Use of
Information and Communications Technologies (ICTs)
in teacher education in Sub-Saharan Africa:
case studies of selected African universities

Inaugural – Dissertation

zur Erlangung des Doktorgrades
der Philosophischen Fakultät
der Universität zu Köln

vorgelegt von
Justine Magambo
Aus Uganda

im Mai 2007

For my son, nieces and nephews

Acknowledgement

I am very grateful to my supervisor, Prof. Hermann Rüppell, for initiating the "Afrika-Projekt" at the department of Educational Psychology, Institute of Education, University of Cologne, and thereby providing me the opportunity to do this dissertation.

Special thanks go to Dr. Karl Steffens for his critical advice and support.

I would also like to thank my colleagues in the "Afrika-Projekt" especially the late Dr. Michael Auerswald for his encouragement and motivation, and Dr. Kristian Klett for his technical advice and support.

Many thanks go to all the lecturers, teachers and students who took time off to participate in this survey, especially from Kyambogo University and Mbarara University of Science and Technology in Uganda, and Kenyatta University in Kenya who despite the power-cuts and low connectivity, turned out in large numbers. This work would not have been accomplished without their active participation.

Finally I wish to thank my family for believing in me, and my friends for their moral and practical support during the difficult times.

Table of Content

A: The Theoretical Part Page

B) The Empirical Part **Page**

Abbreviations:

AAU	Association of African Universities
AED	Academy for Educational Development (US)
AVU	African Virtual University
BECTA	British Educational Communications and Technology Agency
CDC	Centers for Disease Control and Prevention
COL	Commonwealth of Learning
Connect-ED	Connectivity for Educator Development
CTGV	Cognition and Technology Group at Vanderbilt
DFID	Department for International Development (UK)
DEEP	Digital Education Enhancement Project
ECOWAS	Economic Community of West African States
EASSy	Eastern African Submarine System cable
EFA	Education for All
EFAIDS	EFA and HIV/AIDS
EI	Education International
GTZ	German Technical Cooperation
IBE	International Bureau of Education
ICT	Information and Communication Technologies
ICT4D	Information and Communication Technology for Development
IDRC	International Development Research Centre (Canada)
IICBA	International Institute for Capacity Building in Africa
IIEP	International Institute for Educational Planning (UNESCO)
InfoDev	Information for Development program
HIV/AIDS	Human immunodeficiency virus / acquired immunodeficiency syndrome
KTTC	Kenya Technical Teachers College
LRC	Learning Resource Centre
MDGs	Millennium Development Goals
NEPAD	New Partnership for Africa's Development
PTCs	Primary Teacher Colleges
PTR	Pupil/teacher ratio
Odel	Open, Distance and eLearning
ODL	Open & Distance Learning
OECD	Organisation for Economic Co-operation and Development
RH/HIV	Reproductive Health and HIV
SADC	Southern Africa Development Conference
SAFE	South Africa Far East cable
SAT-3/WASC	South Atlantic 3/West Africa Submarine Cable
SITE	Society for Information and Teacher Education
SNA	School Net Africa
TESSA	Teacher Education in Sub-Saharan Africa
TTISSA	Teacher Training Initiative for Sub-Saharan Africa
TVET	Technical and Vocational Education Training
UBE	Universal Basic Education
UPE	Universal Primary Education
USAID	United States Agency for International Development
UNAIDS	United Nations Programme on HIV/AIDS
Unescap	United Nations Economic and Social Commission for Asia and the Pacific

VLEs	Virtual Learning Environments
WorLD	World Links for Development
WSIS	World Summit on the Information Society
WHO	World Health Organization

List of Figures: Page

List of Tables: Page

1. Introduction

In his foreword to the UNESCO "*Information and Communication Technologies in Teacher Training: A Planning Guide*" (2002), the assistant Director-General for Education, John Daniel states that "(T)eacher education institutions may either assume a leadership role in the transformation of education or be left behind in the swirl of rapid technological change. For education to reap the full benefits of ICTs in learning, it is essential that pre- and in-service teachers are able to effectively use these new tools for learning. Teacher education institutions and programmes must provide the leadership for pre- and in-service teachers and model the new pedagogies and tools for learning." (UNESCO 2002 p. 3)

Many countries around the world have established organizations for the promotion of the Information and Communication Technology (ICT) in education in general and with respect to teacher education in particular. There is, however, a clear gap between technological "have" and "have not" regions. The United Nations and the World Bank actively promote ICT for Development (ICT4D) as a means of bridging the "digital divide". According to the European Commission, the importance of ICT lies more in its ability to create greater access to information and communication in under-served populations rather than in the technology itself.

In the search for quality education for all, numerous ICT-in-school projects have been launched around the world. One very visible model is the "schoolnet" which introduces computers and Internet connectivity to schools. Schoolnets have been established in Canada, in Europe and South-East Asian countries. Established in 1999, SchoolNet Africa now has schoolnets in 34 African countries. On the African continent the latest evolutions in this area are the e-schools initiative of the United Nations ICT Task Force and the New Partnership for Africa's Development (NEPAD) schools programme.

The introduction of ICT in education is part of the more fundamental objective to improve education globally and to make it accessible to everyone.

1.1. Education for All (EFA)

At the 1990 World Conference on Education for All in Jomtien, Thailand, delegates from 155 countries and representatives from 150 organisations agreed to universalise primary education and massively reduce illiteracy before the end of the decade, and consequently, a global commitment to provide quality basic education for all children, youth and adults was launched (UNESCO 2000a). A decade later at the World Conference on Education in Dakar, Senegal, the Dakar Framework for Action was adopted, with the 1,100 participants of the Forum reaffirming their commitment to achieve Education for All by the year 2015 and entrusting UNESCO with the overall responsibility of coordinating all international players and sustaining the global momentum (UNESCO 2000a). The 2000 Dakar Framework of Action called for comprehensive national EFA plans to be drawn up by 2002. These plans were to be time-bound, action-oriented and to include specific reforms addressing each of the six EFA goals, along with a sustainable financial framework.

Since their implementation, the EFA plans have made progress in meeting these challenges, many of which have proven to be effective in the African context. According to the *Education for All Global Monitoring Report* 2006, there is evidence of: (1) accelerated access, with particular reference to policies of equity and female enrolment, including affirmative action; (2) community involvement in school decision-making and administration; (3) employment of teachers in their own community of origin; (4) curriculum reform toward locally relevant subjects; (5) affordable reform toward locally relevant subjects; (6) affordable teaching materials and textbooks, (7) use of mother tongue as the language of instruction, (8) use of schools as community of learning centres; (9) evaluation based on an action-research-action paradigm; (10) introduction of management/statistical information systems in planning, evaluation (UNESCO 2005- EFA Report 2006).

An IIEP-UNESCO 2001 - 2004 survey indicates that of the 32 countries in its sample only Benin, India, Indonesia, Kenya, Paraguay, the Sudan and Uzbekistan have plans that include all the six EFA goals. The International Bureau of Education (IBE) survey analysed reports made from 69 countries which took part in 2001 and 2004; the results showed that nearly all of the participating countries identified Universal

Primary Education (UPE) and education quality as high priorities on both occasions (see table 1.1). Other reports also show a noticeable increase in attention between 2001 and 2004 to gender parity and equality, as well as life-skills programmes for young people and adults. References to the importance of the Millennium Development Goals (MDGs) also increased with particular attention being paid to inclusion, equity, quality, gender equality, situations of emergency and HIV/AIDS (UNESCO 2005).

