect on the learning process, both at individual and group level (e.g. conferencing; joint products such as electronic self assessment).

A number of papers provide summaries on the application of ICT to teaching and learning (Bransford et al., 1999; Leach and Moon, 2000; Mumtaz, 2000; Cox et al., 2004) that share key findings:

- that particular ICT applications depend on the teacher successfully adapting them to specific teaching and learning contexts (Davis et al., 2009; Somekh, 2001; Caswell and Lamon, 1999; Moseley et al., 1999; Collins and Duguid, 2000);
- that classroom- and curriculum-focused teacher professional development is a crucial element in realising any investment in the provision of ICT (see Venezky, 2004; Zhao and Frank, 2003).

For many teachers, technology can give them a license to experiment (Means and Olson, 1995) and 'take risks', thus stimulating teachers to think about the processes of learning, particularly when the distinction between what students do and what teachers do is weakened. When teachers bring a new technology in their classrooms, they model the learning process for students while at the same time they gain new insights on teaching. McCormick and Scrimshaw (2001) argue that in this way ICT can make some aspects of teacher pedagogy more efficient, and that it also has the potential to extend and transform the process of teaching and learning itself.

6.4.4 The culture of ICT-using teachers

The nature of the uses made of ICT in SSA schools varies according to context, particularly with respect to: (i) teacher access to adjacent technologies; (ii) geographical location; (iii) local educational and cultural practices; (iv) home language; and (v) subject areas. Yet despite such variation, ICT consistently facilitated new forms of teacher-to-teacher co-operation. Research studies and initiatives such as the Digital Education Enhancement Programme (DEEP) report that ICT use enhances teachers' professional knowledge and capabilities in very specific ways (Leach et al., 2005), by: (a) extending subject knowledge; (b) enabling planning and preparation for teaching to be more efficient, and (c) developing the range of teachers' existing pedagogic practices. In these studies, all teachers introduced ICT into planned lessons with their classes, and there was evidence of positive impact of ICT upon student achievements and motivation. For instance, students quickly developed basic computer skills, learnt to use a variety of softwares and carried out a range of literacy, numeracy and scientific activities. They showed high levels of motivation in using ICT both within and out of lessons (ibid., p. 78). The majority of teachers were shown to be highly motivated to succeed in using ICT for their own development and for their students' learning despite the numerous challenges. So where technical support is scarce teachers must work together to solve the problems, typically in a pragmatic and context-relevant way.

In addition to these broad policy implications, teacher confidence was another key element determining the quality of any ICT-enhanced school-based teacher education in developing contexts. The programmes that built up confidence in the teachers featured:

- use of a personal computer;
- a project partner;
- joint evaluative activities;
- strong initial technical and pedagogical training;
- curriculum activities that progressively built ICT skills and knowledge;
- few prior expectations (including ICT literate peers) to live up to;
- a commitment by school, students and community to support project partners in their efforts;
- clear overall programme management structures to ensure ongoing support;
- affirmative feedback from peers, school principals, students, parents and the project team.

In summary, the most successful uses of ICT were strongly grounded in educational and pedagogic principles (of the teachers, school, education system), employed quality resources (not necessarily the most expensive as the DEEP project demonstrated through the use of accessible, mobile technologies) and ensured that appropriate professional support was available to the school and system.

6.5 Initial teacher education (ITE) and continuing professional development (CPD) policies and practices

The UNESCO *Planning Guide* for ICT in teacher education (Resta, 2002) gives three key principles relevant to Initial Teacher Education (ITE). These are also suggested by the Society for Information Technology and Teacher Education (SITE). These are:

- technology should be infused into the entire teacher education programme, not restricted to a single course (SITE, 2002);
- technology should be introduced in context, not taught as separate topics but rather as and when the need arises in all courses of the teacher education programme;
- students should experience innovative technology-supported learning environments in their teacher education programme. In addition, students should see their lecturers engaging in technology to present their subjects and have the opportunity to use such applications.

In a similar vein, Moon (2000), Leach and Moon (2002), Dladla and Moon (2002) and Leach (2003) have pointed to the potential of communication technologies for transforming the models and processes of teacher development in the less developed countries as ICT offers:

- scaffolding tools, that support teachers' construction and understanding of new professional knowledge;
- environments and new contexts for learning, enabling teachers to experience new situations, practices and people;
- communicative tools, facilitating social participation structures between teachers and other educators (e.g. collaborative tasks);
- metacognitive tools, enabling teachers to reflect on the learning process, at both individual and group level (e.g. conferencing; joint products such as electronic self-assessment).

Venezky's study (2004) found that professional development was one of the most important supports in most schools for ICT integration into teaching, as it has the greatest impact on the beliefs and practice of teachers, and yet professional development time was not budgeted for in many of the schools in the study. The most effective programmes utilised local expertise, such as teachers arranging assistance as needed from other teachers who had ICT skills. This creates a secure environment and context for trying to use ICT in teaching. Zhao and Frank (2003) suggest that teacher-level factors are the most significant in promoting change in technology use by teachers and they recommend that instead of spending time and money on external in-service programs and conferences, teachers could be given more time to help each other.

While there have been many schemes over the last decade to introduce ICT into schools in Africa (infundo[53] offers a database of such activities and others were outlined in Section 3), many have failed to live up to their aspirations because they have been top-down and supply led with insufficient attention being paid to the involvement and training of teachers. The more successful ones have included the Connectivity for Educator Development programme in Uganda[54], Schools OnLine's programmes[55] in Senegal and Tanzania, World Links' programmes[56] in Ghana and Uganda, SchoolNet

[53] http://www.infodev.org/en/TopicResources.4.html

[54] http://www.wougnet.org/Profiles/connect_ed.html

[55] http://www.schoolsonline.org/

[56] http://www.world-links.org/

Namibia's experiences in using Open Source and thin-client solutions in supporting youth empowerment[57] and the Commonwealth of Learning's Southern Africa Teacher Training Programme[58]. For example the Intel Corporation 'Teach' programme is currently supporting Kenya's transition from traditional teaching methods through educating teachers in the integration of ICT into primary and secondary school education (PanAfrican Research Agenda on the Pedagogical Integration of ICTs: Karsenti, 2009)[59]. Using a 'train the trainer' model the 25 selected participants from teacher training colleges, Centre for Maths and Science and Technology Education in Africa, Kenya Institute of Education and Kenya Education Staff Institute are working on the development of online material to then orient 250,000 teachers nationwide. Anecdotal evidence suggests, however, that teachers experiencing national and international training programmes falter after their initial learning success if they do not receive follow-up support in schools.

Cawthera's (2001) study for DfID also suggests that in contexts such as Sub-Saharan Africa, where there is simply not the capacity to train and retrain the huge numbers of teachers currently required, school based, computer-supported teacher training might be part of the solution to this problem. In recent years, there has indeed been a growing emphasis on in-service training (see for example, Anderson & van Weert, 2002; for a comparative Chinese example see Ng and Chow, 1999). School-based teacher development programmes, as in Kenya, Uganda and Tanzania, have thus widely been seen as providing valuable support to teachers, including enhancing their capabilities and self-esteem. In introducing new ICTs to support teacher training, it is important that both pre-service and in-service environments are adequately supported. Above all, it is crucial that there are champions throughout the system who can enthuse and inspire others to participate in their use (see experiences of SchoolNets in Uganda[60]).

Likewise, insufficient teacher training is identified as a barrier for education and therefore the teacher training within the World Links schools (intervention) programme included both a basic training before participants started their teaching practice as well as ongoing in-the-classroom training. 26 schools (organised by World Bank's Economic Development Institute) in 5 developing countries, including two in Africa – Senegal and Uganda, participated in the survey evaluating the programme and its impact on the educational process during the 1998-1999 operational year. Survey data on the computer use was collected from teacher, administrators and technology coordinators in Senegal and in Uganda, as well as during 1999–2000 from these and additional African countries (number in brackets indicates respondents): Ghana (40), Mauritania (36), Mozambique (32), Senegal (56), South Africa (56), Uganda (55), and Zimbabwe (36). Crucially, this survey included not only those teachers participating in the World Links programme, but two additional comparison groups (non-participating or 'least participating' teachers within World Links schools plus teachers from non-participating schools).

Results on teacher improvement are not divided by countries or continents, but overall teachers benefited from the programme in a number of ways (Kozma et al., 2004, pp. 374-376):

- Teachers surveyed in 1998-1999 felt they improved not only their ability to use computer hardware (70%), applications software (67%), and the internet (73%) but their ability to

[57] http://www.schoolnet.na/

[58] http://www.col.org/programmes/catalyst/safricateacher.htm

[59] http://www.elearning-africa.com/newsportal/english/news172.php

[60] http://www.schoolnet.na/

use student groups in their teaching (63%) and to design and lead collaborative student projects (68%).

- A majority of teachers (52%) indicated that the program increased their ability to collaborate with other teachers on the development of materials.
- School administrators felt that the World Links programme greatly affected teachers' computer skills (82%), their ability to use the internet (80%), their attitudes about technology (85%), and their attitudes about their own teaching (90%). A majority felt that the program improved teachers' software skills (67%) and their ability to use student groups in their teaching (60%).
- Both teachers and administrators in the 1998-1999 survey agreed that program had limited impact on teachers' ability to integrate computers into curriculum (39% and 40% respectively) and assessment (46% and 35% respectively).
- Teachers from the 12 countries participating in the 1999-2000 survey agreed with their colleagues in the earlier survey on most questions. These teachers rated the program's impact as higher on integration of computers into the curriculum but they also felt that impact on assessment design was limited.

Further insight may be derived from the national School-based Teacher Development Project run by the Ministry of Education in Kenyan primary schools and evaluated by Hardman et al. (2009). 47,000 teachers participated over a 4-year period, using distance learning materials combined with regular face-to-face support meetings. Although not focused on ICT, there are some generic messages about how the programmes led to teachers becoming more interactive with pupils during whole class teaching and making greater use of group work. The greatest impact on classroom practice was seen in the classrooms of those teachers who had undergone the most systematic in-service training. The approach placed textbooks at the core of new approaches to teaching and learning which expected teachers to develop a wider repertoire of teaching-and-learning activities by using the instructional materials in whole-class, group-based and individual activities (ibid., p.68). These included pupils being expected to carry out research and participate in practical, problem-solving group activities. The same approach to professional development may well prove successful if digital learning resources were used instead of textbooks.

6.5.1 Integrating ICT into Teacher Education

Exactly how ICT should be integrated into the classroom and the continuing professional development of teachers active in schools is set out in Hawkins' (2002) ten lessons for ICT in education in the developing world. Of particular interest here are Hawkins' lessons 7 and 8: *Link ICT and education efforts to broader education reforms* and *Training, training, training*. The literature stresses the importance of context and integration in education policy developments. Many Ministries of Education have made the commitment to bring ICT into schools, but few have developed coherent strategies to fully integrate the use of computers as pedagogical tools in the classroom. Many governments view computers as a stand-alone subject requiring a curriculum focusing on basic computer literacy skills. While computer literacy is required, the integration of computers and the internet into the broader curriculum is where real learning begins. The SRI-World Links evaluation (Kozma et al., 2004) shows that teachers enthusiastically engage in collaborative projects and constructivist pedagogy, but school

administrators offer very little structural support and incentives to effectively use the technology in the classroom. Too often the curriculum in developing countries is rigid and overloaded, leaving little time for innovative classroom practices. Policies should make a commitment to helping teachers effectively integrate computers and internet technologies into the classroom by aligning curricula, exams, and incentives with the educational outcomes that they hope to gain. In the end, computers by themselves bring very little to the learning process – they are only tools for teaching and learning.

The continuing professional development of teachers is central to any successful technology and education programme. Research studies such as Digital Education Enhancement Programme (DEEP) report that there was no significant correlation between teachers' prior knowledge and/or experience of using ICT and the ability to successfully develop ICT-enhanced classroom practices (Leach, Ahmed, Makalima, & Power, 2005, p. 73). Teachers require formal training, but also sustained and ongoing support from their colleagues to help them learn how best to integrate technology into their teaching. ICT use can enhance teachers' professional knowledge and capability by permitting new forms of teacher-to-teacher cooperation (ibid., p. 72). Teachers need to learn to transform their classrooms from static environments where a one-way flow of information from teacher to student occurs, into dynamic, student-centred environments in which learners interact with peers in teams, both in their own classroom and in as well as with virtual classes.

Some teachers, however, are intimidated by technology and are very comfortable with their own established teaching styles. To change that, any teacher training must help teachers see past the technology to the pedagogical and educational gains that use of the technology brings. Teachers need support, examples of good practice, and leadership from their school leaders and necessary time for professional development, in order to truly transform teaching and learning in the classroom. Eventually, teachers need to be transformed from information consumers, using the internet to access resources and information, into information producers who adapt the information for their particular cultural and educational reality. To this end, World Links has focused its training on helping teachers to use technology as a tool, and to transform their classrooms into interactive learning environments (Kozma et al., 2004).

Many teachers initially feel threatened by the loss of control in the classroom as students, who are usually more adept at using technology, can quickly access information and challenge the teacher's role as the primary source of information. Teachers who receive appropriate professional development, however, learn how to more effectively manage their classroom and use the technology to create a more stimulating learning environment while realising that their pedagogic knowledge rather than technical knowledge is what makes them a teacher. DEEP studies (carried out in South Africa and Egypt) show that teachers can be highly motivated to succeed in using ICT for their own development and for their students' learning despite numerous challenges (Leach, Ahmed, Makalima, & Power, 2005, p. 87).

While Lassa (2000) noted that the importance of teachers and the roles that they play in the educative process is central to education, particularly in developing countries, Olakulehin (2007) recognises that it is the challenge of teacher training that appears to be the most daunting challenge facing the education system in general. It has been observed by many researchers that of all the educational problems that beset Africa, none is as persistent as the training of competent teachers as it directly and indirectly influences the quality and quantity of services provided by all other teachers and educators (Fafunwa 1967; Afe, 1999 in Afe, 2002). Afemikhe (2004) adds that teacher education suffered setbacks due to the greater emphasis being placed on how to teach rather than on what to teach. The foregoing suggests a two-pronged challenge that may be aptly dubbed: *the problem of numbers and the*

problem of relevance. These are the two most deluging challenges confronting the education system in Nigeria today. The problem of numbers implies that there is an insufficiency in the quantity of teachers that are available for the various levels of the education system in Nigeria. This has resulted in a situation where the capacities of classes/teachers have been exceeded due to the exponential rise in student population in the last two decades (NUC, 2005). The problem is that the existing teacher training model does not reflect the contemporary social needs as well as economic challenges confronting the nation as a whole.

The fact is that teacher training is limited in impact. So far it has failed to make use of the growing possibilities of information and communication technologies available to teacher training. This is despite the 21st century changes in societies which require everybody, and in particular teachers, to become facilitators of knowledge acquisition in subject areas that often do not have direct links with their primary professional training.

So teachers are required to be at the cutting-edge of knowledge production, modification and application and so must be trained in such. Policies must recognise and encourage this, yet Liverpool (2002) describes how ICT already dominates education in the developed world, but its penetration of the developing world and Africa in particular has been painfully slow. Yet countries must be able to benefit from technological developments. To do so, teachers must be educated with the ability to use ICT effectively and creatively. Teachers can only pass on the latest skills and ideas to learners if they are at the cutting edge of knowledge and developments in their subjects. This is, unfortunately not the case in many developing countries where most teachers have minimal or no ICT skills and hardly use existing opportunities to develop them. Trainee teachers need to acquire very specific ICT competencies to enhance the quality of the teaching and learning that takes place in schools. Clearly, the specific skills cannot be acquired without the general abilities, and the general abilities are not of much benefit if teachers do not possess specific skills for applying ICTs in their teaching activities. Olakulehin (2007) identifies four broad approaches through which ICTs could be adopted for teacher training and professional development.

EMERGING	APPLYING	INFUSING	TRANSFORMING

Figure 6.1. Model depicting a continuum of approaches to ICT application for Teacher training and development

The continuum model above (Figure 6.1) shows teacher skills flowing from the emerging to the applying into the infusing and then culminating in the transforming processes of the educative activities which takes place in schools. The Emerging approach is the first stage of ICT skills development in teachers, focusing on the technical functions, components and general uses of ICTs for education. This approach tends to be theoretical with the practical components involving the personal use of ICT. The emphasis here is on training of teachers in a range of tools and applications, and increasing teachers' awareness of the opportunities for applying ICT to their teaching in the future. Moving along the model, transforming teaching through ICTs involves teachers and other support staff in the school system regarding ICT as a natural part of everyday life of the system with the emphasis changing from a teacher-centric to a learner-centric system where the teacher is seen as helping students as a facilitator. This shift in emphasis in learners' needs also calls for new training needs on the part of the teachers.

6.5.2 Examples of teacher development programmes delivered via ICT

ICT teacher training can take many forms. Teachers can be trained to learn HOW to use ICT or teachers can be trained *via* ICT. ICT can be used as a core or a complementary means to the teacher training process (Collis & Jung, 2003). Building on this, Jung[61] organises various ICT teacher training efforts found in different countries into four categories using the framework below.

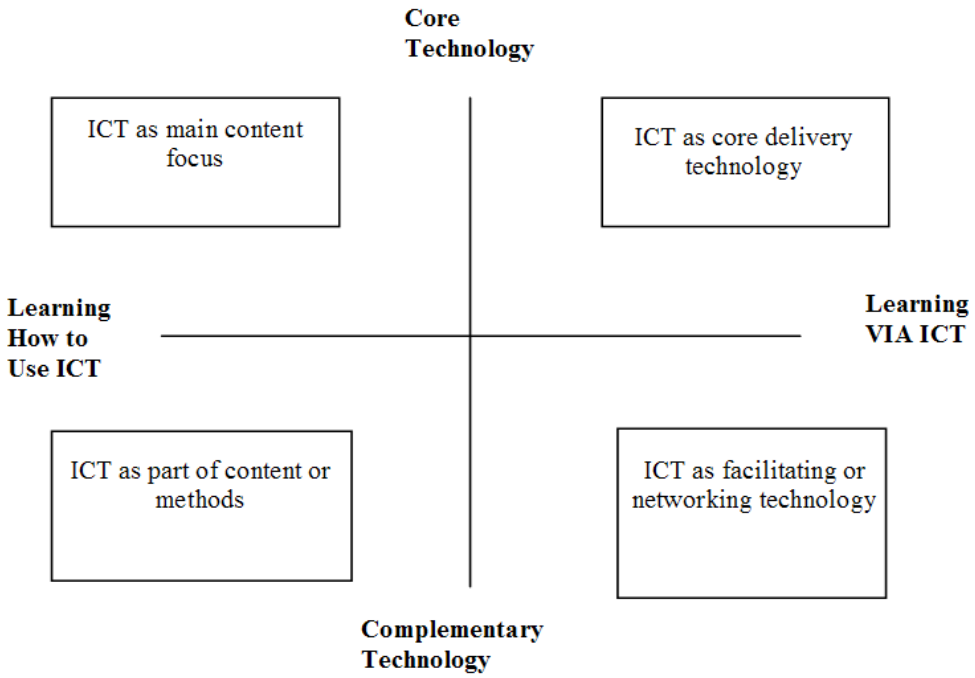

Figure 6.2: Categories for ICT in teacher training (adapted from Collis & Jung, 2003, p. 176)

Enlightenment on the issues concerning effective teacher education comes from the SchoolNet Africa commissioned Commonwealth of Learning study (2004), 'Towards a Strategy on Developing African Teacher Capabilities in the Use of Information and Communication Technology'[62]. This looked in detail across all existing (50) English medium teacher training initiatives in ICT in Africa (+ 11 elsewhere). 27 courses were confined to basic ICT training and the initiatives were largely fragmented and regional. There were very few broadly based, online and scaleable ICT courses linked to African pedagogy and little sharing of experience between nations. There was no comprehensive pan-African framework for building African teachers' ICT capabilities, and that remains the case today; the report concludes that this is sorely needed. National ICT policies with respect to teacher training were likewise deemed fragmented, under-funded and inadequate. Notably few African teacher training institutions appeared to be offering pre-service ICT training. The literature review (p. 6) identified several *debates* currently taking place with respect to the development of African teacher capabilities in ICT. These include:

[61] 'ICT-Pedagogy Integration in Teacher Training: Application Cases Worldwide' Insung Jung

[62] http://www.col.org/resources/publications/consultancies/Pages/2004-10-teachCapabilities.aspx. This study was carried out in conjunction with the International Institute for Communication and Development (IICD) and the Open Society Initiative for Southern Africa (OSISA).

- Whether to focus on developing teachers' theme-based capabilities (ICT integration) or decontextualised ICT skills. There are arguments in favour of both, but the international preference is for ICT skills to be integrated into teaching practice. Several countries, however, have identified the requirement to start with developing teachers' basic ICT literacy prior to integration.
- Whether to focus capacity building on pre-service or in-service teachers. The preference here is obviously to do both, but the shortage of resources available for teacher training suggests that pre-service interventions should be the higher priority (retraining later means additional costs and "old dogs" don't like "new tricks"). However, the literature review highlighted the current ICT gap in African pre-service teacher training and the need to transform teacher training colleges if pre-service ICT training is to become a reality. Current barriers to transformation in these teacher training institutions include a lack of ICT infrastructure and a lack of ICT-trained teacher educators.
- The importance of sufficient access to ICT if teachers are to be able to truly realise the potential transformative benefits of ICT integration in education.
- Related to this, the importance of matching the mode of delivery and types of training to the audience in order to ensure cost effectiveness and successful integration after the training. It is a waste of money to teach teachers skills that require complex ICT infrastructure if the tools at their disposal are so basic that they cannot put what they learn into practice.
- The critical importance of contextual relevance in African teachers' ICT training in order for training to be truly worthwhile. This includes cultural, language and curriculum relevance.

The findings additionally highlighted several significant challenges to integrating ICT capability into teacher training, summarised as follows:

- *Shortage of funding* in many African education ministries and in teacher training institutions, thus ICT programmes for teachers are low in terms of spending priorities. Many of the courses were created with donor funding and their long-term sustainability is unclear. Introducing an ICT curriculum and implementation of training programmes (whether pre-service or in-service) requires extra infrastructure, the development of teacher trainer ICT capabilities, the development of materials for both teacher training and learners (content), and monitoring of course quality and consistency;
- *Inconsistent quality of courses* despite the same accreditation;
- Serious *shortage of locally developed, contextually relevant course content* for both teachers and learners;
- *Time*. Teachers require sufficient time for training and access to information about suitable courses.

The teacher employment situation in Sub-Saharan Africa has been described as a crisis (Dladla and Moon, 2006) and at least one country, Burkina Faso, has officially declared the supply of teachers a

national crisis. To ensure sufficient numbers of teachers, institutions and governments have begun to adopt new and even experimental methods. Projects like Mindset[63] and SchoolNet[64] in South Africa provide some examples as do the DEEP project and the African Virtual University based in Nairobi[65] which is developing a range of resources and courses that can be utilised within new, school-based programmes of teacher education (Dzimbo and Barasa, 2006). Research on the sort of support required by such programmes is taking place (Aguti, 2006).

The Teacher Education in Sub-Saharan Africa (TESSA) project[66] is a consortium involving international and national institutions (nine Sub-Saharan African countries are involved) that will provide resources and systems to support the development of school-based teacher education programmes across the continent. TESSA has taken up eight factors identified in earlier work by Leach and Moon (2002) that, it is suggested, contribute significantly to the success of school programmes:

- vision and sustained commitment on the part of government, educational leaders and policy-makers, to professional development, including ensuring effective technological infrastructures that can support ICT components.
- clearly identified outcomes for teachers, linked closely to their individual, as well as school's ongoing professional needs;
- a curriculum of school-based professional activities, adaptable to local context, progressively structured and providing a common framework and discourse within and across school. (This forms the basis for the work of the DEEP project.)
- access to high-quality multimedia resources that utilise ICT, use teachers' own language(s) and which integrate exemplars that reflect local culture, education and practices;
- clarity of roles, responsibilities and modes of communication between different actors whether at school, regional or national level;
- strong support that is rooted in local contexts and existing structures and closely monitored to ensure its effectiveness for teachers in differing settings.

Microsoft's (2007) Partners in Learning (PiL) programme links educational leaders and governments in 19 African countries (Algeria, Angola, Botswana, Burkina Faso, Egypt, Gabon, Ghana, Kenya, Madagascar, Morocco, Mauritania, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Seychelles, Uganda and South Africa), providing access to technology in the classroom, as well as resources and teacher training to ensure ICT is implemented effectively. By the time the 2007 report was published, PiL had trained 200,000 teachers in the above-mentioned countries through Train the Trainer Programme and Innovative Teachers Programme (an online portal where educators can share classroom success based on high-quality educational resources and teacher-driven content). In Namibia, a highly successful national Teacher 'Train the Trainer' Programme adopted a PiL Five Day Teacher Training model, and was being evaluated for integration into Namibia's National Teacher Training Course. The same scheme for teacher training has been implemented in Kenya, Senegal and Rwanda.

[63] www.mindset.co.za
[64] www.school.za
[65] www.avu.org/
[66] http://www.tessaprogramme.org

Another Microsoft education partnership, African Pathfinder Blueprint for Schools, works with the governments of Nambia, Angola, Rwanda and Madagascar on initiatives for the successful integration of ICT in education and learning including ICT access and teacher skills training. In Namibia specifically, The African Pathfinder Blueprint for Schools piloted a range of elements to ensure effective ICT implementation, replication and scalability (e.g. leadership, policy, research, access, innovative solutions, curriculum, training, partnership with communities, support services).

New communication technologies clearly also have the potential to supply continuing professional development of teachers but currently it is pre-service teacher education that dominates policies and resources and so in-service professional development is suffering from a lack of focus and investment (Moon, 2003). Just as with society in general, technological change is rapidly transforming the pedagogy of teachers and teacher educators. Information and communication tools are becoming increasingly portable, flexible and powerful and numerous studies are beginning to point to the potential of these new technologies as learning tools (Soloway et al., 2001). A research report from DfID, the United Kingdom's Department for International Development (Leach et al., 2004 has demonstrated the value of mobile communication systems for teacher education in the Digital Education Enhancement Programme[67] – which has developed teaching strategies through resources and communication systems derived from handheld computers, cell phones and other related technologies, as have Kukulska-Hulme and Traxler (2005). More country specific is the DFID Multi-site Teacher Education Research Project (MUSTER 2003) looking at teacher training in Ghana.[68] Such projects show there is potential with today's technologies to train teachers in high quality teaching skills even when they are in extreme rural conditions and unable to attend training sessions.

6.5.3 Challenges to ICT use facilitating professional development and networking

Whereas ICT as the core technology underpinning teacher education appears in limited contexts, there are many examples of ICT, particularly internet and Web-based communication technologies, being used to support teachers' ongoing professional development and networking. Many countries have now developed a website or websites to provide online resources for teachers and facilitate teachers' networking based on the assumption that professional development should be an integral part of daily practice for all teachers and the use of the internet would enhance continuous professional development activities of teachers, connecting teachers to larger teaching communities and allowing for interaction with expert groups.

A variety of better ICT-integrated training environments have been created to provide more effective ICT training, such as SchoolNet SA[69], a South African organisation providing support to educators and learners who wish to use ICT in education. Retrieved from such projects, it is clear that teachers tend to integrate ICT in their teaching if they experience ICT skills as a learner (Collis & Jung, 2003). Teacher training approaches that adopt ICT into the training process not just as content of the training but rather as an integrated training environment allow teachers to experience ICT-based pedagogies and so have far greater impact on activities in the classroom.

Another possibility with the use of ICT in teacher training is that it can connect teachers to a larger international teaching community. Best practices in using ICT in teaching and learning and successful

[67] http://www.research4development.info/CaseStudies.asp?ArticleID=116

[68] "Teacher training in Ghana – Does it count?" http://ideas.repec.org/p/ags/dfider/12867.html

[69] http://www.school.za

pedagogies are now being shared among teachers scattered around the world, providing a wealth of resources that can be adapted to the local context and individuals' needs. These new experiences also offer challenges to teachers, teacher training institutions, and nations. First, teacher training approaches need to adopt cost-effective strategies. Most nations have limited resources for teacher training and must make decisions based on cost-effectiveness. The teacher training experiences provide several cost-saving strategies (Collis and Jung, 2003; Power, 2004) and also adopt strategies to enlist staff support and involvement in professional development, indicating that it is useful to:

- Employ a variety of teacher trainer training methods, ranging from face-to-face workshops to online self study programmes depending on training objectives and environments.

- Integrate informal support into the formal teacher trainer training system so that the less experienced teacher trainers can obtain timely assistance.

- Plan to provide multiple incentives such as workload reduction, recognition and reward in faculty evaluations, increased research allocations to encourage use of ICT in teaching, and compensation for those providing educational or technological assistance to others.

As has already been suggested, limited attention though has been given to ongoing professional development for those that are already trained (Day and Sachs, 2004, pp. 3-32; Grundy & Robison, 2004, pp. 146-166). The task of providing teacher education does not end with the certification of teachers. Professional development is a very important part of teacher education but how to deliver it effectively has become the central challenge. Furthermore, current changes in technology, new advances in learning and the inherent challenges arising from curriculum renewal and reform requires that there is the need for radical changes in teaching and learning methodologies to conform with the current technological trends. Additionally, once the desirability of adopting rich and flexible curriculum frameworks has been recognised, then alternative ways require the promoting of teaching and learning methodologies different from those used in the past. This will inevitably involve moving away from a rigid, prescriptive approach in classroom work (Pillai, 2001, p. 1).

With the reported growing gap between the numbers of trained teachers in low-income countries, and the demand for primary education physical institutions, offering full-time, centre-based teacher education, ICT offers the possibility of having potentially cheaper and more effective school-based development of teachers. Applied appropriately, such open learning approaches, availing themselves of the power of ICTs, may make a significant contribution to the goal of Universal Primary Education by ensuring there are sufficient numbers of trained teachers. The literature (Moon, 2000; Dladla and Moon, 2002; Leach and Moon, 2002) has called for more such innovative solutions to be applied to the problems of Sub-Saharan Africa. New, school- and community-based forms of training can exploit the recent developments in communication and information technologies and there is recognition among teachers that such a flexible approach is required, with changes in lesson style to a less formal classroom atmosphere with greater pupil autonomy, differing modes of teacher/pupil interaction, and flexible study space are all recognised as key success factors for effective use of ICT (Harrison et al., 2003).

In such settings, the ICT then becomes one of many pedagogic means where:

- teachers and learners are more likely to see the subject as centre stage;

- teachers and learners are more likely to use computers to support collaborative work, as well as individual computer use.

Capper, J (2001) suggests a number of key principles that determine the quality of such ICT-enhanced school-based teacher education in developing contexts. These include:

- personal teacher access to ICT;
- ICT appropriate to local setting and conditions;
- teachers are given the opportunity to integrate ICT activity into daily routines and practices;
- teachers make use of ICT-supported peer and team learning;
- the focus is on ICT for curriculum and classroom purposes, not skills;
- relevant content in an appropriate language medium needs to be made available;
- local, national and international professional e-networks need to be provided;
- school assessment practices need to be relevant to ICT-enhanced learning and the learners' needs;
- there needs to be a strong vision of the potential of ICT for learning from national ministries and educational policy makers.