Country	Number of countries in the sample	Goal 1 ECCE	Goal 2 UPE	Goal 3 Youth/adult learning	Goal 4 Literacy	Goal 5 Gender	Goal 6 Quality	Number addressing all six goals	Number addressing at least five goals
Sub-Saharan Africa	10	5	10	3	6	8	9	2	4
Arab States	4	3	4	2	4	1	2	1	1
Central Asia	3	3	3	2	3	2	2	1	2
East Asia and the Pacific	3	3	3	1	3	2	3	1	2
South and West Asia	5	4	5	1	4	3	5	1	3
Latin America and the Caribbean	7	6	7	3	5	2	6	1	3
Total	32	24	32	12	25	18	27	7	15

Source: UNESCO-IIEP (2005b).

Table 1.1: Coverage of the EFA time-bound goals in planning documents of thirty-two countries (source: UNESCO 2005 – EFA Report 2006)

However, though progress towards the EFA goals is steady, it is too slow in terms of the target dates, especially in Sub-Saharan Africa (UNESCO 2005 - EFA Report 2006), such that some first time-bound goals like gender parity in primary and secondary school by 2005, have already been missed. Meeting the goals for 2015 requires accelerating the pace of change in many countries which likewise requires more attention to planning, strategies, resources and key policy issues like gender disparity, inclusion, education in difficult country circumstances, response to the HIV/AIDS pandemic and assuring student's health and safety (UNESCO 2005 - EFA Report 2006).

1.2. EFA and the teacher supply/demand challenge in Sub-Saharan Africa

According to the UNESCO Institute of Statistics (2006), Africa needs a 68% teacher increase to meet the Millennium Development Goals (MDGs) in 2015. That is, due

to the increasing growth both in school-age population and universal primary education, Africa will need to increase its teacher supply from 2.4 to 4 million (UNESCO 2006). This situation is further challenged by the low levels of qualification of the teaching force. With less than ten years to 2015, the EFA report figures show that in about half the countries with 2004 data available (76 for primary and 59 for secondary education), 20 % of teachers in both primary and secondary education lacked pedagogical training. Some countries like Togo have fewer than 50 % of trained teachers, while others like Rwanda have shown some increase in teacher supply (UNESCO 2006 - EFA 2007).

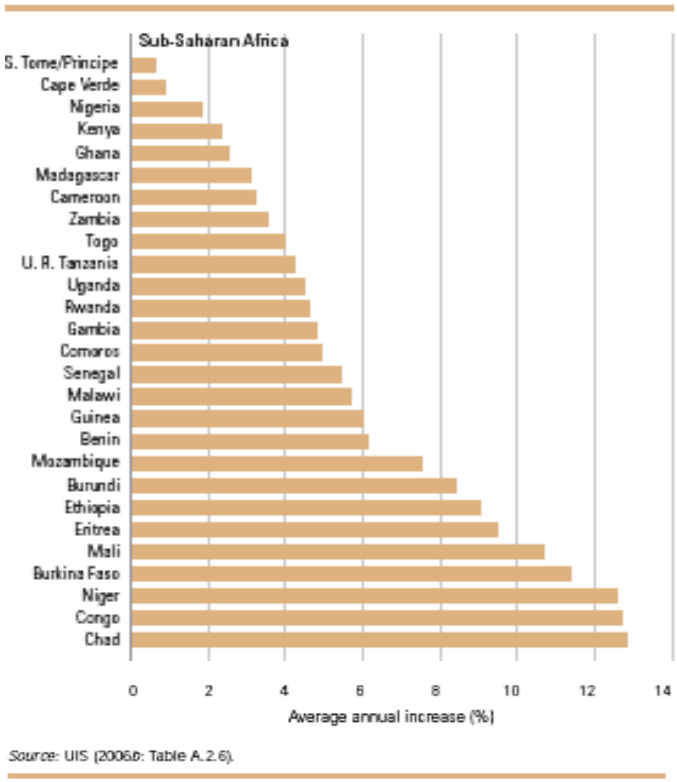


Figure 1.1: Annual percentage of primary teachers required to reach UPE in selected countries from 2004-2015 (source: UNESCO 2006 – EFA report 2007)

Figure 1.1 shows the annual increase in percentage of teachers needed to reach UPE in Sub-Saharan Africa which still faces increasing primary school-age populations. According to the above report, Sub-Saharan African countries will need to increase its recruitment of teachers by an average of 6% each year or from 2.4 million to 4.0 million teachers by 2015. Some countries like Chad, the Congo, Burkina Faso and Niger will need to increase their recruitments by at least 10% each year. Questions

have been raised among international organisations and stakeholders of how this tremendous challenge can be met; this, in turn, has led to the exploration of alternative models for education.

One of the currently discussed alternatives for increasing the supply of teachers is to reform teacher training by, for instance, reducing the length of time spent on pre-service training. Evidence shows that some countries are moving towards shorter and more school-based training, like the UK where trainees now can spend two-thirds of their training in schools, or Cuba where all pre-service training is school-based (UNESCO 2005 – EFA Report 2006). The shortening of the teacher training cycle is becoming common especially in Sub-Saharan Africa, where countries like Ghana, Guinea, Malawi, Mozambique, Uganda and Tanzania are adopting this model of training. In Guinea, a primary teacher education programme initiated in 1998 shortened the cycle of initial training from three years to two, enabling it to train 1,522 teachers per year as compared to 200 teachers before the reform. Evidence showed that teachers trained in the new programme were as effective as those who graduated from the three-year programme. The programme enabled a large number of student teachers to be trained at lower costs and is thus considered to be cost-effective in part because of a higher ratio of student teachers to teacher trainers (Dembélé 2004 in UNESCO 2006).

1.3. ICT in education and the Millennium Development Goals (MDGs)

"The Dakar summit of 2000 set an ambitious target to provide primary schooling for all children by 2015. International and national policies have become focused on this key Millennium Development Goal and, although its full achievement remains unsure, there has been important progress in many countries. Equally challenging, however, although much less discussed, is the task of training the existing teachers and recruiting the millions of new teachers required if the goal of Universal Basic Education (UBE) is to be meaningful" (DEEP Report 2004 p. 13).

At the Summit United Nations Millennium in September 2000, the global community adopted eight Millennium Development Goals (MDGs) as part of the

Millennium Declaration. These goals set targets to be met by the year 2015 which in summary refer to the eradication of extreme poverty and hunger, achievement of universal primary education, strengthening of gender equity, improvement of sanitary conditions, promotion of environmental sustainability and, in general terms, the promotion of development in poorer countries. One of the issues included in goal eight precisely refers to ensuring that the benefits provided by new technologies, particularly ICTs, are made available to all people (United Nations ICT Task Force 2003).

According to the World Bank Report 2003, large numbers of elementary school teachers will be needed to meet the MDGs educational targets. ICT is seen as a powerful tool for training as it transfers knowledge to the person most likely to achieve effective dissemination. Moreover, ICT has the potential to increase the availability of quality educational materials through interactivity and global reach, and by sharing knowledge, materials and databases quickly and cheaply independent of geographic distances (World Bank 2003).