The research shows that new digital technologies are appropriate for use in the African context in that they have the potential to revolutionise the quality of training when carefully integrated within programmes that are pedagogically strong and well supported. Most significant of all, perhaps, the study suggests that the use of ICT in some of the poorest parts of the world, if well planned and implemented, could have a significant impact on the self-image, confidence and professionalism of teachers. So ICT offers the potential to redefine, even enhance the status of teachers within communities and more broadly across the societies they serve.

6.5.4 Recommendations for a policy framework for ICT-based teacher training

Overall, it is argued that distance learning models, delivered through the use of new ICTs, have much to offer in overcoming problems in the education systems of African countries (DFID, 2001; Perraton, 2000a; Yates and Bradley, 2000; Grace and Kenny, 2003; Gaskell and Tait, 2003). Perraton (2000a) suggests that distance education can be used effectively for all four main aspects of teacher training: providing trainee teachers with a general education; improving their knowledge of the subjects they will teach; teaching them about children, the curriculum and pedagogy; and developing their classroom skills (for a wider discussion on relevance of distance learning see Hegarty, Phelan and Kilbride, 1998; OECD, 2000; Perraton, 2000b).

There are many attempts (UNESCO, 2002; Bof, 2004; Anderson and Elloumi, 2004) to establish the general set of principles that need to be in place for ICTs to be used effectively in teacher training. The emphasis is primarily placed on the necessity for teachers first to be trained in basic ICT skills. So the UNESCO review comments that 'For education to reap the full benefits of ICTs in learning, it is essential that pre-service and in-service teachers have basic ICT skills and competences' (UNESCO, 2002, p. 13). The literature further argues that four competencies need to be addressed: pedagogy, collaboration and networking, social issues and technical issues (UNESCO, 2002). So the key themes

for a successful programme are established as: context and culture (see also Selinger, 2004), leadership and vision, lifelong learning, and the planning and management of change, building on the principles of the Society for Information Technology and Teacher Education (SITE, 2002) that:

- Technology should be infused into the entire teacher education programme;
- Technology should be introduced in context; and
- Students should experience innovative technology-supported learning environments in their teacher education programme.

A recent evaluation of the national in-service initiative a few years ago to train all school teachers in England to use ICT in teaching (widely regarded as a dismal failure, albeit with some pockets of success) yielded some important messages concerning the inadequacy of centralised skills-focused approaches, especially those with online access to trainers (Davis et al., 2009). The most successful model proved to be an 'organic' approach that provided school-based training designed to support evolution of each teacher's classroom, school and region, as well as the training of the ICT teacher trainers. Training was provided largely face-to-face for teachers in a sequence of three modules: (1) teacher's own professional use of ICT; (2) management skills relating to use of ICT directly with pupils when teaching; and (3) evaluating the impact of ICT on learning. There was an additional module (4) that enabled recommended teachers to become trainers. For the majority of teachers, the training was located in their own school using the school's equipment and resources. In addition to face-to-face training, teachers used workbooks and worked in groups on assignments in their own classrooms. This was supported by case studies of good practice and indicative tasks embedded within the training materials that made 'specific links to participants' professional practice'. Teachers set personal objectives and there was also a collective needs analysis for each training group. While the cultural context was very different to that in Africa, particularly in terms of ICT provision in the schools beforehand and thus probably a greater level of technical proficiency among teachers entering the programme, its principles were derived from successful characteristics identified in the literature and validated in many studies. These are expected to be more generally applicable:

- a direct relationship with each teacher's beliefs, subject discipline and pedagogy;
- active learning opportunities by teachers developing their own professionalism over an extended period of time with teachers in the same community of practice;
- coherence with policy and standards;
- support for organisational change.

In addition, there was a complementary community of practice for the ICT trainers. Therefore, the simple strategy of 'training the trainers' centrally so they may cascade workshops to others in their locality was not recommended.

Unwin (2005) draws on his work over 3 years for DFID in presenting a highly pertinent and critical analysis of previous initiatives and develops a useful, practical framework for teacher training in Africa. This outlines the fundamental issues that need to be addressed for programmes involving ICT to be coherent and effective, including the two most damaging features: the duplication of effort and the lack of integration in many ongoing activities. Moreover national ICT strategies have been led primarily by telecommunications interests, and have not paid sufficiently detailed attention to the real

potential for ICT to deliver on development agendas and to transform the processes of learning. Indeed there remains considerable misunderstanding across the continent about this potential:

> To date, the emphasis of supply-led initiatives across the continent has been to provide teachers and pupils with so-called ICT skills, more often than not defined largely as the ability to use Microsoft Office packages, in the hope that this will mystically enable them to become better citizens and to gain information that will be of some use to them and the societies in which they live. This has frequently led to wasteful and inappropriate initiatives. (Unwin 2005, p. 126)

Infrastructure provision is a hindrance too, as described above. Finally, delivery mechanisms for both initial and in-service teacher education vary across Africa and local solutions are needed. Elements of the proposed framework are:

- *Strategic leadership and integration with overall national ICT strategies*. Training programmes and curriculum development need to be owned at a national level by the Government as a whole and led by the relevant Ministry of Education. A small, focused team needs to have the overall leadership of the ICT for teacher training strategy, and the willingness and power to decline offers of assistance from well intentioned, but misplaced, supply-driven initiatives.

- *Ownership and involvement of relevant stakeholders and potential partners at an early stage.* These would include at least representatives of the teachers themselves (such as Teaching Unions), those involved in teacher education, higher education institutions, curriculum developers, and providers of hardware and software. All need to understand the importance of developing a coherent and logical programme to be implemented in a staged fashion over a number of years.

- *Awareness raising workshops* providing hands-on experience of the use of audio, video, the internet, CD ROMs, DVDs, and other new ICTs are crucial at an early stage in the development of strategies for the use of ICT in teacher training, "so that administrators, heads of teacher training colleges, government officials and teachers' leaders can grasp the true significance of the transformations possible, and can thereby contribute effectively to the development of such strategies" (Unwin 2005, p. 124). (For examples, see the Commonwealth of Learning website[70], and Imfundo's workshops in Ghana.[71]) A cascade model allows some participants in such workshops to themselves become trainers (however see the warnings of Davis et al. 2009 about this).

- *Shaping implementation strategies within the context of infrastructure provision.* "Blended solutions for the use of ICT in teacher training need to be thought through carefully in specific national contexts so that teachers can have access to similar training in different media depending on the infrastructure available to them. A comprehensive ICT in teacher training programme will thus make optimal blended use of print, audio/radio, video, television, computers, the internet, peer-group face-to-face (f2f) contact, and more traditional forms of classroom based learning if it is to be successful" (Unwin 2005, p. 124). Many African countries already have an existing framework of teacher training colleges in place, and given limited connectivity and resources, it may often be most logical for the provision of computers and the use of the internet for teacher training to begin in these institutions (most of which

[70] http://www.col.org

[71] http://imfundo.digitalbrain.com/imfundo/web/activities/Ghana/ghana8.htm

already have electricity) than it is to provide such access scattered more widely across a country. Subsequent links can then be established to other educational institutions.

- *Beginning with pre-service training.* Apart from it being easier to begin with the provision of infrastructure in teacher training colleges, most pre-service trainee teachers are also young, and more open to the use of new technologies than are many, but by no means all, older teachers. Considering both activities that can be undertaken within the colleges, and at a distance, and drawing on established examples of good practice elsewhere in the world, Unwin (2005) lists a number of specific ways in which ICT can best be used in an African context.

- *In-service training.* Blended solutions to in-service training needs can best be seen as a combination of the existing use of distance-based methods of support to teachers, with elements of the use of ICTs recommended in the context of pre-service training. Any attempts to use new ICTs should build on local practices and experiences, however certain uses of multimedia computers and the internet are envisaged as being particularly important in the delivery of African in-service teacher training programmes in the future.

- *Sustainability through community-led agendas.* Unwin (2005) argues that it is not possible to incorporate new ICTs in teacher education in Africa effectively and sustainably without local community support. This complements the existing commitment of the private sector, governments and civil society organisations at a macro-scale in global initiatives, ensuring that initiatives are appropriately designed, implemented, maintained and resourced. In particular, he asserts that hardware and connectivity are currently too expensive at present for these initiatives to be self-sustaining without a commitment to their wider use by communities for gaining access to information relating to health, agricultural, enterprise, lifelong learning and governance issues. Appropriate response to the integrated needs of poor communities is much more likely to succeed and to be sustainable than supplying ready made technical solutions from elsewhere.

Conclusions

The importance of an ICT-oriented education system in SSA is captured by Moore (2002, quoted in Olakulehin, 2007) thus:

> …in what has already become known as the information age, economic advantage will accrue to countries in which the population acquires competence in processing information into knowledge and applying it in work and everyday life. They must be skilful in using the devices and procedures that give access to information and learn the processes of searching for and manipulating information. Skilfully transforming information into knowledge is the profession of the educator.

The role of the teacher in developing ICT use in schools in SSA is utterly critical, yet there are many obstacles to be faced, in addition to those already listed that emerge more generally (such as access to ICT facilities). A primary barrier to teachers' readiness and confidence in using ICT – despite general enthusiasm and belief in benefits for learners – is their lack of training, either initially or in-service. This results in lack of proficiency in using ICT, and knowledge of all of the potential uses and roles of ICT in teaching and learning. Lack of time is another factor, linked in turn to large classes and teacher shortage rates currently at crisis level, exacerbated by growing HIV/AIDS rates, lack of funding for salaries and ironically, the admirable goal of universal primary education which requires increasing

numbers of trained teachers. Levels of teacher education and literacy rates are low and ICT training courses in place are inconsistent in quality. Moreover, there is a dearth of locally produced, contextually relevant course content for either teachers or learners. Identifying which competencies particular teachers need to acquire is far from simple either, as these are context-dependent and personal teaching styles and school location and circumstances play a major role.
The UNESCO (2008) ICT competency standards for teachers helpfully describe three approaches – technological literacy; knowledge deepening; knowledge creation – and ICT plays a different but complementary role in each of these approaches, which require new teacher roles, new pedagogies and classroom practices, and new approaches to teacher education. Collectively the issues raised in the previous paragraph mean, however, that integrating ICT into teacher education in SSA has been patchy to date. There are some recent examples of successful practice outlined above. However, according to Unwin (2005), provision has often been characterised by well meaning, but misguided, supply-driven initiatives across the continent to provide teachers and pupils with ICT skills, which have proved "wasteful and inappropriate", with limited impact. The research shows that new digital technologies appropriate for use in SSA have the potential to revolutionise the quality of education for subject teaching when carefully integrated within both pre-service and in-service programmes that are instead pedagogically driven and well supported. Conclusions we can draw from the literature about *features of successful teacher education programmes* are as follows:

- pedagogically rather than technically focused and concerned with integrating ICT use into subject teaching rather than as a discrete subject in school; likewise technology needs to be infused into an entire teacher education programme, not a "bolted-on" course;
- tailored as far as possible to individual teachers' attitudes, knowledge levels, subject disciplines and pedagogical approaches ("one-size-fits-all" does not work);
- developing awareness of the potential of ICT through a workshop approach providing hands-on experience;
- modeling interactive and participatory rather than transmission-based pedagogy in teacher education programmes themselves and offering ongoing, collaborative and active learning opportunities for teachers working within a professional community of practice;
- increasing sustainability through community-led agendas and participation;
- based on locally developed course content with cultural, linguistic and curricular relevance;
- coherence with national and school policies for ICT use and with standards; professional development being ongoing and aligned with other educational reforms; related to this, strategic leadership and involvement of relevant stakeholders and potential partners at an early stage, especially the appropriate ministry of education;
- support for organisational change and development of necessary infrastructure whilst working within recognised constraints; beginning with pre-service education within the existing framework of teacher training colleges, but addressing in-service development using blended solutions.

This last point shifts the emphasis to construing ICT as the medium as well as the message of teacher education. Unwin (2005, p. 126) concludes that its potential to support appropriate and sustainable teacher education programmes is immense, but that we have only just started to grapple with these issues effectively.

It seems that ICT tools now present an opportunity to address the growing shortage of qualified teachers in SSA, and while full-time, centre-based teacher education is impractical for in-service provision, a blend of using ICT for open and distance learning (Davis et al., 2009, indicate that alone this may bring its own problems) along with school-based teacher development offers a possible and relatively inexpensive solution.

Section 7

Implications for developing educational uses of ICT in East Africa

Sara Hennessy & Brown Onguko

Key words: *ICT, investment, education, policy, East Africa, equity, barriers, teacher education.*

Introduction

In this final section we outline the perceived implications of our review for educators, government policymakers, researchers, donors, business and community leaders with an interest in developing educational uses of ICT in East Africa or in SSA more generally (as we believe the central messages are universal). Key implications and recommendations are in italic font throughout. We would like to acknowledge David Harrison and Leonard Wamakote for their contributions to this section.

7.1 Policy, investment and partnership initiatives for integrating ICT into schooling: Rhetoric and reality

The review reveals that significant progress is being made in the endeavour to incorporate ICTs into schooling in the five countries in the East African Community (Burundi, Kenya, Rwanda, Tanzania and Uganda), which generally now have clearly formulated policies and strategies in place to promote use in schools (Burundi is the exception). These policies are wide ranging but tend to focus on the curriculum and on professional development in particular. Encouragingly, there is growing awareness that *providing equipment is insufficient to promote educational change*. Governments are emphasising development of teacher skills and pedagogy as the key to effectively implementing curricula, to using ICT to enhance teaching and learning, and to raising educational standards. The elaboration of policies on integrating ICT into education has led to increased government investments in ICT in all countries except Burundi, and most prominently in Rwanda where pioneering use of ICT is well established. Available data on ICT infrastructure and usage is limited, however, and in many cases outdated, so the true picture is hard to assemble and trends cannot easily be charted. *Annual collection of information about pupil:computer ratios etc. would be most useful.* (Web-based data management systems that allow users to directly upload data to central databases in real time are most useful because they enable timely analysis of data and taking of remedial action when needed.) From what we can glean and in our experience, exposure to ICT in public schools remains negligible, especially in poorer, rural schools. Moreover, emphasis is on secondary school education in all of the countries except Tanzania where ICT has been introduced in the primary sector. While the policies are highly ambitious, the limited evidence available of their implementation indicates that their status remains largely at the level of rhetoric in some countries and in some aspects.

Equally ambitious are the aims of the wide variety of ICT initiatives now in place to support teaching and learning in schools in SSA. These projects are funded through a myriad of public and private sources and partnerships including governments, commerce, philanthropic donors and other charities, educational institutions and NGO / development agencies. They are generally recently initiated, regionally bound and time limited. There are certainly some success stories, at least in terms of improved facilities; stakeholders have equipped schools with computers for teaching, learning and

administration purposes and students are enthusiastic about using computers for learning despite the lack of equipment available. Access to ICT facilities in schools in Eastern Africa is growing and connectivity is improving, especially in urban areas through wireless networks. There is also extensive use of mobile phone technology, and some countries are developing digital content for use across the curriculum. Nevertheless, access and usage remain sporadic and the claims made in reports of impact upon teaching and learning are tricky to corroborate as evidence is often anecdotal. As with ICT policies, *a lack of tendency to systematically evaluate the outcomes makes it hard to assess their success, and we suggest that this situation needs to be redressed as new schemes are planned.* Sustainability of schemes and potential for further rollout are also highly uncertain once funding runs out and deserve some attention; further support may be needed over the longer term, or ideally the principle of self-sustainability through development of local capacity will be addressed. Forward thinking in particular about the shelf life of equipment (especially refurbished machines) and *building in financial support for technical assistance and maintenance and/or developing local technical expertise* are needed too. A further recommendation we would make is that Ministries of Education could *publicise information on all ongoing initiatives, achievements so far and lessons learnt.* This would reduce unnecessary duplication and help newcomers to learn from both mistakes and successes of past projects.

It is notable that most of the countries in SSA (and in developing contexts generally) have a common feature in their ICT policies, curricula and initiatives in schools in the form of promotion of computer science or information technology as a discrete subject, examined by the national examination boards (in addition to increasing integration of ICTs within school information and management systems). This is reinforced by the lack of technology in classrooms and its concentration instead in purpose-built computer labs (containing networked or stand-alone PCs), a model that countries like the UK with high penetration of ICT in schools are now moving way from, especially as mobile or classroom-based technologies such as portable devices and interactive whiteboards increase in prevalence. Location of equipment in a locked, gatekeeper-controlled lab some distance from the classroom is a deterrent to its use in the East African context, especially with large classes that are not easily or quickly relocated. Moreover, where computers are set aside for use on only special occasions, they remain an object of curiosity, fear, uncertainty, awe or mystery, rather than being seen as the useful, enabling tool that they can be.

There are many national initiatives and others such as NEPAD, Intel World Ahead, Schoolnet, One Laptop per Child, PanAfrican Research Agenda, that span several countries in SSA, albeit sometimes with limited participation in each. Nevertheless, the majority of schemes to develop ICT use in African schools in fact operate in isolation from each other, as summed up rather eloquently by Unwin:

> There is considerable interest in delivering educational ICT initiatives across Africa. African governments are eager to use ICTs so that they are at the forefront of technological change; donors and international agencies are eager to provide resources to help 'Bridge the Digital Divide'; the private sector is keen to invest where companies see potential market growth possibilities in the future; academics are interested in sharing the results of their research on the subject; and civil society organisations are willing to help facilitate delivery of schemes on the ground. However, this **multiplicity of interest means that there is frequent duplication of effort, lessons are not sufficiently learnt and shared, and there is a wasteful lack of co-ordination in the activities that actually take place.** There are many examples of small scale initiatives, embarked on with the best will in the world, but that only benefit a few people for a short while. If all those involved would truly work together for the interests of the poor and marginalised in Africa, rather than primarily for their own agendas and targets, it would be possible to achieve very much more than has heretofore been achieved. (Unwin, 2005, p. 121).

The largely fragmented, regional, under-funded and inadequate nature of initiatives to build teachers' ICT capabilities is similarly pointed out in a damning snapshot report of all (English medium) teacher training initiatives in ICT in Africa by the Commonwealth of Learning (COL 2004). Unwin (2005) makes the complementary point that ambitious supply-led and externally driven teacher training schemes are being discussed at a pan-African level, with far too little thought being paid to the ways in which they can be integrated into existing and ongoing initiatives in specific countries. In recent years, a more optimistic picture has emerged, with many new national initiatives that involve appropriate public-private partnerships between relevant stakeholders; experiences of the World Links for Development Programme in connecting schools to the internet, training teachers and grappling with curriculum and education reform issues in developing countries indicates that this is the most successful partnership model (Hawkins, 2002). However our conclusion must be to *call for "joined-up thinking", namely a comprehensive framework across the East African Community at least, for both development of ICT use in schools and for large-scale professional development – whereby experience is shared both between and within nations*. This would undoubtedly be far more cost-efficient and effective in exploiting the potential that partnerships between governments, the private sector, civil society, academic institutions and global organisations can provide. Moreover, formal *evaluation of new policies and the aims and impacts of investments and initiatives is often lacking and needs to be culturally embedded so that lessons are learned and again wisdom is accumulated*, offering a much firmer foundation for future strategy and investment by both governments and donors.

Important questions remain about the level of investment required to introduce ICT in the most optimal way and form so as to improve the quality of teaching and learning in schools; research in this area would be extremely useful. Related to this is decision making about opting for low-cost, low maintenance portable technologies such as mobile phones and low energy or alternative energy handheld devices, versus aiming for introduction of more powerful but energy-intensive technologies. Likewise is broadband connectivity – intended to leap ahead in the developmental process and "catch up" with the developed world – desirable, or are current explorations into less powerful but low bandwidth technologies that support locally sustainable models of rural connectivity to be encouraged? Hawkins (2002) reports that wireless technology is most effective for connecting schools in developing countries but this may be more costly.

7.2 Barriers to developing ICT use in the East African context

A number of important physical, cultural, socioeconomic and pedagogical factors hindering the use of ICT by teachers and students in sub-Saharan Africa, particularly in rural schools, emerge from our review. These include lack of electricity and frequent power outages, poor technology infrastructure, overcrowded computer labs and low bandwidth, high costs of (mainly satellite) internet connectivity, software licences and equipment maintenance, insufficient and inappropriate software. Non-competitive telecommunications policies and regulations may impede connectivity and sustainability (Hawkins, 2002). Geographic and demographic factors include population density and dispersion, linguistic and political factors. Wider socioeconomic factors such as extreme poverty and increasing HIV/AIDS levels exacerbate the situation and political will is needed to alleviate the situation through further *"joined-up thinking" in terms of devising an integrated framework to improve standards of living, education and health provision,* along with ICT infrastructure enhancement.

Further challenges to be faced include the optional status of ICT within the curriculum, and a universal emphasis on teaching basic skills for software use and information gathering. C*hanging this culture towards one of using ICT as a tool to support and enhance subject learning using active knowledge*

building approaches is a key message for policymakers. It is crucial for technologies, including print media, audio, video, computers and portable devices, the internet and a range of appropriate software, to be integrated across the curriculum, and *research into the optimal ways to achieve this integration in the East African context is sorely needed.* We do not yet really know whether the ICT subject curriculum has been implemented and how this may have impacted on ICT integration in specific subjects, but it seems as though it has not. While school leaders are important agents of change, negative attitudes among school leaders and governors towards computers and internet obstruct prioritisation of ICT integration. Anecdotal evidence suggests a lack of 'technology' leadership to oversee the institutionalization of ICT integration and policy. In order to address these multi-faceted challenges, *schools may have to develop capacity of its leaders to guide effective and more holistic integration of ICT.* The lack of contextually appropriate course content for either teachers or learners also needs to be addressed and the potential here for *creating and integrating locally produced or adapted digital open educational resources* is currently being explored by Hennessy and colleagues in a pilot project in Zambia conducted by a schools-Ministry-academic-NGO-private sector partnership.[72]

Finally, having ICT-literate and confident teachers is clearly a prerequisite for integrating any form of ICT into schooling. Until recently training opportunities have remained limited in availability and inconsistent in quality, and teachers' ICT proficiency and knowledge of the potential of ICT for supporting teaching and learning have thus remained limited too. Lack of teacher time to get to grips with new technologies is another obstacle, linked to the growing shortage of qualified teachers. The COL (2004) report pointed out that the prohibitively high cost of training teachers to use ICT and the shortage of public funds to devote to this are fundamental challenges to be overcome before ICT capacity building can become a reality in African education. The situation has since become even more acute in the face of the recent economic downturn globally and increasingly large school classes as countries respond to the Millenium development goals concerning universal primary education. The consequences of this and of the designation of ICT as a discrete subject include a lack of subject teachers trained to integrate ICT into learning in their areas. Once more, *integrated initiatives are needed, with participation from multiple players in each country including Ministries of Education for provision of a policy framework, curriculum and software developers and teacher training colleges.* ***Our key message here is that teacher education is an absolutely essential area for development in East Africa if ICT use is ever to effectively support learning.***

7.3 Teacher education and development

Considerable encouragement can be drawn from the recognition of the need for teacher education within recent policy changes and the finding that most SSA countries have invested in developing the capacity of teachers to use ICT for teaching and learning through both in-service and pre-service programmes. In theory this vastly increases the chances that facilities will actually be used. Long experience in many Northern and Southern country contexts indicates that *when a government or other body provides new technology equipment in schools it is likely to remain idle or used poorly unless teachers are cognisant about what they can do with it, and a short induction from its supplier is far from adequate to realise pedagogical potential.* It is extraordinary to find time and again that this lesson has not been learned (as witnessed in the UK's recent saturation of schools with expensive interactive whiteboards that are largely not used interactively at all: eg. Moss et al., 2007) and *we strongly hope that fuller awareness of the needs of teachers encountering new digital tools will shortly*

[72] http://www.educ.cam.ac.uk/centres/cce/projects/ictzambia/

be realised; in particular new initiatives need to take heed of what has been trialled before, including in other country contexts.

Identifying the *characteristics of apparently successful teacher training and development programmes* is our contribution to this endeavour. In summary, we suggest that these

- are pedagogically rather than technically focused, promoting active, independent, inquiry-based and collaborative classroom learning, and exploiting the potential of ICT to support it – while attending to teachers' prior attitudes, knowledge levels, subject disciplines and pedagogical approaches;
- infuse technology into an entire teacher education programme using blended solutions (rather than "bolting it on");
- model interactive pedagogical approaches including employing hands-on workshops to develop awareness of the potential of ICT; offer ongoing, collaborative and active learning opportunities for teachers.

Overall Conclusions

The needs identified through this review include:

- a shift from 'Education for ICT' to the use of 'ICT for Education' and for ICTs to be integrated throughout the curriculum, blending their use with other tools and resources to support student learning;
- prioritising provision of initial and ongoing in-service teacher education that effectively equips teachers to integrate ICT into subject teaching and learning using contemporary pedagogical approaches;
- a holistic and comprehensive framework within and across East African countries to include infrastructure enhancement, development of ICT use in schools and large-scale professional development; this requires significant investment and strategic leadership by governments working closely with other partners, and decision making grounded in research evidence;
- building evaluation and sustainability into these programmes and into policies from their inception and linking them to broader education reforms and community agendas;
- linked to this, research that identifies the forms of ICT and of teacher education that work within this developing context and its particular constraints.

We acknowledge that these are demanding recommendations given the current state of play but perceive that striving towards bringing East African schooling into the 21st century in these ways will help national leaders and educators to harness ICTs in support of their countries' further educational and economic development.

ACKNOWLEDGEMENTS

We are very grateful to our main sponsors, the Aga Khan University Institute for Educational Development – Eastern Africa, the Centre for Commonwealth Education at the Faculty of Education, University of Cambridge, and the UK government's Department for International Development (DFID) whose DelPHE (Development Partnerships in Higher Education) grant has supported the Cambridge–IED-EA partnership over the last 2 years. The funding covered the time of the review authors, plus assistance in compiling the review and extensive bibliography from Manzoorul Abedin, Mona Bani, Amy Devine, Bryony Horsley-Heather and Antonina Tereschenko at Cambridge. We appreciate the contributions made by all, including Sarah Ojuando and Sally Roach for administrative help, and our colleagues Susan Crichton (Calgary) and Peter Kajoro (IED-EA) within the partnership who helped us to shape the review.

BIBLIOGRAPHY

Acana, S. (2006). *Reporting results of National Assessment: Uganda Experience*. Paper presented at the 32nd Annual Conference of the International Association for Educational Assessment.

Afe, J. O. (2002). *Reflections on becoming a Teacher and the Challenges of Teacher Education*. Paper presented at the Inaugural Lecture Series 64 of the University of Benin.

Afemikhe, O. A. (2004). Quality assurance in teacher education in Nigeria: reflections of an evaluator. In O. A. Afemikhe & J. G. Adewale (Eds.), *Issues in Educational Measurement and Evaluation in Nigeria* (pp. 17-26). Ibadan: Institute of Education, UI.

Africa Science News, S. (2009). Rwanda now plans to have a laptop per child in 3 years. Retrieved from http://africasciencenews.org/asns/index.php?option=com_content&task=view&id=1363&Itemid=2

Afshari, M., Abu Bakar, K., Luan, W. S., Abu Samah, B., & Fooi, F. S. (2008). School leadership and information communication technology. *The Turkish Online Journal of Educational Technology - Tojet, 7*(4).

Aguti, J. (2006). *New models of teacher education and training: Responding to the crisis of conflict in Uganda*. Paper presented at the American Educational Research Association Annual Conference.

Agyeman, O. T. (2007). *Survey of ICT in Education in Nigeria*. Washington, DC: infoDev / World Bank.

Alemneh, D. G., & Hastings, S. K. (2006). Developing the ICT infrastructure for Africa: overview of barriers to harnessing the full power of the Internet. *Journal of Education for Library and Information Science, 47*(1), 4-16.

Anderson, E. A. (Ed.). (2002). *Improving schools through teacher development: Case studies of the Aga Khan Foundation Projects in East Africa.* Lisse: Swets and Zeitlinger.

Anderson, J. (1997). Integrating ICT and Other Technologies in Teacher Education: Trends, Issues and Guiding Principles. *Infotech Trends*

Anderson, J. (1997). *Information technology options for educational management: Challenges and responses. Managing Educational Realities in Asia and the Pacific: A Report of the South East Asia and Pacific Region Educational Administrators' and Managers' Symposium (Vol. II)*. Darwin: SEAPREAMS.

Anderson, J., & van Weert, T. (Eds.). (2002). *Information and Communication Technology in Education: A Curriculum for Schools and Programme of Teacher Development*. Paris: UNESCO.

Anderson, T., & Elloumi, F. (2004). *Theory and practice of online learning*. Athabasca: Athabasca University.

Association of African Universities. (2002). *Guidelines for institutional self-assessment of ICT maturity in African universities*. Accra: Association of African Universities.

Avlos, B. (1985). Training for better teaching in the third world: Lessons from research. *Teaching and Teacher*

Education, 1(4), 289-299.

Ayodo, H. (2009, 15th October 2009). Many false starts in taking computers to schools. *The Standard, Online Edition*.

Bachmair, B. (2007). M-learning and media use in everyday life: towards a theoretical framework. In N. Pachler (Ed.), *Mobile learning: towards a research agenda*. London: Work-Based Learning Centre, Institute of Education.

Banks, K. (2008). Mobile learning in developing countries: present realities and future possibilities. In D. Harper (Ed.), *Education for a Digital World. Advice, Guidelines, and Effective Practice from Around the Globe*. Vancouver: BC campus and Commonwealth of Learning.

Becta. (2001). *The "Digital Divide": a discussion paper*. Coventry: BECTA.

Becta. (2002). *The Impact of Information and Communication Technologies on Pupil Learning and Attainment. (ICT in Schools Research and Evaluation Series - No. 7)*: DfES.

Benjamin, P. (2001). Telecenters in South Africa. *Journal of Development Communication, 2*(12), 32-38.

Blurton, C. (1999). New directions of ICT-use in education, UNESCO's World Communication and Information Report 1999. Retrieved from http://www.unesco.org/education/educprog/lwf/d1/edict.pdf

Bof, A. M. (2004). Distance learning for teacher training in Brazil. *The International Review of Open and Distance Learning, 5*(1).

Botswana College of Distance and Open Learning. (2009). e-Learning. Retrieved from http://www.bocodol.ac.bw/PGContent.php?UID=606

Bowes, J. (2003). *The emerging repertoire demanded of teachers of the future: surviving the transition*. Paper presented at the IFIP Working Groups 3.1 and 3.3 Working Conference: ICT and the Teacher of the Future.

Bowker, A., Hennessy, S., Dawes, M., & Deaney, R. (2009). Supporting professional development for ICT use in mathematics using the T-MEDIA multimedia resource. In M. Joubert (Ed.), *Proceedings of the British Society for Research into Learning Mathematics* (Vol. 29, pp. 19-24). Cambridge.

Bransford, J. D., & Brown, A. L. (1999). *How People Learn: Brain, Mind, Experience, and School*. Committee on Developments in the Science of Learning, National Research Council, National Academic Press.

Brown, T. H. (2005). Towards a model for m-Learning in Africa. *International Journal on ELearning, 4*(3), 299-316.

Buchele, S. F., & Owusu-Aning, R. (2007, December). *The One Laptop Per Child (OLPC) Project and its applicability to Ghana.* Paper presented at the Proceedings of the 2007 International Conference on Adaptive Science and Technology.