In recent years there have been numerous efforts and resources directed at improving teachers' competence and confidence in using ICT effectively in classroom teaching and learning. Ministries of education are developing policies on ICT in education and running in-service programmes for practising teachers. Teacher-training institutes are incorporating ICT education in their pre-service programmes. And many schools are organizing in-house school-based training for their teachers, while worldwide an increasing number of private providers are developing ICT training materials and courses for teachers.

However, few studies have been carried out to locate and identify uses of ICTs and how they benefit education. According to the Information for Development program (*InfoDev*) 2005, no standard reference or methodology exists for identifying ICT in education programmes; observations and conclusions on the use of ICT in Africa are drawn from OECD experience (*InfoDev* 2005).

The present thesis is taking as its point of departure a project initiated by the institute of Educational Psychology, Cologne University, in Germany, which was influenced by the overwhelming reaction to Millennium Declarations (Dakar 2000), the enthusiasm of the world bodies to bridge the educational and digital divide and to

promote Africa's participation in the global effort to improve education and make it accessible to everyone. The present study will examine the results of the efforts to implement ICTs in teacher education in Africa by analysing the use of ICT in teacher education in a small number of selected cases.

Teachers as multipliers are the key agent in respect to educational change and innovation and, therefore, a foundation for any new strategy to establish. Each teacher trained in the use of ICT is capable of sharing that knowledge with and extending it to a large number of students.

In the last ten years African universities have been introduced to ICT at varying degrees of access and implementation. Mozambique, for example, became the second country to South Africa in Sub-Saharan to achieve full Internet connectivity in 1995, with the university staff being responsible for workshops explaining the draft policy in every province. Tanzania's University of Dar es Salaam followed suit in 1995 by being fully serviced with Internet in 1995. Others like Makerere University of Uganda had been participating in a joint e-mail project as far back as 1991(www.foundation-partnership.org). All of the universities in this study have homepages with details on the university, faculty, admission, departments and in most cases ICT strategies and policies.

1.4. The research question

With the increasing realisation among various educational and political stakeholders that present-day educational challenges cannot be met with traditional means alone, the increasing advocacy of information and communication technologies (ICTs) as an important contribution to the solution of the problems in education in Africa, and the need for teachers, professors and technical and administrative staff to be given training that enables them to integrate new ICTs in their teaching programs, this research aims at investigating how ICTs are currently used at the pre-service and in-service level to train teachers in selected African universities.

The present dissertation entails two major parts, a theoretical and empirical part. The first part (chapters one to five) is based on a literature review of the history and

current state of ICT and education generally and in Africa in particular. This part will review studies carried out in this field: the projects involved in advancing ICT in education and in particular in ICT teacher education. Also learning theories and new approaches in instructional design relevant to ICT-based education will be discussed.

The second part (chapters six and seven) will report and discuss the results of an empirical investigation carried out in selected African universities. The study involved three phases:

1. based on the foundations laid down by the project *"Facilitating Use of ICT in African universities*" of the Department of Educational Psychology at the University of Cologne, implementation and application of ICT in selected African universities was assessed;
2. an on-line survey was conducted which aimed at investigating ICT use in teacher education in these universities;
3. a follow-up study was carried out through telephone and face-to-face interviews with teachers/instructors at the participating universities which aimed at investigating their attitudes towards and knowledge of ICT use in teaching.

The study on ICT use in teacher education was carried out in the following countries in Sub-Saharan Africa: Kenya; Uganda; DR Congo, Rwanda, and Cameroon. However the biggest number of participants came from Kenya and Uganda.

2. ICT-based teacher education

Education systems around the world are under increasing pressure to use the new Information and Communication Technologies to teach students the knowledge and skills they need in the 21st Century. The 1998 UNESCO World Education Report, *Teachers and Teaching in a changing World*, describes the radical implications ICTs have for conventional teaching and learning. It predicts the transformation of the teaching-learning process and the way teachers and learners gain access to knowledge and information.

With the emerging new technologies, the teaching professions are evolving from an emphasis on teacher-centred, lecture-based instruction to student-centred, interactive learning environments. Designing and implementing successful ICTs enables teacher education programmes and is the key to fundamental wide-ranging educational reforms.

As noted in the UNESCO World Education Report (1998), the young generation is entering a world that is changing in all spheres: scientific and technological, political, economic, social and cultural. The emergence of a knowledge-based society is changing the global economy and the status of education. Consequently, teacher education institutions are faced with the challenge of preparing a new generation of teachers to effectively use the new learning tools in their teaching practices. For many teachers' education programs, this task requires the acquisition of new resources, expertise and careful planning.

There has been a joint effort of international bodies (UNESCO, World Bank) to provide a guide to help teacher educators, administrators and policy-makers infuse, integrate and embed ICTs into teacher education. Development of resources would be carried out by an international group of experts such as *InfoDev* (Information Development program), with extensive experience in the integration of ICTs into teacher preparation. This would provide a framework for ICTs in teacher education and describe the essential conditions that must be met for successful technology integration. Furthermore, this should offer case studies illustrating the variety of approaches that may be used in integrating ICTs into teacher education. Guidelines

for the development of a high quality strategic technology plan could then be provided thereby enabling planning and managing the change process, and building a broad base of support among all stake holders to achieve the goals of integrating ICTs into the teacher education programme.

Projects such as DEEP in 2003 and 2005; Imfundo in 2004; and SchoolNet Africa in 2004, have carried out extensive research on the use and implementation of ICT use in Africa. For instance in its 2003 report on teachers and technology in Egypt and South Africa, the DEEP project highlights the potential of ICTs for transforming teacher development and learning, as well as professional support. The project reaches the following conclusions:

- ICTs have enormous potential for facilitating teacher training and enabling new forms of teaching and learning.
- Training that focuses first and foremost on curriculum skills and processes, rather than ICTs skills, can empower teachers to use ICTs purposefully and effectively in the classroom.
- Working together and sharing laptops can result in effective peer support, create more enthusiasm and ensure high levels of equipment usage, making ICTs provision more cost-effective.
- Providing teachers and schools with 'professional' equipment and enabling them to use it for professional learning can raise their knowledge and status and that of their community; especially in contexts which might have previously undermined their dignity and self-esteem.

Using ICTs in teaching and learning have created changes in the education and training for both the educator and the learner. Education systems worldwide are calling for a revision of the learning and teaching processes so as to accommodate the new media as well as optimise learning in a fast changing world. Traditional forms of teaching and learning are changing to incorporate new concepts and life-long learning. The following section looks at some of the learning theories supporting ICT use in the teaching/learning process.

2.1. Theories supporting learning with ICT

New technologies challenge the traditional conceptions of both teaching and learning. ICT is transforming the present teacher-centred and text-bound classrooms into student-centred interactive knowledge environments. It is therefore recommended for schools and learning institutions to move toward a new paradigm of learning that can accommodate and utilise the new technologies in learning / teaching process (UNESCO 2002). However, as UNESCO (2002) notes, most teaching/learning institutions still lack a general theoretical framework from which to develop criteria and guidelines for improving teacher education.