Capper, J. (2001). *Uses of technology to support high quality teacher professional development*. Retrieved from http://unesdoc.unesco.org/images/0013/001347/134793eo.pdf

Carlson, S., & Gadio, C. T. (2002). Teacher professional development in the use of technology. In W. D. Haddad & A. Draxler (Eds.), *Technologies for education: potential, parameters, and prospects*. Paris and Washington, D.C: UNESCO and AED

Caswell, B., & Lamon, M. (1999). *The Development of Scientific Literacy: the Evolution of Ideas in A Knowledge Building Classroom*. In J. Leach & R. E. Moon (Eds.), *Learners & Pedagogy*. London: Paul Chapman.

Cawthera, A. (2001). *Computers in Secondary Schools in Developing Countries: Costs and Other Issues* (No. 12831): Department for International Development (DFID) (UK).

Centre for Educational Technology. (2007). Report on ICTs in Higher Education in Uganda. Retrieved from http://www.cet.uct.ac.za/files/file/uganda.pdf

Centre for Information Technology in School and Teacher Education. (2004). *An integrated approach to bridging the digital divide through supporting the development of e-educational leadership*. Hong Kong: The University of Hong Kong.

Chen, D. H., & Kee, H. L. (2005). *A model on knowledge and endogenous growth*. Washington, DC: World Bank.

Chonjo, P. N. (1994). The Quality of Education in Tanzanian Primary Schools: An Assessment of Physical Facilities and Teaching Learning Materials. *UTAFITI (New Series), 1*(1), 36-46.

Clegg, A., Bregman, J., & Ottevanger, W. (2008). *Uganda secondary education & training curriculum, assessment &*

examination (CURASSE). Roadmap for reform: Association for the Development of Education in Africa.

Cloke, C. (2000). Planning to use ICT, factors which influence teachers. *ESRC ICT & Pedagogy*.

Collins, J., & Duguid, P. (2000). *The Social Life of Information*. Cambridge, Mass.: Harvard University Press.

Collis, B., & Jung, I. S. (2003). Uses of information and communication technologies in teacher education. In B. Robinson & C. Latchem (Eds.), *Teacher Education through Open and Distance Learning* (pp. 171-192). London: Routeledge Falmer.

Commonwealth of Learning. (2004). *Towards a strategy on developing African teacher capabilities in the use of information and communication technology*. Retrieved from www.thutong.doe.gov.za/resourcedownload.aspx?id=18626

Communications Commission of Kenya. (2005). Kenya ICT Trust Fund. Retrieved from http://www.cck.go.ke/html/child.asp?title=&contcatid=12&childtitle=WSIS+PROCESS&childcontid=135&pg=3

Cox, M., Webb, W., Abbot, C., Blakeley, B., Beauchamp, T., & Rhodes, V. (2004). *ICT and Pedagogy: A Review of the Research Literature*. London: Department for Education and Skills.

Cox, M. J., Preston, C., & Cox, K. (1999, 2-5 September). *What motivates teachers to use ICT?* Paper presented at the British Educational Research Association (BERA), University of Sussex, Brighton.

Cradler, J., Bridgforth, E., & WestEd. (2002). Recent research on the effects of technology on teaching and learning. Retrieved 25/10/2002, from www.wested.org/techpolicy/research.html

Cuban, L. (1993). Computers meet classroom: classroom wins. *Teachers College Record, 95*(2), 185-210.

Cuban, L. (2001). *Oversold and Underused: Computers in the Classroom*. London: Harvard University Press.

Daniels, J. S. (2002). Foreword. In J. Anderson & T. van Weert (Eds.), *Information and Communication Technology in Education: A Curriculum for Schools and Programme for Teacher Development*. Paris: UNESCO.

Davis, N., Desforges, C., Jessel, J., Somekh, B., Taylor, C., & Vaughan, G. (1996). Can quality in learning be enhanced through the use of IT? In *Using IT Effectively in Teaching and Learning: Studies in Pre-Service and In-Service Teacher Education* (Vol. 1 (Part 2), pp. 14-27). London: Routledge.

Davis, N., Preston, C., & Sahin, I. (2009). ICT teacher training: Evidence for multilevel evaluation from a national initiative. *British Journal of Educational Technology, 40*(1), 135–148.

Day, C., & Sachs, J. (2004). Professionalism, performativity and empowerment: discourses in the politics, policies and purposes of continuing professional development. In C. Day & J. Sachs (Eds.), *International Handbook on the Continuing Professional Development of Teachers* (pp. 3-32). Maidenhead: Open University Press.

Department of Education, University of Oxford. (2008). *Changing spaces: young people, technology and learning. The educational and social impact of new technologies on young people in Britain*. Oxford: ESRC.

DFID. (2001). *Imfundo: Partnership for IT in Education inception report*. London: DFID.

DFID. (2004). *Finding new approaches to teacher education in developing countries*.

DFID. (2006). *DEEP Impact: How ICT can improve teacher education*.

Dhanarajan, G. (2001). Learning Technologies: where is the challenge? *Education, Communication and Information (now published as: Learning, Media and Technology), 1*(1), 133-139.

Dladla, N., & Moon, B. (2002). *Challenging the assumptions about teacher education and training in sub-Saharan Africa: a new role for open learning and ICT*. Paper presented at the Pan-Commonwealth Forum on Open Learning from http://www.open.ac.uk/deep/why/PanCommonwealth.doc.

Dladla, N., & Moon, B. (2006). Why teachers matter: The challenge of teacher supply and teacher development in sub-Saharan Africa, *Symposium presentation to the American Educational Research Association (AERA) annual conference*. San Francisco.

du Toit, I. (2005). *The effect of ICT curriculum support on the measured skills levels of learners of two sub-projects of the Khanya project*. Paper presented at the 8th IFIP World Conference on Computers in Education (WCCE 2005). Retrieved from www.khanya.co.za/news/events/files/wcceisabel.pdf

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1990). *Teacher beliefs and practices part 1: Patterns of change. The*

evolution of teachers' instructional beliefs and practices in high-access-to-technology classrooms. First to fourth year findings. Cupertino: Apple Computer Inc.

Dzimbo, P., & Barasa, F. (2006). *Creating Pan-African models of teacher education: Repositioning the role of the African Virtual University*. Paper presented at the American Educational Research Association (AERA) annual conference. San Francisco.

e-Africa Commission. (2004). *NEPAD e-Schools initiative concept framework document.*

EdQual. (2008). *The use of ICT*. London: EdQual/DiFD.

eLearning Africa News Portal. (2008). New ideas for teaching chemistry. Retrieved from http://www.elearning-africa.com/newsportal/english/news152.php

eLearning Africa News Portal. (2008). Pilot phase in full progress. Retrieved from http://www.elearning-africa.com/newsportal/english/news129b.php

eLearning Africa News Portal. (2009). What do football and mathematics have in common? from http://www.elearning-africa.com/newsportal/english/news141.php

Enakrire, T. R., & Onyenania, O. G. (2007). Causes inhibiting the growth or development of information transfer in Africa: a contextual treatment. *Library Hi Tech News, 4*, 20-28.

Etta, F. E., & Parvyn-Wamahiu, S. (Eds.). (2003). *Information and communication technologies for development in Africa* (Vol. 2: The Experience with Community Telecentres). Ottawa: IDRC.

Fafunwa, A. B. (1967). *New Perspectives in African Education*. Lagos: Macmillan (Nigeria).

Fafunwa, A. B. (1974). *History of Education in Nigeria*. London: Allen & Unwin.

Fall, B. (2009). African education knowledge warehouse.

Farrell, G. (2007). *Survey of ICT in Education in Kenya*. Washington, DC: infoDev / World Bank.

Farrell, G. (2007). *Survey of ICT in Education in Rwanda*. Washington DC: infoDev/World Bank.

Farrell, G. (2007). *Survey of ICT in Education in Uganda*. Washington, DC: infoDev/World Bank.

Farrell, G., & Isaacs, S. (2007). *Survey of ICT and Education in Africa. A Summary Report, Based on 53 Country Surveys*. Washington, DC: infoDev/ World Bank.

Farrell, G., Isaacs, S., & Trucano, M. (2007). *The NEPAD e-Schools Demonstration Project: a work in progress*. Washington, DC: infoDev / The World Bank.

FGN/UNICEF. (1993). *Situational and policy analysis of basic education in Nigeria: national reports*. Lagos: Federal Ministry of Education.

Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of Educational Administration, 41*(2), 124-142.

Fontaine, M. (2000). Teacher training with technology: Experience in five country programs. *TechKnowLogia, November/December*, 69-71.

Fox, B., & Twining, P. (2006). *Comparing perspectives on the role of ICT in education.* Paper presented at the Society for Information Technology & Teacher Education 2006 Conference (SITE), Orlando, Florida.

Freeman, M. (1997). Flexibility in access, interaction and assessment: the case for web-based teaching programs. *Australian Journal of Educational Technology, 13*(1), 23-39.

Fuller, B., & Kapakasa, A. (1991). What Factors Shape Teacher Quality? Evidence from Malawi. *International Journal of Educational Development, 11*(2), 119-127.

Futurelab. (2003). *Literature Review in Primary Science and ICT*. Belfast: Graduate School of Education, Queens University.

Gakuu, C. M., Kidombo, H. J., Bowa, O., Ndiritu, A., Mwangi, A., & Gikonyo, N. (2009). Kenya report. In T. Karsenti (Ed.), *The PanAfrican Research Agenda on the Pedagogical Integration of Information and Communications Technologies: Phase 1 National Reports* (pp. 91-96). Ottawa: IDCR.

Gaskell, A., & Tait, A. (Eds.). (2003). *The future of open and distance learning. Proceedings of the 10th International*

Conference on Open and Distance Learning. Cambridge: The Open University in the East of England.

Gatana, K. (2009). Growth and Improvement of Information Communication Technology in Kenya. Retrieved from http://ijedict.dec.uwi.edu/viewarticle.php?id=667&layout=html

GeSCI. (2005). Educational development. Retrieved from http://www.gesci.org/content.asp?ct_id=5

Ghana. The Ministry of Education, Science and Sports. (2006-2007). *Report on the Education Sector Annual Review (ESAR)*. Retrieved from http://planipolis.iiep.unesco.org/upload/Ghana/Ghana_ESAR_2006_Report_Final.pdf

Gillwald, A., & Stork, C. (2008). *Towards evidence based ICT policy and regulation Vol 1 Paper 2: ICT access and usage in Africa*. Braamfontein: Research ICT Africa.

Glazer, E. M., & Hannafin, M. J. (2006). The collaborative apprenticeship model: situated professional development within school settings. *Teaching and Teacher Education, 22*(2), 179-193.

Grace, J., & Kenny, C. (2003). A short review of information and communication technologies and basic education in LDCs - what is useful, what is sustainable? *International Journal of Educational Development, 23*(6), 627-636.

Grundy, S., & Robison, J. (2004). Teacher professional development: themes and trends in the recent Australian experience. In C. Day & J. Sachs (Eds.), *International Handbook on the Continuing Professional Development of Teachers* (pp. 146-166). Maidenhead: Open University Press.

Haddad, W. D. (2003). Is instructional technology a must for learning? *TechKnowLogia, January-March*, 5-6.

Haddad, W. D., & Draxler, A. (2002). *Technologies for Education*. Washington DC/Paris: UNESCO and the Academy for Educational Development.

Hallinger, P., & Kantamara, P. (2000). Educational change in Thailand: opening a window onto leadership as a cultural process. *School Leadership & Management, 20*(2), 189-205.

Hansen, N., Postmes, T., Bos, A., & Tovote, A. (2009). *Does technology drive social change? Psychological, social and cultural effects of OLPC among Ethiopian children*. Paper presented at the The ICT for Development Collective. Retrieved 15 July 2009, from www.gg.rhul.ac.uk/ict4d/NinaandTom.pdf

Hare, H. (2007). *Survey of ICT in Education in Tanzania*. Washington, DC: infoDev/World Bank.

Hare, H. (2007). *Survey of ICT in Education in Burundi*. Washington, DC: infoDev/World Bank.

Harle, J. (2007 August). *Frameworks for Africa-UK research collaboration in the social sciences and humanities. African University Perspectives*. London: The Association of Commonwealth Universities for The British Academy.

Harris, S. (1999). *INSET for IT: a review of the literature relating to preparation for and use of IT in schools.* Slough: National Foundation for Educational Research.

Harrison, B. (2005). *Information and communication technology policy in Rwanda*.

Harrison, C., Comber, C., Fisher, T., Haw, K., Lewin, C., Lunzer, E., et al. (2003). *ImpaCT2: the impact of information and communication technologies on pupil learning and attainment.* London: DfES.

Hawkins, R. J. (2002). Ten lessons for ICT and education in the developing world. In G. Kirkman, P. K. Cornelius, J. D. Sachs & K. Schwab (Eds.), *Global Information Technology Report 2001-2002: Readiness for the Networked World* (pp. 38-44). New York: Oxford University Press.

Hawkridge, D. (2003). *Models for open distance learning: 2. Globalisation, education and distance education*. Vancouver: Cambridge Commonwealth of Learning.

Herselman, M. E. (2003). *ICT in rural areas in South Africa: various case studies.* Paper presented at the Informing Science & Information Technology Education Joint Conference, Pori, Finland.

Hexel, D., De Marcellus, O., & Bernoulli, M. (1998). Potentials and constraints of ICT in schools. *Educational Media International, 35*(3), 149-156.

Hirtz, S., Harper, D. G., & Mackenzie, S. (Eds.). (2008). *Education for a Digital World: Advice, Guidelines, and Effective Practice from Around the Globe*. Vancouver: Commonwealth of Learning.

Imfundo. (2001). *Imfundo: Partnership for IT in education. Inception Report* (No. 1 86192 338 4). London: DFID.

Institute for Information Technologies in Education. (2002). *For teacher training*. http://www.iite.ru/iite/publications/publications?id=38

Institute for the Study of Knowledge Management in Education. (2008). *CurriculumNet: Creating Freely Available Curriculum Materials to Meet Uganda's Growing Student Population*: Institute for the Study of Knowledge Management in Education.

International Development Research Centre (IDRC). (2005). Wireless teacher training & e-learning platform. Retrieved 19th March 2005, from http://web.idrc.ca/en/ev-51270-201-1-DO_TOPIC.html

Isaacs, S. (2007). *Survey of ICT in Education in Botswana*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Lesotho*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Malawi*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Mauritius*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Mozambique*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Namibia*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in the Seychelles*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Swaziland*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Zambia*. Washington, DC: infoDev/World Bank.

Isaacs, S. (2007). *Survey of ICT in Education in Zimbabwe*. Washington, DC: infoDev/World Bank.

Isyaku, K. (2002). The curriculum of teacher education in Nigeria: issues of relevance and quality - Proceedings of the First Teachers' Summit. In *Teacher Education in Nigeria: Past Present and Future*. Kaduna: NTI.

Jain, P. (2006). Empowering Africa's development using ICT in a knowledge management approach. *The Electronic Library, 24*(1), 51-67.

James, J. (2001). Low-cost computing and related ways of overcoming the global digital divide. *Journal of Information Science, 27*(6), 385-392.

James, T., Hesselmark, O., Akoh, B., & Mware, L. (2003). *Review of basic ICT skills and training software for educators in Africa*: Imfundo.

James, T., Kartano, K., & Mutinda, T. (2004). *Country Specific Market Analysis: Kenya*: International Finance Corporation.

Janczewski, L. J. (1992). Factors of information technology implementation in under-developed countries: Example of the West African nations. In S. Palvia, P. Palvia & R. M. Zigli (Eds.), *The Global Issues of Information Technology Management* (pp. 187-212). London: Idea Group Publishing

Jegede, O. J. (2002). A celebration of teacher education and open and distance learning (ODL) in Nigeria: attainments, challenges and strategies. In *Teacher Education in Nigeria: Past Present and Future - Proceedings of the First Teachers' Summit*. Kaduna: NTI.

Jensen, M. (2005). *The African experience: building both supply and demand*. Paper presented at the InfoDev Workshop.

JISC. (2004). Developing maturity in e-learning [Electronic Version]. Retrieved June 2007 from http://www.aclearn.net

Jones, R., & Kozma, R. (2003). Local and national ICT policies. In *Technology, innovation, and educational change: A global perspective*: International Society for Technology in Education.

Jones, S., Tanner, H., Kennewell, S., Parkinson, J., Denny, H., Anthony, C., et al. (2009). Using video stimulated reflective dialogue to support the development of ICT based pedagogy in mathematics and science. *Welsh Journal of Education, 14*(2), 63-77.

Josue, T. T. (2007). *Survey of ICT in Cameroon*. Washington, DC: infoDev/World Bank.

Jung, I. (2005). ICT-Pedagogy Integration in Teacher Training: Application Cases Worldwide. *Journal of Educational Technology and Society, 8*(2), 94-101.

Jung, I. S. (2001). Singapore's approach to preparing new teachers to use technology in the classroom. In J. Capper (Ed.), *Case studies of innovations in teacher training and technology*. Washington, DC: The World Bank.

Jung, I. S. (2003). A comparative study on the cost-effectiveness of three approaches to ICT teacher training. *Journal of Korean Association of Educational Information and Broadcasting, 9*(2), 39-70.

Jung, I. S., & Rha, I. (2000). Effectiveness and cost-effectiveness of online education: A review of literature. *Education Technology, July-August*, 57-60.

Kariuki, G. (2009). Growth and improvement of information communication technology in Kenya [Electronic Version]. *International Journal of Education and Development using ICT*. Retrieved 2nd October 2009 from http://ijedict.dec.uwi.edu/viewarticle.php?id=667&layout=html

Kariuki, G. (2009). *Growth and Improvement of Information Communication Technology in Kenya*.

Karsenti, T. (2009). Summary. In T. Karsenti (Ed.), *The PanAfrican Research Agenda on the Pedagogical Integration of Information and Communications Technologies: Phase 1 National Reports* (pp. 7-10). Ottawa: IDRC.

Kawooya, D. (2004). Universal access to ICT and lifelong learning: Uganda's experience. *New Library World, 105*(1206/1207), 423-428.

Kelles-Viitanen, A. (2003). The Role of ICT in Poverty Reduction. 82-94.

Kelles-Viitanen, A. (2005). The Role of ICT in Governing Rural Development.

Kemmis, S., Wright, E., & Atkin, R. (1977). *How do students learn?: Working papers on computer assisted learning: a report by the UNCAL (Understanding Computer Assisted Learning) independent educational evaluation of the National Development Programme in Computer Assisted Learning*. Norwich: UNCAL.

Kenya. (1998). *Master Plan on Education and Training 1997-2010*. Retrieved from http://openlibrary.org/books/OL6863380M/Master_plan_on_education_and_training_1997-2010

Kenya. Ministry of Education, Science and Technology, Kenya Institute of Education. (2002). *Secondary schools syllabus*.

Kenya. Ministry of Education. (2005). *ICT in Education options paper*. Retrieved from http://www.pdf.usaid.gov/pdf_docs/PNAIDI898.pdf

Kenya. Ministry of Education. (2006). *National information and communication technology ICT strategy for education and training*. Retrieved from www.education.go.ke/ICTstrtegy.htm.

Kenya. Ministry of Education. (2008). *Kenya Education Sector Support programme: Financial monitoring report 4th quarter 1st April to 30th June 2008*.

Kenya. Ministry of Education, Science and Technology. (2008). *Kenya Education Sector Support Programme 2005 - 2010*.

Kenya. Ministry of Education Science and Technology. (2006). *Strategic Plan 2006/2011*. Retrieved 15th October 2009. Retrieved from http://www.education.go.ke/#.

Kenya. Ministry of Education Science and Technology. (2008). Kenya Education Sector Support Programme 2005 - 2010. Retrieved from http://planipolis.iiep.unesco.org/upload/Kenya/Kenya%20KESSP%20FINAL%202005.pdf

Kenya. Ministry of Finance. (2009). *Economic Stimulus Programme: Overcoming today's challenges for a better Kenya tomorrow*. Retrieved 15th October 2009. Retrieved from http://www.treasury.go.ke/index.php?option=com_docman&task=cat_view&Itemid=54&gid=87.

Kenya. Ministry of Information and Communications. (2006). National Information and Communications Technology Policy. Retrieved from http://www.cck.go.ke/UserFiles/File/national_ict_policy.pdf

Kenya. Ministry of Information and Communications. (2006). *2006 Kenya ICT Strategy*. Retrieved from http://www.ictvillage.com/Downloads/2006_Kenya_ICT_Strategy.pdf

Kenya. Ministry of Information and Communications. (2006). *National Information and Communications Technology Policy*.

Kirkman, G. S., Cornelius, P. K., Sachs, J. D., & Schwab, K. (Eds.). (2002). *The Global Information Technology Report 2001-2002. Readiness for the Networked World*. New York: Oxford University Press, USA.

Kozma, R. (1999). *World links for development: accomplishments and challenges. Monitoring and evaluation Annual Report 1998–1999*. Washington, DC: SRI International.

Kozma, R., & Anderson, R. E. (2002). Qualitative case studies of innovative pedagogical practices using ICT. *Journal of Computer Assisted Learning, 18*, 387-394.

Kozma, R., McGhee, R., Quellmalz, E., & Zalles, D. (2004). Closing the digital divide: evaluation of the World Links Program. *International Journal of Educational Development, 25*(4), 361-381.

Kozma, R. B. (2005). National policies that connect ICT-based education reform to economic and social development. *An Interdisciplinary Journal on Humans in ICT Environments, 1*(2), 117-156.

Kraemer, K. L., Dedrick, J., & Sharma, P. (2009). One Laptop Per Child: Vision vs. Reality | June 2009 | Communications of the ACM. Retrieved from http://cacm.acm.org/magazines/2009/6/28497-one-laptop-per-child-vision-vs-reality/fulltext

Kukulska-Hulme, A., & Traxler, J. (2005). *Mobile Learning: A Handbook for Education and Trainers*. London: Routledge.

Kuzu, A. (2007). *Need of school technology adviser of primary and secondary schools in Turkey*. Paper presented at the 7th International Educational Technology (IETC) Conference. (Nicosia, Turkish Republic of Northern Cyprus, May 3-5, 2007)

Lankshear, C., & Snyder, I. (2000). *Teachers and Technoliteracy*. St. Leonards, NSW: Allen & Unwin.

Lassa, P. N. (2000). Teacher production: a focus on Nigeria. In *Proceedings of the Education Mini Summit held at Abuja, Monday 29 November 1999*.

Leach, J. (2003). Deep Impact: teachers and technology. *Insights Education 1*, from http://www.id21.org/insights/insights-ed01/insights-issed01-art01.html

Leach, J. (2005). Do new information and communication technologies have a role to play in achieving quality professional development for teachers in the global south? *Curriculum Journal, 16*(3), 293-329.

Leach, J. (2008). Do new information and communications technologies have a role to play in the achievement of education for all? *British Educational Research Journal, 34*(6), 783-805.

Leach, J., Ahmed, A., Makalima, S., & Power, T. (2005). *DEEP IMPACT: an investigation of the use of information and communication technologies for teacher education in the global south*. London: DFID.

Leach, J., McCormick, B., Moon, B., & Harrison, D. (2004). Developing teacher knowledge and pedagogy in a large scale, electronic conference environment for professional development. In V. Vrasidas & G. V. Glass (Eds.), *Current Perspectives on Applied Information Technologies: Online Professional Development for Teachers*. Auckland: Current Perspectives.

Leach, J., McCormick, R., Harrison, D., Hills, L., & B, M. (2003). *Professional development and ICT: the teachers' experience*. Paper presented at the British Educational Research Association (BERA) Annual Conference, Herriott Watt University, Edinburgh.

Leach, J., & Moon, B. (2002). *Globalisation, digital societies and school reform: realising the potential of new technologies to enhance the knowledge, understanding and dignity of teachers*. Paper presented at the 2nd European Conference on Information Technologies in Education and Citizenship: A Critical Insight.

Leach, J., & Moon, B. (2004). *4D technologies: can ICT make a real difference in achieving the goal of Universal Primary Education?* Paper presented at the Pan-Commonwealth Forum on Open Learning, Dunedin, New Zealand.

Leach, J., Moon, B., & Power, T. (2002). *Building teachers' professional knowledge through ICT: experience and analysis across the 'digital divide'*. Paper presented at the European Conference on Educational Research (ECER). Retrieved from http://www.leeds.ac.uk/educol/documents/00002349.htm.

Leach, J., & Moon, R. E. (2000). *Pedagogy, information and communication technologies and teacher professional knowledge*. *Curriculum Journal, 11*(3), 385-404.

Leach, J., Patel, R., Peters, A., Power, T., Ahmed, A., & Makalima, S. (2004). Deep Impact: A Study of the Use of Hand-Held Computers for Teacher Professional Development in Primary Schools in the Global South. *European Journal of Teacher Education, 27*(1), 5-28.

Leach, J., Peters, A., & et al. (2004). *In the DEEP end: a study of the use of hand held computers for teacher professional development in twenty four primary schools in Egypt and South Africa*.

Lei, J., & Zhao, Y. (2007). Technology uses and student achievement: A longitudinal study. *Computers & Education, 49*(2), 284.

Leng, N. W. (2008). Transformational leadership and the integration of information and communications technology into teaching. *The Asia-Pacific Education Researcher, 17*(1).

Lewin, K. M., & Stuart, J. S. (2003). *Researching teacher education: new perspectives on practice, performance and policy. Multi-Site Teacher Education Research Project (MUSTER) synthesis report*. London: DFID.

Liverpool, L. S. O. (2002). Information and communication technology in teacher education. In *Teacher Education in Nigeria: Past Present and Future - Proceedings of the First Teachers' Summit*. Kaduna: NTI.

Makrakis, V. (2005). *Training teachers for new roles in the new era: Experiences from the United Arab Emirates ICT program. Proceedings of the 3rd Pan-Hellenic Conference on Didactics of Informatics*. Korinthos, Greece.

Malakata, M. (2009). *Rwanda chosen for pilot OLPC learning center*: "The Industry Standard".

Manda, P. A. (2006). *State of ICTs in LIS curriculum in Tanzania*. Paper presented at the IFLA workshop on integrating ICTs in LIS curriculum in Africa.

Mangesi, K. (2007). *Survey of ICT in Education in The Gambia*. Washington, DC: infoDev/World Bank.

Mangesi, K. (2007). *Survey of ICT in Education in Ghana*. Washington, DC: infoDev/World Bank.

Mangesi, K. (2007). *Survey of ICT in Education in Sierra Leone*. Washington, DC: infoDev/World Bank.

Manjulika, S., & Reddy, V. V. (2002). The changing context of higher education in the 21st century. In V. V. Reddy & S. Manjulika (Eds.), *Towards Virtualization-Open and Distance Learning* (pp. 1-47). New Delhi: Kogan Page.

Marshall, S. (2000). *Report on the 2000 UTDC Survey of Academic Staff Needs for Teaching Technology Support*. Wellington, New Zealand: Victoria University of Wellington.

Marshall, S., Elgort, I., & Mitchell, G. (2003). Raising the valleys: an approach to developing staff capability in e-learning. Retrieved from http://surveys.canterbury.ac.nz/herdsa03/pdfsnon/N1123.pdf

McCarney, J. (2004). Effective use of staff development in ICT. *European Journal of Education, 27*(1), 61-72.

McCormick, R., & Scrimshaw, P. (2001). Information and communications technology, knowledge and pedagogy. *Education, Communication and Information (now published as: Learning, Media and Technology), 1*(1), 37-57.

McDougall, A., & Squires, D. (1997). A framework for reviewing teacher professional development programmes in information technology. *Journal of Information Technology for Teacher Education, 6*(2), 115-126.

McGhee, R., & Kozma, R. (2000). *World links for development: accomplishments and challenges. Monitoring and evaluation Annual Report 1999–2000*. Washington, DC: SRI International.

Means, B., & Olson, K. (1995). *Technology's role in education reform: Findings from a national study of innovating schools*. Washington, D.C.: US Department of Education.

Menda, A. (2006). *ICT in education: content issues as Kiswahili reigns*: iConnect-Online: Applying knowledge to development.

Mentz, E., & Mentz, K. (2003). Managing technology integration into schools A South African perspective. *Journal of Educational Administration, 41*(2), 186-200.

Microsoft Corporation. (2006). A Blueprint for Success: Kenyan Partnership Leads National Drive to Harness the Power of ICT in Education. Retrieved from http://download.microsoft.com/download/8/8/f/88f04e62-169a-4d9f-b8eb-7f857bddb650/11477_CaseStudy_KENYA.pdf

Microsoft Corporation. (2007). *Africa - Realising Potential Through People and Technology*.

Minishi-Majanja, M. (2004). *Mapping and Audit of Information and Communication Technologies in LIS Education in Africa: unpublished doctoral thesis.* University of Zululand, South Africa.

Minishi-Majanja, M. (2007). *Integration of ICTs in library and information science education in sub-Saharan Africa*. Paper presented at the World Library and Information Congress: 73rd IFLA General Conference and Council. Retrieved from http://www.ifla.org/IV/ifla73/index.htm.

Ministry of Education and Culture. Tanzania Government. (2005). *Revised financial management and accounting guidelines for the secondary education development plan. 2004-2009*. Retrieved from http://www.tzonline.org/pdf/revisedfinancialmanagementandaccountingguidelines.pdf

Monk, M. (1999). *In-service for teacher development in sub-Saharan Africa: a review of literature published between*

1983-1997. London: DFID.

Moon, B. (2000). The open learning environment: a new paradigm for international developments in teacher education. In B. Moon, S. Brown & M. Ben-Peretz (Eds.), *The Routledge International Companion to Education* (pp. 756-771). London: Taylor & Francis.

Moon, B. (2003). A retrospective review of the national case studies on institutional approaches to teacher education. In B. Moon, L. Vlasceau & L. C. Barrows (Eds.), *Institutional approaches to teacher education within higher education in Europe: Current models and new developments*. Bucharest: UNESCO.

Moon, B. (2007). *Research analysis: Attracting, developing and retaining effective teachers: A global overview of current policies and practices*. Paris: UNESCO.

Moore, G. (1999). *Crossing the Chasm*. New York: Harper Collins.

Moore, M. G. (2002). A personal view: distance education, development, and the problem of culture in the information age. In V. V. Reddy & S. Manjulika (Eds.), *Towards Virtualization-Open and Distance Learning* (pp. 633-640). New Delhi: Kogan Page.

Moseley, D., Higgins, S., Bramald, R., Hardman, F., Miller, J., Mroz, M., et al. (1999). *Ways forward with ICT: Effective pedagogy using information and communication technology for literacy and numeracy in primary schools*. Newcastle: University of Newcastle.

Moss, G., Jewitt, C., Levacic, R., Armstrong, V., Cardini, A., Castle, F., et al. (2007). *The Interactive Whiteboards, Pedagogy and Pupil Performance Evaluation: An Evaluation of the Schools Whiteboard Expansion (SWE) Project: London Challenge* (No. RR816). London: DfES.

Muijs, D., & Lindsay, G. (2008). Where are we at? An empirical study of levels and methods of evaluating continuing professional development. *British Educational Research Journal, 34*(2), 195-211.

Mulimila, R. T. (2000). Information technology applications in East Africa government-owned university libraries. *Library Review, 49*(4), 186-192.

Multi-site Teacher Education Research Project (MUSTER). (2003). *Teacher training in Ghana – Does it count?*

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. *Journal of Information Technology for Teacher Education, 9*(3), 319-341.