Woodhill (2004), observes in his content analysis study of a large number of websites of "e-learning providers", that there is little evident interest in or exploration of the nature of learning or teaching. His results, documented in *"Where is the Learning in E-Learning"*, indicated that of the 1080 websites, only 73 company websites mentioned learning theory, instructional design, instructional strategies, pedagogy or teaching methods.

According to Muwanga-Zake (2001), "(T)here are no African discourses and paradigms in the academia. Africa requires the development of paradigms that are suitable for African contexts". Some educationists believe that unless Africa starts to develop its own educational theories and paradigms which suit its own cultures and contexts, it will always have to rely on theories developed to suit other cultures and contexts. There is a view that African education researchers need to realise that the education paradigms imported from the industrialised nations in their raw form can wipe out African initiative and create dependency whereby Africa becomes a perpetual consumer of goods and ideas (Ogunniyi 1996 in Muwanga-Zake 2001). Therefore, there is need for cultural or contextual sensitivity when adopting or developing practices as direct implementation of best practices models from industrial nations would widen the digital divide in the future (Ogunniyi 1996 in Muwanga-Zake 2001; Pipa 2001). Although some discourses and paradigms are useful in African contexts, there has to a concerted effort to use them with a clear understanding of their origins and to critique how they fit into contexts in which they are used (Muwanga-Zake 2001). *InfoDev* (2005) has expressed the need for

cooperation between international and local groups in the early stages of ICT content development and not to simply import from abroad educational content.

This chapter looks at the learning theories that are often referred to in writings on ICT-based education in Africa, even if these are not genuine "African" theories. The UNESCO Planning Guide (2002) has outlined theories and concepts which support the new view of learning. These include Vygotsky's sociocultural theory, constructivist theories, self-regulated learning, situated cognition, cognitive apprenticeship, cognitive flexibility theory and distributed cognition (UNESCO 2002). All the theoretical approaches referred to by the UNESCO Planning Guide share a constructivist perspective on learning, i.e. a perspective which assumes that individuals are active agents who are purposefully seeking and constructing knowledge within a meaningful context (UNESCO 2002).

2.1.1. Constructivist theories of learning

Constructivist learning theories have their foundations in Piaget's works on cognitive and developmental and in Bruner's and Vygostsky's interactional and cultural perspectives (Driscoll 1994). Constructivist theories of learning assume that the knowledge we acquire about the world is not just a photocopy of the outside world that was put into our heads by some instructional process. Rather, knowledge is actively constructed by the individual, as part of a process of "meaning-making", in socially, culturally, historically and politically situated contexts. In a constructivist learning environment, students construct their own knowledge and apply it to new tasks, contexts and situation, integrating the new knowledge into their already existing knowledge structures.

Constructivism holds that knowledge is not 'about' the world, but rather 'constitutive' of the world (Sherman 1995). Knowledge is not a fixed object; it is constructed by an individual through her/his own experience of that object. Constructivist approaches to learning stress the importance of authentic, challenging projects that include students, teachers and experts in the learning community. Their goal is to create learning communities that are more closely related to the collaborative practice of the real world. In an authentic environment, learners assume the responsibilities of their

own learning, they have to develop metacognitive skills to monitor and direct their own learning and performance. When people work collaboratively in an authentic activity, they bring their own framework and perspectives to the activity. But they can see a problem from different perspectives, and are able to negotiate and generate meanings and solution through shared understanding.

Constructivism holds that meaningful learning occurs when students construct and give their own meaning to knowledge based on their prior experiences and background knowledge (Fosnot 1996). It also recognizes that challenging and helping students to correct their misconceptions is essential to effective learning (Schunk 2000). Conditions that foster such knowledge construction include an instructional approach that has come to be called "cognitive apprenticeship", the use of authentic learning tasks, and exposure to multiple perspectives (Biehler & Snowman 1997).

2.1.2. Situated cognition and learning

Almost twenty years ago, Allan Collins and his colleagues pointed out that the way we perceive and understand the world, the manner in which we learn, is not independent of the situation in which we do this. “The activity in which knowledge is developed and deployed, it is now argued, is not separable from or ancillary to learning and cognition. Nor is it neutral. Rather, it is an integral part of what is learned. Situations might be said to co-produce knowledge through activity. Learning and cognition, it is now possible to argue, are fundamentally situated” (Brown, Collins, & Duguid 1989, p.32).

The view that cognition and learning are situated has had an impact on instructional design. Collins himself proposed an instructional approach which he called “cognitive apprenticeship” (Collins, Brown & Newman, 1989). He considers learning as a process of enculturation and suggests that it may occur in a way that is similar to learning a specific trade. To view the acquisition of knowledge and skills as a process of cognitive apprenticeship implies a three-stage model (modelling, coaching, and fading):

1. There is a master or expert who models authentic activities which the learner (the apprentice) is to acquire (modelling).
2. The learner will start to participate in these activities, but under the supervision of the expert (coaching) who will also provide for scaffolding.
3. The learner will work on his own, but the expert will still be there to provide help should it be needed (fading)

In his opinion, the works of Palincsar and Brown (1984) on reciprocal teaching, of Scardamalia and Bereiter (1985) on procedural facilitation, and of Schoenfeld (1985) on mathematical problem solving are good examples of the cognitive apprenticeship approach.

Collins sees his cognitive apprenticeship approach as an alternative to the way children are instructed in schools. In his opinion, traditional instructional methods favour the acquisition of “inert” knowledge, i.e. knowledge which can be reproduced (in examinations, for instance), but which cannot be used to solve problems. In a cognitive apprenticeship setting, on the contrary, students not only acquire knowledge, they are also shown how to apply this knowledge. An analysis of possible causes for knowledge to remain inert was published some time ago by Renkl (1996). Renkl subsumes one group of factors that may contribute to the fact that knowledge is not applied under the heading “metaprocedural deficits”. These include deficits in metacognition and in motivational and emotional aspects of self-regulation of learning.

Social interaction is a critical component of situated learning, that is, learners become involved in a "community of practice" which embodies certain beliefs and behaviours to be acquired. As the beginners or newcomers move from the periphery of this community to its centre, they become more active and engaged within the culture and hence assume the role of expert or old-timer (Lave & Wenger 1991; Smith 2003).

The ideas of situated cognition and cognitive apprenticeship have also inspired the development of technology enhanced learning environments which aim at supporting learning in authentic learning contexts with the help of ICT.

Bransford and his colleagues from the Cognition and Technology Group at Vanderbilt University in the U.S. proposed an instructional approach which they called “anchored instruction”. The “anchor” is a complex and close to real life problem which is presented on video disk and which in general is being solved by a group of students. “The major goal of anchored instruction is to overcome the inert knowledge problem. We attempt to do so by creating environments that permit sustained explorations by students and teachers and enable them to understand the kinds of problems and opportunities that experts use as tools. We also attempt to help students experience the value of exploring the same setting from multiple perspectives (e.g., as a scientist or historian)” (CTGV 1990, p.3).