Murenzi, R. (2009). *Rwanda ICT policy framework*. Paper presented at the Development of an equitable information society: the role of African Parliaments Conference.

Mutonyi, H., & Norton, B. (2007). ICT on the margins: lessons for Ugandan education. *Language and Education, 21*(3), 264-270.

Mutula, S. (2004). IT diffusion in sub-Saharan Africa: implications for developing and managing digital libraries. *New Library World, 105*(1202/1203), 281-289.

Nation Reporter. (2009). Digital learning comes to Kenyan schools in 2010. *Daily Nation* Retrieved 28th September, 2009, from http://www.nation.co.ke/News/-/1056/634386/-/ulkh5t/-/index.html

National Teachers' Institute. (2004). *Annual Report, 2004*. Kaduna: NTI.

National Universities Commission. (2005). *Review of statistics on universities in Nigeria*.

Ndidde, A., Lubega, J., Babikwa, D., & Baguma, G. (2009). *Pedagogical integration of ICTs in Ugandan education institutions*. Kampala, UG: Makerere University.

Ndidde, A. N., Lubega, J., Babikwa, D., & Baguma, G. (2009). Uganda report. In T. Karsenti (Ed.), *The PanAfrican Research Agenda on the Pedagogical Integration of Information and Communications Technologies: Phase 1 National Reports* (pp. 55-75). Ottawa: IDRC.

Nduati, C., & Bowman, W. (2005). Working from the sidelines: the Kenya private sector foundation ICT board story. In E. F. Etta & L. Elder (Eds.), *At the crossroads: ICT policy making in East Africa* (pp. 56-67). Nairobi: East African Educational Publishers Ltd.

Nepad e-Africa Commission. (2004). *NEPAD e-Schools initiative concept framework document*.

Newhouse, P. (2002). The impact of ICT on learning and teaching: A literature review by Dr. C. Paul Newhouse for the

Western Australian Department of Education.

Ng, H.-m., & Chow, P.-y. (1999). School-Based Teacher Development in Guangzhou, China. *International Studies in Educational Administration, 27*(2).

Ngugi, C. (2007). *ICTs and higher education in Africa*. Cape Town: PHEA.

Nigeria, Federal Government. (1977 [revised 1998, 2005]). *National Policy on Education*.

Novatech. (2008). *Country profile Burundi*.

Nugroho, D., & Lonsdale, M. (2009). Evaluation of OLPC programs globally: A literature review (Version 2): Australian Council for Educational Research.

Obanya, P. (1999). *The Dilemma of Education in Africa*. Ibadan: Heinemann.

Obura, A., Musili, T., & Etta, F., Etta. (2005). The Winning Formula of Computers for Schools Kenya. In E. F. Etta & L. Elder (Eds.), *At the Crossroads: ICT Policy Making in East Africa*. Nairobi: East African Educational Publishers Ltd.

Ocholla, D., & Bothma, T. (2007). Trends, challenges and opportunities for LIS education and training in Eastern and Southern Africa. *New Library World, 108*(1/2), 55-78.

Ocholla, D. N. (2003). An overview of Information and Communication Technologies (ICT) in the LIS schools of Eastern and Southern Africa. *Education for Information, 21*, 181-194.

Ochuodho, S., & Matuga, M. (2004). A national orchestra? Civil society involvement in ICT policy making. In E. F. Etta & L. Elder (Eds.), *At the crossroads: ICT policy making in East Africa* (pp. 68-83). Nairobi: E.A.E.P.

Odero-Musakali, D., & Mutula, S. (2007). Internet adoption and assimilation in Kenyan university libraries. *Library Review, 56*(6), 464-475.

Office for Standards in Education (Ofsted). (2002). *Recruitment and retention of teachers and headteachers: Strategies adopted by LEAs, e-publication HMI 709*. Retrieved from http://www.ofsted.gov.uk/Ofsted-home/Publications-and-research/Browse-all-by/Education/Leadership/Governance/Recruitment-and-retention-of-teachers-and-headteachers

Okebukola, P. (2002). Teacher Education in Nigeria: Past, Present and Future. In *Teacher education in Nigeria: past, present and future - Proceedings of the First Teachers' Summit*. Kaduna: NTI.

Olakulehin, F. K. (2007). Information and communication technologies in teacher training and professional development in Nigeria. *Turkish Journal of Distance Education TODJE, 8*(1), 133-142.

Olatokun, W. M. (2008). Gender and national ICT policy in Africa: issues, strategies, and policy options. *Information Development, 24*(1), 53-65.

Oloo, L. M. (2009). Baseline survey report for ICT in secondary schools in selected parts of Kenya - draft report. Retrieved from http://www.gg.rhul.ac.uk/ict4d/Kenyaschools.pdf

OLPC News. (2009). *One laptop per child overview: the status of OLPC and its iconic XO-1 laptop in 2009*.

Ondari-Okemwa, E. (2004). Impediments to promoting access to global knowledge in sub-Saharan Africa. *Library Management, 25*(8/9), 361-375.

Onguko, B. B. (2007). *Schools in East Africa yet to enter the initiation stage in computer assisted management information systems*. Paper presented at the Twelfth Conference on Open and Distance Learning. Retrieved from http://www2.open.ac.uk/r06/conference/CambridgeConferencePapers3.pdf

Opolot-Okurut, C., Opyene-Eluk, P., & Mwanamoiza, M. (2008). *The current teaching of statistics in schools in Uganda.* Paper presented at the ICMI Study 18 Conference and IASE 2008 Round Table Conference, ITESM, Monterrey, Mexico.

Organization for Economic Co-operation and Development [OECD]. (1999). *Human capital investment*. Retrieved from linkinghub.elsevier.com/retrieve/pii/S0272775799000709

Organization for Economic Co-operation and Development [OECD]. (2002). Measuring the information economy 2002 ICT in education and government. *OECD Science & Information Technology, 22,* 140-161.

Pacey, L. (1999). *Integration of information and communication technologies (ICTs) through teacher professional development: comparative analysis of issues and trends in seven APEC economies*: July Roberts & Associates Inc,

Council of Ministers of Education, Canada (CMEC).

Peansupap, V., & Walker, D. H. T. (2006). Information communication technology (ICT) implementation constraints. A construction industry perspective. *Engineering, Construction and Architectural Management, 13*(4), 364-379.

Pelgrum, W., & Plomp, T. (1991). *The Use of Computer in Education Worldwide*. Oxford: Pergamon Press.

Pelgrum, W. J. (2002). *The effectiveness of ICT in schools: Current trends and future prospects discussion paper*. Paper presented at the OECD Japan Seminar: Teachers, teacher policies and ICT.

Pelgrum, W. J., & Brummelhuis, A. C. A. (2001). *ICT-Monitor 2000: voortgezet onderwijs. [ICT-Monitor 2000: secondary education]*. Enschede: Universiteit Twente, Onderzoekscentrum Toegepaste Onderwijskunde.

Peraton, H. (2000b). *Open and distance learning in the developing world* London: Routledge.

Peraton, H., & M, P. (1997). Teacher education at a distance. *Education and Technology Technical Notes Series, 2*(2).

Pergola Founder, T. (2003). *A computer lab in the 'bush'. Linking up a transitional Tanzanian community to bridge the digital divide*. http://pcmlp.socleg.ox.ac.uk/archive/it4d/thinkpieces/pergola.pdf

Perraton, H. (2000). Knowledge Bank Paper 5 - Teaching the Teachers (Publication.: http://imfundo.digitalbrain.com/imfundo/web/teach/documents/kb5/kb5.pdf

Perraton, H. (2000a). *Teaching the Teachers*. London: DFID.

Perraton, H., Robinson, B., & Creed, C. (2001). *Teacher education through distance learning: technology, curriculum, cost, evaluation*. Paris: UNESCO.

Pillai, R. (2001). *Teachers must engage is active capacity building*. Paris: UNESCO.

Pohjola, M. (2003). The adoption and diffusion of ICT across countries: Patterns and determinants. In D. C. Jones (Ed.), *New Economy Handbook* (pp. 77-100). San Diego, CA: Elsevier-Academic Press.

Power, T. (2004). *ICT and Teacher Education in the Global South: Costing the Benefits of Learning*: Research Centre for International Research and Development in Teacher Education across Cultures and Societies (RITES). The Open University, United Kingdom.

Power, T. (2005). *ICT and teacher education in the global south: costing the benefits of learning*. Paper presented at the Development Studies Association Annual Conference. Retrieved from http://www.open.ac.uk/deep/Public/web/publications/pdfs/TPower2004-COL.pdf

Prensky, M. (2005). What can you learn from a cell phone? Almost anything! [Electronic Version]. *Innovate: Journal of Online Education* from http://www.innovateonline.info/index.php?view=article&id=83

Ratemo, J. (2009, 10th October 2009). Doing away with books in the classroom. *Standard: Online Edition*.

Reeves, T. C. (1998). *The impact of media and technology in schools: A research report prepared for the Bertelsmann Foundation*.

Research and Analysis Working Group, United Republic of Tanzania. (2007). *Poverty and human development report 2007*. Dar es Salaam, Tanzania.

Resta, P. (Ed.). (2002). *Information and Communication Technologies in Teacher Education: A Planning Guide*. Paris: UNESCO.

Ringstaff, C., & Kelley, L. (2002). The Learning Return on Our Educational Technology Investment: A Review of Findings from Research: For full text: http://www.wested.org/online_pubs/learning_return.pdf

Robinson, B., & Latchem, C. (2003). Teacher education: challenges and change. In B. Robinson & C. Latchem (Eds.), *Teacher education through open and distance learning* (pp. 1-27). London: RoutledgeFalmer.

Rodrigo, M. M. T. (2001). Review: Information and communication technology use in Philippine public and private schools. *Loyola Schools Review: School of Science and Engineering, 1*, 122-139.

Rwanda. (2005). A Review of the Implementation of the Rwanda ICT4D/NICI-2005 Plan: the key achievements, lessons and the challenges.

Rwanda Government. (2006). *An Integrated ICT-led Socio-Economic Development Plan for Rwanda: The NICI 2010 Plan*.

Rwanda Information Technology Authority. (2007). One Laptop Per Child Project. Retrieved from http://www.rita.gov.rw/spip.php?article25

Rwanda. UNECA. (2006). The National Information and Communication Infrastructure (NICI-2010) Plan in Rwanda.

Ryckeghem, D. V. (1995). Information technology in Kenya: a dynamic approach. *Telematics and Informatics, 12*(1), 57-65.

Schmidt, J. P., & Stork, C. (2008). *Towards evidence based ICT policy and regulation: e-Skills*. Braamfontein: Research ICT Africa.

SchoolNet Africa. (2004). *Towards a strategy on developing African teacher capabilities in the use of information and communication technology*.

SchoolNet Uganda. (2009). About SchoolNet Uganda. Retrieved from http://schoolnetuganda.sc.ug/about-schoolnet-uganda

Sedoyeka, E., & Hunaiti, Z. (2008). WiMAX in Tanzania: a breakthrough for underserved areas. *info, 34*(10), 34-46.

Selwyn, N. (2004). Exploring the role of children in adults' adoption and use of computers. *Information Technology & People, 17*(1), 53-70.

Senzige, J. P., & Sarukesi, K. (2003). *An approach to ICT based school education in Tanzania*. Paper presented at the African Studies Association of Australasia and the Pacific 2003 Conference - African on a Global Stage.

Seppälä, P., & Alamäki, H. (2003). Mobile learning in teacher training. *Journal of Computer Assisted Learning, 19*(3), 330-335.

Shapshak, D. (2002). Unwiring Africa (Publication: http://groups.yahoo.com/group/DigAfrica)

Sheriff, S. (2007). *Rural access: options and challenges for connectivity and energy in Tanzania*.

SITE (Society for Information Technology and Teacher Education). (2002). *SITE position paper: statement of basic principles and suggested actions ('Ames White Paper')*: SITE.

Skuse, A. (2000). *Draft 1: Information communication technologies, poverty and empowerment*. London: Social Development Department, DFID.

Slay, H., Sieborger, I., & Hodgkinson-Williams, C. (2008). Interactive whiteboards: Real beauty or just "lipstick"? *Computers & Education, 51*(3), 1321-1341.

Soloway, E., Norris, C., Blumenfeld, P., Fishman, B., Krajcik, J., & Marx, R. (2001). Log on education: handheld devices are ready-at-hand. *Communications of the ACM, 44*(6), 15-20.

Somekh, B. (2001). *The role of evaluation in ensuring excellence in communications and information technology initiatives*. *Education, Communication and Information, 1*(1), 75-101.

South African Institute for Distance Learning (SAIDE). (2008). *Using Mobile Technology for Learner Support in Open Schooling* (Project Report).

Stellefson, M., Chaney, B., & Chaney, D. (2008). The digital divide in health education: myth or reality? *American Journal of Health Education, 39*(2), 106-112.

Tahir, G. (2001). Federal government intervention in universal basic education. *UBE Forum, 1*(1), 7-11.

Tanzania. Ministry of Communications and Transport. (2003). National Information and Communications Technologies Policy. Retrieved from http://www.tanzania.go.tz/pdf/ictpolicy.pdf

Tanzania. Ministry of Education and Culture (MoEC). (2001). *Basic Education Master Plan (BEMP), medium term strategic and programme framework 2000-2005*.

Tanzania. Ministry of Education and Culture (MoEC). (2004). Education Management Information System Development Plan.

Tanzania. Ministry of Education and Culture (MoEC), Tanzania Institute of Education. (2005). *Information and computer studies syllabus for secondary schools; form i-iv*.

Tanzania. Ministry of Education and Vocational Training. (2007). *Information and communication technology (ICT) policy for basic education*.

Tanzania. Ministry of Education and Vocational Training (MoEVT). (2003). *National information and communication*

technologies policy for basic education. Retrieved from www.moe.go.tz/pdf/ICT%20Policy%20for%20Basic%20Education.pdf

Tanzania. Ministry of Education and Vocational Training (MoEVT), Tanzania Institute of Education. (2005). *Information and communication technology syllabus for primary schools; standard one to seven*.

Tanzania. Ministry of Education and Vocational Training (MoEVT). (2007). *Information and communication technology (ICT) policy for basic education*. Retrieved from http://planipolis.iiep.unesco.org/upload/Tanzania%20UR/Tanzania_ICT_Policy_for_BasicEducation_2007.pdf

Tanzania. Research and Analysis Working Group. (2007). Poverty and Human Development Report 2007.

Tanzania. Research and Analysis Working Group. (2008). *Views of the People 2007: Tanzanians give their opinion on: growth and reduction of income poverty, their quality of life and social well-being, and governance and accountability* (No. 978-9987-615-23-0). Dar es Salaam, Tanzania: Mkukuta Monitoring System.

Tanzania. Research and Analysis Working Group. (2008). *Tanzanian Children's Perceptions of Education and Their Role in Society: Views of the Children 2007*. Dar es Salaam, Tanzania: REPOA.

Tchinda Josue, T. (2007). *Survey of ICT in Education in Cameroon*. Washington, DC: infoDev/World Bank.

Telecommunications Development Bureau of ITU. (2009). *Measuring the Information Society: the ICT Development Index*: International Telecommunication Union.

Tella, A., Tella, A., Toyobo, O. M., Adika, L. O., & Adeyinka, A. A. (2007). An Assessment of Secondary School Teachers Uses of ICTs: Implications for Further Development of ICT's Use in Nigerian Secondary Schools. *Online Submission, 6*(3).

The World Bank. (2008). *Curricula, Examinations, and Assessment in Secondary Education in sub-Saharan Africa* (No. 978-0-8213-7348-4). Washington: World Bank.

Thijs, A., Almekinders, R., Blijleven, P., Pelgrum, W. J., & Voogt, J. (2001). Learning through the web: A literature study on the potential uses of the web.

Thomas, & Ranga. (2004). ICT Pedagogy. In *UNESCO (2004)* UNESCO.

Tilvawala, K., Myers, Michael D. Andrade, Antonio Diaz. (2009). Information Literacy in Kenya. *EJISDC (2009), 39*(1), 1-11.

Torach, J., Okello, D., & Amuriat, G. Uganda Report. Retrieved from http://www.giswatch.org/files/pdf/GISW_Uganda.pdf

Toure, K. (2009). Appropriating technologies and making them work for you in teaching and learning: depth is essential. In T. Karsenti (Ed.), *Pedagogical Use of ICT: Teaching and Reflecting Strategies* (pp. 94-110). Ottawa: IDRC.

Traxler, J. (2009). *Making good use of mobile phone capabilities (eLA 2007)*. Paper presented at the 4th International Conference on ICT for Development, Education and Training.

Traxler, J. (2009). The mLearning guru and the eLearning Africa debate. Retrieved from http://www.elearning-africa.com/newsportal/english/news190.php

Trend, R., Davis, N., & Loveless, A. (1999). *Information and Communications Technology*. London: Letts Educational.

Trinidad, S., Newhouse, P., & Clarkson, B. (2005). *A framework for leading school change in using ICT: Measuring change*. Paper presented at the The Association for Active Educational Researchers conference.

Twati, J. M., & Gammack, J. G. (2006). The impact of organisational culture innovation on the adoption of IS/IT: the case of Libya. *Journal of Enterprise Information Management, 19*(2), 175-191.

Twining, P. (2001). Planning to use ICT in schools? *Education 3-13, 29*(1), 9-17.

Twining, P. (2001). *E211 learning matters: challenges of the information age - software guide*. Milton Keynes: The Open University.

Twining, P. (2002). Conceptualising computer use in education: Introducing the computer practice framework (CPF). *British Educational Research Journal, 28*(1), 95-110.

Twining, P. (2002). *ICT in schools: estimating the level of investment*. Milton Keynes: meD8.

Twining, P. (2002). *Enhancing the impact of investments in educational ICT*. Open University, Milton Keynes.

U. N. Economic and Social Council. (2000). Development and international cooperation in the twenty-first century: the role of information technology in the context of a knowledge-based global economy.

Uganda National Examinations Board (UNEB). (2005). *Regulations and syllabuses 2006-2010*. Retrieved from http://siteresources.worldbank.org/INTAFRREGTOPSEIA/Resources/Uganda_Curasse.pdf

Uganda. Ministry of Education and Sports, National Curriculum Development Centre. (1999). *Uganda Primary School Curriculum*. Kampala.

Uganda. Ministry of Education and Sports, National Curriculum Development Centre. (2005). *Draft policy for information and communication technology in the education sector*. Retrieved from http://www.education.go.ug/ICT/ICT%20policy%20July%2005.pdf

Uganda. Ministry of Education and Sports. (2005). *Education and Sports sector Performance Report 2005*.

Uganda. Ministry of Education and Sports. (2006). *Revised ICT Draft policy for information and communication technology in the education sector*.

Uganda. Ministry of Education and Sports, National Curriculum Development Centre. (2007). *Primary school curriculum for Uganda, Primary 2*. Retrieved from http://www.unesc.go.ug/index.php?option=com_content&task=view&id=359&Itemid=113.

Uganda. Ministry of Education and Sports. (2007). *Education and Sports Sector Performance Report 2007*.

Uganda. Ministry of Education and Sports. (2008). *Education and Sports Sector Performance report 2008*.

Uganda. Ministry of Education and Sports. (2009). *Implementation of the Activities in Information and Communication Technology (ICT) for FY 2008/09*.

Uganda. Ministry of Education and Sports, National Curriculum Development Centre. (n.d.). *Status of ICT in the Education Sector*.

Uganda. Ministry of Works, Housing and Communications. (2003). *National information and communication technology policy*. Retrieved from http://www.i-network.or.ug/index2.php?option=com_docman&task=doc_view&gid=57&Itemid=130.

Uganda. National Council of Science and Technology. (2002). Status of ICT in Uganda, Scan-ICT Preliminary Baseline Study. Retrieved from http://www.uneca.org/aisi/ScanGhana/Documents/3.%20SCAN%20ICT%20UGANDA.pdf

Ukeje, B. O. (2002). The future of teacher education in Nigeria. In *Teacher Education in Nigeria: Past Present and Future - Proceedings of the First Teachers' Summit*. Kaduna: NTI.

UNESCO. (2002). *Information and Communication Technology in Education – A Curriculum for Schools and Programme for Teacher Development*. Paris: UNESCO.

UNESCO. (2004). Open and distance learning. Retrieved 19th March 2005, from http://portal.unesco.org/education/en/ev.php-URL_ID=48440&URL_DO=DO_TOPIC&URL_SECTION=201.html

UNESCO. (2004). Teacher education. Retrieved 19th March 2005, from http://portal.unesco.org/education/en/ev.php-URL_ID=32268&URL_DO=DO_TOPIC&URL_SECTION=201.html

UNESCO. (2004). Use of Technology. Retrieved 19th March 2005

UNESCO. (2004). *ICT pedagogy*: UNESCO office.

UNESCO. (2005). *Information and communication technologies in schools: A handbook for teachers*. Paris: UNESCO.

UNESCO. (2008). *ICT Competency Standards for Teachers - Implementation Guidelines, Version 1.0*. Retrieved 28th September 2009. Retrieved from http://www.unesco.org/en/competency-standards-teachers

UNESCO Bangkok. (n.d.). ICT in education: Introduction. Retrieved 19th March 2005, from http://www.unescobkk.org/index.php?id=1704

UNESCO Bangkok. (n.d.). Sri Lanka: the training of teachers in information technology. Retrieved 19th March 2005, from http://www.unescobkk.org/index.php?id=1227

United Nations Development Programme (UNDP). (2002). Using distance learning and ICT to improve teacher quality in poor areas of western China. Retrieved 19th March 2005, from http://www.undp.org.cn/modules.php?op=modload&name=News&file=article&sid=235&mode=thread&order=0&t

hold=0

University of Oxford Department of Education. (2008). *Changing spaces: young people, technology and learning. The educational and social impact of new technologies on young people in Britain*: ESRC.

Unwin, T. (2005). Towards a framework for the use of ICT in teacher training in Africa. *Open Learning: The Journal of Open and Distance Learning, 20*(2), 113-129.

Unwin, T. (2009). The technologies: identifying appropriate solutions for development needs. In T. Unwin (Ed.), *ICT4D: Information and Communication Technology for Development*: Cambridge University Press.

van Braak, J., Tondeur, J., & Valcke, M. (2004). Explaining different types of computer use among primary school teachers. *European Journal of the Psychology of Education, 19*(4), 407-422.

van Brakel, P. A., & Chisenga, J. (2003). Impact of ICT-based distance learning: the African story. *The Electronic Library, 21*(5), 476-486.

Van der Merwe, C. (2003). African information revolution in wireless. Retrieved from www.acacia.org.za.WEBTIMES/news_releases.htm

Venezky, R. (2004). Technology in the classroom: steps toward a new vision in education. *Communication and Information, 4*, 3-21.

Wadvalla, B.-A. Africa still dependent on satellite net access. Retrieved 1 August 2008, from http://www.scidev.net/en/news/africa-still-dependent-on-satellite-net-access.html

Waema, M. T. (2005). A brief history of the development of an ICT policy in Kenya. In E. F. Etta & L. Elder (Eds.), *At the Crossroads: ICT Policy Making in East Africa* (pp. 25-43). Nairobi: East African Educational Publishers Ltd.

Wafula, J. M., Wanjohi, N. G., Etta, F. E., & Elder, L. (2005). ICT Policy and ICT Initiatives: What Linkages? In *At the Crossroads: ICT Policy Making in East Africa*. Nairobi: East African Educational Publishers Ltd.

Wagner, D. A. (2002). *ICT and the poor: problems and possibilities*. University of Pennsylvania, Philadelphia: UNESCO.

Wambui, M., & Barasa, E. (2007). ICT: dawn of a new era. *Elimu News: a newsletter of the MoEST*(1).

Wells, R., & Wells, S. (2007). Challenges and opportunities in ICT educational development: a Ugandan case study. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 3*(2), 100-108.

Were, E., Rubagiza, J., Denley, P., & Sutherland, R. (2007). *The use of ICT to support basic education in disadvantaged schools and communities: a review of literature*: EdQual RPC (Rwanda).

World Bank. (2007). Education - Burundi: Education Sector Reconstruction Project. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTEDUCATION/0,,contentMDK:21227474~menuPK:2643854~pagePK:64020865~piPK:149114~theSitePK:282386,00.html

Yates, C., & Bradley, J. (Eds.). (2000). *Basic education at a distance: World review of distance education and open learning*. London: Routledge and Commonwealth of Learning.

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools; an ecological perspective. *American Research Journal, 40*(4), 807-840.

Zulu, B. (2009). *Education during health emergency: Is eLearning a solution?*

Zwart, R. C., Wubbels, T., Bergen, T. C. M., & Bolhuis, S. (2007). Experienced teacher learning within the context of reciprocal peer coaching. *Teachers and Teaching: Theory and Practice, 13*(2), 165-187.

Note that all URLs in the footnotes and references were last accessed 17.07.09 or more recently.

Appendix A: Key ICT initiatives in education in Uganda

ICT initiative	Target	Role played	External Funding Support
Microsoft Partners in Learning Program	Secondary schools nationally	Equipping schools with PCs and developing localised content that maps directly to the national curriculum. Through donated PCs from Microsoft and other entities, the country was able to equip 100 schools with approximately 10 computers each. Plans are to have all secondary schools – a total of 8,000 schools – along with 1,000 other educational establishments, equipped with computers and training modules by the end of 2015.	Microsoft Partners in Learning Program
SchoolNet	Secondary schools nationally	A national network of professional educators and schools whose vision is to transform the Uganda educational system from an industrial model (learning by assimilation) to a knowledge-based model to prepare the youth of Uganda to effectively enter a global economy based on knowledge, information and technology). Activities include: Advisory work on ICT, ICT training, installation of LANs (local area networks), and specialised ICT training to teachers and administrators. SchoolNet Uganda runs the Uganda Digital Education Resource Bank (www.uderb.org) which is an online repository of digital resources created or identified by Uganda teachers and students. It is also currently implementing a School-Based Telecentre (SBT) Project in 5 secondary schools located in 5 underserved districts.	Various, differing per project. Started by World Links
Connect-ED	Primary Teacher Colleges	Using technology to enable and enhance learning and teaching for primary educators through the creation of multifaceted approaches to integrating media and computers in the Primary Teacher Colleges (PTC). Accomplished this by setting up Education Technology Centres at 8 core PTCs to increase access, availability, and provision of relevant and quality learning materials and support for teacher professional development.	United States Agency for International Development under the Education for Development and Democracy initiative. (USAID – EDDI)
Global Teenager Program	Secondary schools globally	In partnership with SchoolNet to offer educational virtual exchange programmes to secondary school students worldwide, dedicated to promoting cross- cultural understanding through new ways of learning with the use of ICT	Institute for Information and Communication Development (IICD)
Curriculum Net	Primary and secondary schools nationally	Develop, test and implement a mechanism for curriculum integration of ICT in primary and secondary schools in Uganda via communication networks using computer-related tools. It is intended to enable students, educators and educational administrators to develop appropriate competencies to effectively use ICT in the teaching and learning process	National Curriculum Development Centre with International Development Research Centre

UNESCO Creating learning networks for Africa	Teacher training colleges (4-6 in 20 countries)	Improve the quality of education and learning by connecting teacher training colleges in Africa to each other and to the Information Highway in order to develop local, national and regional networks to initiate activities	UNESCO
U-connect	Secondary and primary schools in rural towns	Raising awareness of the benefits of ICT-enhanced primary and secondary school education, especially the ability to dramatically amplify the limited educational resources in rural towns, and demonstrate best practices in the economical provision of school computer labs and affordable high bandwidth connection to the Internet in a developing country.	Consortium of private companies
NEPAD e-schools initiative	Selected primary and secondary schools	• To provide ICT skills and knowledge to primary and secondary school students that will enable them to function in the emerging Information Society and Knowledge Economy. • To provide teachers with ICT skills to enable them to use ICT as tools to enhance the teaching and learning. • To provide school managers with ICT skills so as to facilitate efficient management and administration in the schools.	New Partnership for African Development (NEPAD)

Sources: Farrell et al. (2007)

Appendix B: Key ICT initiatives in education in Kenya

ICT initiative	Target	Role played	Funding Support
Computers for Schools - Kenya	Secondary schools nationally (mainly), training and community centres	• Sourcing, placement and support of over 16,000 computers in over 531 institutions • Training of well over 3,106 Principals & Deputy Principals, ICT Teachers and other teachers; sensitisation of others including educational administrators and policy makers. • Development of model curricula for training from simple user proficiency to high level professional competence • Development of model examinations, administered to over 10,000 students so far • A successful Volunteer and Internship Programme for national capacity development in ICT, which has benefited over 200 young people • Extension of ICT access to disadvantaged groups in society – including two children's homes, a school for the deaf and a rehabilitation centre for street children	Various donors mainly international but some local
ICT equipment for schools	Secondary schools nationally	142 computers distributed to schools by 2007	MoEST and donors through the Kenya ICT Trust Fund
Development of learning content	Secondary schools nationally	Digitisation of curriculum content for schools. (Unable to locate up-to-date info)	MoEST through the Kenya Institute of Education
NEPAD e-schools initiative	Selected secondary schools	Multi-partner project. In first (demo) phase it equipped six secondary schools with state-of-the-art ICT and provided teacher training and learning content	NEPAD e-Africa commission & MoEST in association with a consortium of donors
School Broadcasting	18,000 primary and 3,000 secondary schools	Nationwide school broadcast service, using WorldSpace technology to broadcast educational content to 11 million students.	Kenya Institute of Education with Worldspace Inc.

Sources: Farrell et al. (2007)

Appendix C: Key ICT initiatives in education in Tanzania

ICT initiative	Target	Role played	Implementing agency and funding support
ICT Implementation in Teachers' Colleges	Primary teacher training colleges nationally	All 32 teachers' colleges are equipped with a total of 1,250 networked thin client computers in laboratories, using open source software; Training of tutor technician and trainers; Training tutors and students in basic ICT skills leading to ICDL	Govt with support from SIDA and other agencies
ICT for Secondary Education in Tanzania: The eSchool Programme	All secondary schools nationwide	Phased rollout of ICT infrastructure in secondary schools nationwide.	MoEVT in consortium with key stakeholders
ICT in primary and pre-primary education, Teknolojia ya Habari na Mawasiliano (TEHAMA)	Primary and pre-primary schools nationally	Developed curriculum for ICT in primary and pre-primary schools Currently very limited coverage in a few urban schools	MoEVT
Education Management Information System (EMIS)	Educational Administrative units nationally	The main function is to collect, process, utilise and disseminate education data as well as related information to educational stakeholders on a timely basis	MoEVT
Computer Procurement and Refurbishment for schools	Secondary schools nationally	Procures and receives donations of used computers, refurbishes them and uses them to equip computer labs in secondary schools. The project also trains students in basic computer maintenance to become the first-level support for the labs.	Tanzania Computer Literacy for Secondary Schools Trust supported by the International Institute of Communication Development
Tanzania Education Services Web site	Entire educational sector nationally	Website publishes information on the education sector in Tanzania, including information about schools, examination results, and school administration and contact information for schools and teacher colleges	IICD

Barclays/Digital Links/TEA Computer for Schools Project	Selected secondary schools in East Africa	Targets to place 10,000 computers in approximately 500 schools in East Africa	Tanzania Education Authority (TEA), Tanzania Commission of Science and Technology (COSTECH), and Mkombozi Centre for Street Children with funding from Barclays Bank, Digital links International and other partners

Sources: Hare (2007); MoEVT (2007)