The anchor that the Cognition and Technology Group is using in their Jasper series is a collection of 12 adventures on videodisc that focus on mathematical problem finding and problem solution (CTGV 1997). A more recent technology enhanced learning environment developed by the CTGV is SMART - Scientific and Mathematical Arenas for Refining Thinking (Vye et al. 1998). This is an interactive Internet-based learning environment conceived as a framework that will help fifth graders to learn about ecosystems with a focus on the pollution of a specific river. Additional features are Web-based components that aim at encouraging students to monitor and reflect their learning and to revise decisions in preference of alternate learning paths.

Another ICT-based instructional approach that was inspired by the ideas of situated cognition and cognitive apprenticeship is based on the cognitive flexibility theory developed by Spiro et al. (1991). Spiro and his colleagues are interested in processes of knowledge acquisition where the knowledge domain in question is highly complex and possibly ill-structured.

The basic idea of cognitive flexibility theory is that processing complex information may not be achieved by the activation, modification and possibly creation of complete schemata. An adequate processing of complex information requires cognitive flexibility in the sense that the student has to be able to activate partial schemata and to combine these into complex new ones.

According to Spiro, the traditional approach to teaching is insufficient with respect to this. Textbooks have the tendency to simplify problems and to offer textbook solutions. Simplified solutions may, however, make it difficult for students to achieve an understanding of highly complex phenomena. Referring to an image that Wittgenstein uses, he compares knowledge to a landscape. In order to acquaint oneself with this landscape, one has to traverse it many times in different directions, one has to criss-cross it. Acquiring knowledge then means to construct a mental structure from different conceptual and case perspectives. This requires to provide the learner with a flexible learning environment, and to Spiro, there is no doubt that multimedia computer program can do this best.

"The computer is ideally suited, by virtue of the flexibility it can provide, for fostering cognitive flexibility. In particular, multidimensional and non-linear hypertext systems ... have the power to convey ill-structured aspects of knowledge domains and to promote features of cognitive flexibility in ways that traditional learning environments (textbooks, lectures, computer-based drill) could not (although such traditional media can be very successful in other contexts or for other purposes). We refer to the principled use of flexible features inherent in computers to produce non-linear learning environments as, *Random Access Instruction* ..." (Spiro et al. 1991, p.24/25).

2.1.3. Self-regulated learning

According to Zimmermann (1989), "(S)tudents can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviourally active participants in their own learning process". In other words, a self-regulated learner is aware of her own learning processes and knows how to monitor and control these. She views knowledge and skill acquisition as a systematic and controllable process, and she accepts greater responsibility for her learning outcomes. She is the initiator of the learning process.

Self-regulation plays a crucial role in all phases of learning. Schoenfeld (1987) states that self-regulation has the potential to increase the meaningfulness of students'

classroom learning; the creation of a "mathematics culture "in the classroom best fosters metacognition. Schoenfeld (1983) showed that many problem-solving errors are due to metacognitive failure rather than to lack of basic mathematical knowledge.

Advocators of self-regulated learning argue that students can be taught to become more self-regulated learners by acquiring effective strategies and by enhancing perceptions of self-efficacy. Poor learners can benefit from reciprocal teaching, that is, through processes of modelling, guiding, and collaborative learning. Research has shown (Swanson 1990) that teaching regulatory behaviours improved students' performance significantly. In fact, after such training, low-achieving students demonstrated outcomes similar to those who were typically high-achieving (White & Frederiksen 1998 in McGee et al. 2001).

Lifelong learning is increasingly becoming important and will in the future occur in non-academic learning environments (Steffens 2006). Rapid development in the field of ICT has made it possible to develop highly sophisticated technology enhanced learning environments (Steffens 2006). Ultimately, the power of ICTs will be determined by the ability of teachers to use the new tools for learning to create rich, new, and engaging learning environments of their students. According to the UNESCO World Education Report (1998), there are indications that the new technologies could have radical implications for conventional teaching and learning process. The report notes that, in remodeling how teachers and learners gain access to knowledge and information, the new technologies challenge conventional conceptions of both teaching and learning materials, and teaching and learning methods and approaches.

2.1.4. Self-efficacy in ICT use

Social cognitive theorists believe that behaviour, cognition, and context (or environment) interact with each other to form a reciprocal relationship (Bandura 1986, 1997). They argue that the relationship between these three factors provide the best path to understanding behaviour. Levels of self-efficacy indicate a person's perceptions of her/his competence in a nominated area.

Self-efficacy has been defined as a construct relating to a person's self-perceived belief in her/his ability to carry out actions that will achieve designated goals (Bandura 1986, 1997; Pintrich & Schunk 1996). It differs from constructs such as self-concept and self-perceptions of competence because it is specific and it applies to particular goals. Self-efficacy is based on beliefs about what a person can accomplish with the skills and knowledge she/he already possess. Since self-efficacy is said to be situation-specific, it is likely that a person will exhibit different levels of self-efficacy in different domains. Bandura assumes that the acquisition of self-efficacy beliefs will be facilitated by four factors: (1) the successful completion of a task (inactive experience or mastery), (2) observation of a successful model (vicarious experience), (3) verbal persuasion and (4) emotional or affective state.

In his study of pre-service teachers Kellenberger (1996) reports that belief about success with computers in the past has some influence on perceived computer self-efficacy. However, the results of his study suggest that past achievement might not influence self-efficacy as much as the level of value a student teacher places on computers in an educational context. Other research has found strong links between self-efficacy and later competence or achievement (Pintrich & Schunk 1996; Bandura 1986).

With the increase of the use of computers at all levels of education, researchers have become interested in links between beliefs about personal ability to perform educational computer tasks and subsequent learning about, and use of, computers. Self-efficacy appears to be an important indicator of whether an individual will teach with computers at a later stage. Ropp (1999) notes that while many teachers have positive attitudes to the use of educational technologies, they do not necessarily believe in their own ability to use technology in a classroom with students. Delcourt and Kinzie (1993) reported that learning about computers is aided by high levels of self-efficacy and a positive attitude. Other researchers have reported a high correlation between level of self-efficacy and computer use (Jones 2002).

Peter Albion (1999) argues that self-efficacy beliefs are an important, and measurable, component of the beliefs that influence technology integration. Albion

notes that decisions made by teachers about the use of computers in their classrooms are likely to be influenced by multiple factors including the accessibility of hardware and relevant software, the nature of the curriculum, personal capabilities and constraints such as time. However, there is substantial evidence to suggest that, teachers' beliefs in their capacity to work effectively with technology, is a significant factor in determining patterns of classroom computer use.

From the stand point of self-efficacy theory, the ideal method for developing teachers' self-efficacy for computer use would be to provide them with training and support to work successfully with computers in their classrooms. The study conducted by Borchers et al. (1992) demonstrated that a professional development program which included several workshops over an extended period and on-site support for participants was effective for increasing both self-efficacy and computer use.

As for the factors which according to Bandura might facilitate the acquisition of self-efficacy beliefs, in the context of a teacher education program, enactive experience and resultant increase in self-efficacy might be achieved though successful experiences with the use of computers. In practice, variation in the experience and expectation of cooperating teachers and in the availability of equipment make it impossible to ensure that all students will experience the success that builds self–efficacy beliefs. Vicarious experience through direct observation of experienced teachers engaging in appropriate behaviour pose similar difficulties and verbal persuasion has limited application unless students have opportunity to perform the appropriate behaviors (Albion 1999).

Self-efficacy theory, when applied to use of new technologies, suggests that real experience is more effective than vicarious experience for increasing self-efficacy beliefs. Thus it seems reasonable to suppose that multimedia course designs (Albion 1999) which encourage increased involvement of the user in the case should be most effective at increasing self-efficacy beliefs. As community expectations for integration of information technology into the daily practices of teaching grows, it will become increasingly important that all teachers are adequately prepared for this dimension of their professional practice. Research suggests that teachers' self-

efficacy beliefs about using technology for teaching are directly related to their practice.

2.2. Integrating theory into practice

In many countries higher education is undergoing a transformation. Today higher education has to deal with significantly increased student enrolments with comparatively reduced resources, while still delivering on quality (Harvey & Knight 1996). As higher education strives to foster active and autonomous lifelong learners, it must equip students with the necessary skills and strategies that will allow them to reach this potential (Candy 1998). Increasingly, aspects of teaching and learning are being mediated through information and communication technologies, both on and off campuses, partly driven by the changes in student characteristics. Many students are notionally part-time and the distinction between full-time and part-time study is becoming blurred. Thus the delivery of higher education is changing both in perception and implementation. Research and developments from distance educators e.g. Open University, are now setting the agenda for ICT use in higher education in general. Thus the question today is not "if" but rather "how" technologies, current and new, can be exploited to flexibly support a more diverse student population in the 21st century (Moon et al. 2002a). So far ICTs have been introduced into higher education largely as a supplement to existing teaching and learning practices. However, there is still much to be done in terms of exploiting ICTs for rich pedagogical use (enhanced teaching and learning), and for serving learners in different target groups (Collis & Van Der Wende 2002).

While there is great advocacy for using ICT education, it is argued that teaching and learning in higher education is unlikely to be improved simply by the application of a new technology. Learning can be enhanced when innovations take into account not only the characteristics of the technology, but also the pedagogic design, the context within which learning takes place, student characteristics, their prior experiences and their familiarity with the technologies involved. Kirkwood and Price (2005) observe that it is essential for teachers and decision-makers in higher education to develop a better understanding of the issues surrounding the use of ICT. The new

circumstances for learners and learning require consideration to be given not only to the characteristics of technologies, but to (a) the pedagogic models and processes they have to serve; and (b) the contexts within which learners engage with ICT. Thus designers and implementers of ICT need to consider access and use of ICT. They should consider the increasingly diverse backgrounds and circumstances of students and potential students; pay attention to the 'digital divide' and use ICT where most appropriate.

Access to ICT is rarely ideal and unrestricted and most often learners need to share computing and communication facilities with others. Therefore course design should reflect this and not be over-dependent upon ICT. Regardless of the medium being used, it is very unlikely that students will make use of the materials and activities unless they are embedded in the course pedagogy. If materials are not linked to the assessment strategy then the medium is likely to be unused and its potential will remain fallow. The medium itself is not the most important factor in any educational programme but rather how it is creatively exploited and constructively aligned (Kirkwood & Price 2005).

Castro (2003) further cautions on the rash to implement new technologies in developing countries. He argues that the rich countries can afford most if not all these technologies, even if they do not work well. However, the best alternatives for rich countries are not necessarily the same for less affluent countries and despite the domestic controversies surrounding the inadequacy of teachers and teacher training in OECD countries, the nature of the limitations is not the same. The shortcomings of poorer countries are much more basic and the lack of preparation of teachers has a different order of magnitude. In rich countries, instructional technologies are used to take an additional step, to improve learning beyond the levels previously reached – levels already vastly superior to those reached by developing countries.

Over 30 countries in Africa still have less than one telephone line per 100 inhabitants compared to the average global ratio of 13 lines per 100 inhabitants (Mannisto et al. 1997). Castro therefore argues that the Internet is doomed to remain an elitist resource, available only to a small number of students and it, therefore, remains an expensive technology for developing countries. Even with falling costs over the last

several decades, a computer in an American school costs less than half of the student/year cost while in developing countries it may cost ten times the student/year cost, which indicates that these technologies require resources that are particularly scarce in poor countries (Castro 2003). Furthermore, new technologies require technological resources and well-trained teachers necessary to implement the most creative use of computers in the classroom in any large scale.

What is good for developing countries is what is affordable for the masses and what compensates for the chronic scarcity of quality teachers. Castro proposes that instructional technologies should compensate for the shortcoming of existing teachers and for their complete absence in very poor regions. Just as rich countries have used technology to respond to their own needs, developing countries must use technology to respond to their own (but different) needs. For instance software for computers in schools must be easy to use and non-threatening to the teachers (in the initial phases of implementation). Hence the need to be critical, selective and use a technology that best responds to local needs, rather than another one that is the latest or most sophisticated or appropriate for other (developed) countries. It is thus recommended that there should be a policy to focus initially on those institutions that have less fear of computers, such as technical and vocational schools, or those institutions created especially to use new technologies, e.g. the UK Open University. As experience in OECDs shows the K-12 schools are the ones that most resist the use of technologies, making waste higher and results less impressive (Castro 2003).

Technology today offers many exciting alternative paths for improving education, but each of these alternatives is not equally good or appropriate for all countries. Rich countries have used technology to make their good education even better. Therefore, when thinking of new technology solutions for education, the best solutions for less affluent countries are not necessarily to be found in the rich countries. Experiments are doomed to remain enclaves, catering to local elites but incapable of being scaled up to reach the number of people who are in dire need of better instructions. While the use of computers in classrooms is not denigrated, despite considerable efforts and after many years, developing countries need to understand that computers have not yet lived up to their educational potential, even in rich countries (Castro 2003).

Developing countries need to focus on those technologies that compensate for the factors that are lacking, e.g. well-trained teachers and the resources to pay for expensive equipment. They should concentrate on those technological alternatives which, at low costs, bring to the students the imagination and creativity of a few excellent teachers, for example TV or radio. Since teachers will not be replaced by technology, much more effort should be focused on their training and selection. Technology can only bring to the classroom the talent of other teachers and scientists which add to the skills expected from the average teacher (Castro 2003).

2.3. A need for new paradigm in teacher education

Research has shown that the traditional instructional approaches whereby teachers are the ultimate sources of knowledge while students passively receive and record this knowledge in memory are not effective (Bransford et al 2000; Moon 2004; Kozma 2005). Kozma, among others, suggests that the professional development of teachers needs to be approached as a human capital in business. He argues that the productivity of education can be significantly improved by upgrading the skills and knowledge of teachers and their ability to apply these in the classroom. Researchers advocate an approach to teacher professional development that builds a community of practice focused on continuous improvement (Bransford 2000 cited in Kozma 2005).

In regard to the global crisis in the supply of educated and well prepared primary teachers, and the prevailing problems of brain-drainage and HIV/AIDS impact whereby roughly 860,000 children in Sub-Saharan Africa have lost their teachers to AIDS, Leach et al. (2004) call for radical solutions. Moon and his colleagues (DEEP project) argue that with the current situation of inadequate institutions for teacher education to serve the 21st century, new developments in teacher education should focus on the following:

- emergence of new interactive technology
- make the school a more central ‘site for learning’ in the teacher education process
- the emergence of new forms of professional ‘communities of practice’ working through new modes of communication (Leach et al. 2004)

Many education experts urge for a rethinking and reforming of teacher education into a career long process of development equal in form and status to the education in law and medicine. And many of these experts see the emerging of open learning and school based development programmes as the best means to exploit the interactivity and communicative possibilities of ICT (LearnLink 2006). ICTs are seen as potential cost-effective approaches for teacher professional development in improving the quality of education and training, in that they can provide training to a large numbers of people more quickly. This is seen as cost-effective in the long run, for as the demand of these technologies increases their costs are expected to lower. Teachers would be able to keep abreast of new developments as they will be exposed to a wider range of current and new information enabling them to construct new knowledge.

Research around the world has shown that teacher training in use and application of technology is the key determining factor for improved student performance in terms of both knowledge acquisition and skills development enabled by technology. ICT can not be transformative on its own and requires teachers to integrate it into the curriculum and use it to improve student learning (Carlson & Gadio 2002).

However, providing technical skills training to teachers in the use of technology is not enough. Teachers need professional development in the pedagogical application of those skills to improve teaching and learning rather than the traditional one-time teacher training workshops which have not been effective in helping teachers to feel comfortable using technology or to integrate it successfully into their teaching. According to Haddad (2002) a new paradigm is emerging that replaces training with lifelong professional preparedness and development of teachers (Carlson & Gadio 2002). This approach includes three different strategies:

- initial preparation/training (pre-service) that provides teachers with a solid foundation of knowledge; competence in teaching, classroom management, organisation skills, and mastery of the subject matter they will teach; proficiency in using a variety of educational resources, including technology;
- workshops, seminars, and short courses (in-service) that offer structured opportunities for acquisition of new teaching skills and subject matter

knowledge, as well as skills development in the use of technology in the classroom, that are government-certified and linked to teachers' professional career development;

- ongoing pedagogical and technical support for teachers as they address their daily challenges and responsibilities.

In addition, during pre-service teacher training ICTs can improve practice by providing access to more and better educational resources, offering multimedia simulations of good teaching practice, catalysing teacher-to-trainee collaboration, and increasing productivity of non-instructional tasks. In in-service teacher professional development these ICTs enable distance and asynchronous learning, and individualised training opportunities. ICTs can overcome teachers' isolation, breaking down their classroom walls and connecting them to colleagues, mentors, curriculum experts, and the global teacher community (Haddad 2002; Carlson & Gadio 2002). However, despite the crucial need of teacher professional development, traditionally both pre-service and in-service is under-funded, especially with regard to use of technology as budgets give priority to hardware and software acquisition over teacher professional development (Carlson & Gadio 2002).

Among developing countries Costa Rica is cited as a successful example of utilising the advantages of technological use in teacher professional development. Over the last 12 years, Costa Rica has trained more than 15,000 teachers and administrators using face-to-face and distance methodologies. Teachers engage in training on-line on their own, at their convenience, and as often and as long as they want. Ongoing pedagogical support and teacher networking, key ingredients of effective in-service training, are facilitated by technology. Technology is infused into the teaching and learning process, thus teachers' career-long professional development has become a continuous and planned process. This dramatically increased Costa Rican teachers' motivation for, and participation in, professional development in the use of technology to improve teaching and learning (UNESCO 2006-EFA 2007; Carlson & Gadio 2002).

In addition to providing training opportunities, the use of the web as the training medium exposes teachers to pedagogical practices analogous to what they may do

with their own students using technology. Teachers begin to learn skills and develop new knowledge on-line, through interaction with instructors, mentors, peers, and subject matter experts, modelling the potential learning experience of their students after training. However, it is acknowledged that using technology to train teachers is very hard to implement and the number of successful cases in developing countries is very small. Such is the case, that even in developed countries like the United States, on-line teacher professional development programs experience an average drop-out rate of more than 30%, in most cases because of a decline or availability of time (Stryker 2000 in Carlson & Gadio 2002 p.127).

2.4. On-line learning, e-learning or OdeL in teacher education

On-line education or learning is becoming popular both in developed and developing countries. According to Farrell et al. (1999), one of the biggest challenges for most governments as they compete in the free global market is the provision of education. Thus bold steps have to be considered by states to provide their people with affordable access to education such as using methods of mass education "(O)ne solution available for Governments of the Commonwealth is to use the newer technologies as vehicles to bring a variety of educational opportunities to individuals in their respective countries" (Farrell et al. 1999 p.11). It brings wider opportunities to people in the form of flexible, open and distance learning. On-line education can be defined as an innovative form of distance education that delivers instruction to a remote audience, using computer networks as the main medium (Jung 2001). On-line education is generally expected to (a) increase access to education for individuals located throughout the world, (b) remove barriers of time and space, and (c) develop a cost-effective approach to providing interactive learning opportunities for adults (Jung 2001). On-line teacher training is a form of on-line education that uses computer network technologies to organise, develop, manage, and administer in-service teacher training. Well designed on-line teacher training programmes can broaden the range of teacher training opportunities and reduce the costs of providing retraining opportunities to teachers by adopting information technology, and sharing educational resources. Jung (2001) who carried out research on on-line training via the Internet in South Korea observes that the Internet provides an opportunity to

develop new learning experiences for learners by managing self-directed learning, and sharing information and ideas in a cooperative and collaborative manner.

Results from his study revealed that on-line teacher training had several benefits: (a) teachers can access in-service training without leaving their classrooms; (b) teachers can improve their computer literacy; (c) teachers are better able to interact with their trainers and other teachers on-line; and (d) once a database of on-line courses had been developed, teachers could access those courses that met their individual needs (Jung 2001). He observed that in general web-based training is more cost-effective than classroom teaching mainly due to the reduction in course delivery time and the potential to deliver courses to a larger number of students. Adult students who dropped out of distance education were characterised as being field-dependent, possessing a pessimistic attribution style and an external locus of control, and lacking self-regulation in their learning (Capper & Fletcher 1996 in Jung 2001). In other words, distance education is easier for those who have self-directing or self-regulating skills (Butler & Winne 1995 in Jung 2001).

In the case of Korea (Jung 2001), strategies for supporting distance learners to complete their programmes were introduced and these included providing academic, social and administrative support services through study centres; encouraging study group activities, allowing students' own pacing of study and assignment and providing opportunities for synchronous and asynchronous interaction using various technologies (Capper & Fletcher 1996 in Jung 2001). It is suggested that sessions to facilitate self-directed or self-regulated learning, along with a long-term vision, are necessary to help learners develop and strengthen competencies such as an understanding of the concepts of on-line learning, and how these differ from traditional concepts of education and the ability to manage and regulate their on-line learning skills that are necessary to successfully complete on-line training programmes (Jung 2001).

In most developing countries, education is hampered by problems of low band-width, telecommunications costs, and limited computer access, among others. Thus such countries require maximum use of off-line training modalities, such as CD-ROMs; use of store-and-forward e-mail for sharing documents and mentor support, video,

diskettes and even printed materials to support other technologies (Carlson & Gadio 2002). However, such countries could in the long term benefit cost-effectively from e-learning as it has been the case in the corporate world. In the corporate world, e-learning has demonstrated over the past years that it can cut training time by one-third, increase training effectiveness by one-third, and reduce training costs by one-third (Kozma 2005). Education planers and implementers are discussing if this can be transferred to public sectors like teacher training (Kozma 2005). However, as Carlson and Gadio (2002) note, most observers agree that the key to successful e-learning programs is attaining sufficient economies of scale from both cost and effectiveness perspectives. A good example of this in a developing country is the Fundacion Chile on-line training programme which even with a 50% drop-out rate, at a cost of $50 per teacher reached far greater numbers of teachers at lower unit costs than a traditional programme (Carlson & Gadio 2002).

According to Carlson and Gadio (2002), future trends in teacher professional development in the use of technology will be shaped by two main factors: increasing demand for teacher training and new technologies/methodologies to enable training. Ministries of education in countries as diverse as Chile, Senegal, Turkey, and Sri Lanka are implementing nationwide educational technology programs, which will require a greater complexity and content of the training as the Internet and other new technologies are introduced.

In this information age, what teachers are expected to know and do is increasing tremendously. In the world of today teachers need not only to know their subject matter and basic pedagogy, but are also expected to model higher-order thinking processes, work in interdisciplinary teams, and demonstrate leadership and communication skills (Carlson & Gadio 2002). Likewise teachers are supposed to deliver better student results on standardised tests, while addressing larger societal problems like HIV/AIDS, conflict resolution, and disintegration of families (Delannoy 2000 in Carlson & Gadio 2002). ICTs can help teachers to meet these expectations by providing productivity tools, access to information and colleagues, and collaboration opportunities.

E-learning is seen as a new way for teachers to acquire new knowledge and skills using computer network technologies. Technologies provide not only text, but also sound, video, simulations, and collaborations with other learners scattered around the country and the world (Carlson & Gadio 2002). Currently e-learning is delivered through the WWW. Future trends are expected to include e-learning via mobile hand-held devices, cell phones, and digital video devices. Rapidly declining hardware and software costs, e.g. DVD production and replay, will provide access to master teachers and trainers and sharing this technology world wide. A new range of visual and audio possibilities in distance learning format is expected to emerge through the WWW and WWW-enabled DVD which would enable access to materials and resources located on the DVD itself and the WWW (Carlson & Gadio 2002). Four factors are attributed to the rapid development of e-learning: 1) gradually increasing availability of higher-speed computer networks to deliver information and services; 2) recognition that teachers need to "work smarter" with constant updating of skills; 3) convenient just-in-time education for teachers (often "anytime, anywhere"); and 4) cost-effective alternative to traditional classroom-based education and training.

On the African continent, the African Virtual University (AVU) is taking the lead in implementing ICT in education, particularly in teacher education. With a grant from the African development Bank and support from NEPAD and other stakeholders (Dzvimbo et al. 2006), the AVU initiated the teacher education programme. Its main objectives were: (1) to enhance the capacity of teachers in the use of ICTs in teaching and learning, with a particular focus on mathematics and science; (2) to develop the capacity of teachers to deliver ICT education – teaching ICT skills as a subject to secondary school pupils and (3) to increase the number of mathematics and science teachers by expanding access to training through the OdeL initiative. Through workshops a curriculum was designed and developed by the ministers of education from 10 participating countries (Djibouti, Ethiopia, Kenya, Madagascar, Somalia, Tanzania, Uganda, Zambia, and Zimbabwe). The curricula structures for ICT-integrated modules for mathematics, physics, chemistry and biology, modules of ICT basic skills as well as modules for pedagogy and integration of ICT in mathematics for both in-service and pre-service teachers, were developed. The content developed in the three main languages of instruction: Portuguese, French and English, was

authored by experts from 12 institutions in the 10 countries (Amoud University, East African University and University of Hargeisa – Somalia; Jimma University – Ethiopia; Kyambogo University – Uganda; Open University of Tanzania; Universidade Pedagogica – Mozambique, Universite d'Antananarivo – Madagascar; University of Nairobi; University of Zambia; and University of Zimbabwe). Despite the challenges encountered in this project such as the linguistic division, bureaucracy, different education systems and the scarce skills in ICT integration in subject areas it enabled three linguistically divided regions to work together to develop a curriculum and collaborate within the participating ministries of education (Dzvimbo et al. 2006).

In utilising the potentials of ICT in teacher education through distance learning, perhaps Africa can take a look at other countries which have utilised technology such as Iceland's rural teacher certificate programme. Iceland is a sparsely populated country with a persistent shortage of teachers. Uncertified teachers in widely dispersed locations needed to earn certification to maintain their employment, but leaving the schools for an on-site university programme would mean to leave the schools without adequate teachers. Through distance education teacher certification programmes allowed rural and remote communities to hire unlicensed teachers when they were unable to find fully licensed teachers. The teacher certification programme gave individuals the opportunity to earn a teaching degree while they continued to hold their teaching jobs, regardless of their geographical location (Lefever 2004).

Moon in *The Open Learning Environment: a new paradigm for international developments in teacher education* argues that expanding populations make huge demands on the institutions responsible for preparing teachers. In countries like South Africa, for example, pre-service teacher training expanded at 15% per year through the 1990s, and training by distance education by 23% (Moon 2006 p. 1). Moon argues that teacher education is not an African problem alone but is rather a result of the competition from a range of increasingly knowledge-based occupations which is threatening the supply of teachers in many countries. Even in developed countries like the UK, the recruitment of teachers for subjects such as mathematics, technology and languages fell significantly short of need. Presently, there is a widespread recognition that teacher education must be a career-long process of

development, at least equal in form and status to that enjoyed in law, medicine and comparable professional groups.

Moon argues that: (1) the 'brick and mortar' institutions developed around teacher education to serve the needs of the 20th Century will be wholly inadequate for the 21st; (2) that the implicit and explicit models of development, derived from such brick and mortar institutions, are insufficient to meet the changed circumstances of most, if not all, national contexts; and (3) that developing a research agenda to inform the processes of institutional change and rebuilding is now an urgent priority. Thus Moon urges for interrelated but contrasting movements towards: (1) the globalisation of the debate in part provided by the emergence of new interactive technology; (2) the localisation of action through giving greater prominence to making school a more central 'site for learning' in the teacher education process; (3) the emergence of new forms of professional 'communities of practice' working through new modes of communication (Moon 2000).

Moon et al. (2002a) argue that the education systems in Africa are confronted with severe problems:

(1) the global challenge of over 100 million children without primary schooling, the greatest number of these in sub-Saharan Africa,

(2) the imbalance between the demand for and output of trained teachers in low-income countries,

(3) insufficient training: 33 % of teachers in sub Saharan Africa are untrained (see table 2.1 below), while thousands of teachers being recruited each year to primary schools have inadequate subject knowledge and little or no pedagogic preparation, and

(4) the low supply of teachers severely affected by the impact of HIV/AIDS epidemic.

	(in thousands):		Percentage of trained teachers:		
	Total:	**Female:**	**Total:**	**Male:**	**Female:**
Botswana	11,7	9,5	92	87	93
Kenya	192,3	80,9	97	96	97
Lesotho	14,5	11,6	44	41	45
Malawi	34,4	13,9	54	57	49
Namibia	12,0	8,0	29	29	29
South Africa	223,0	174,2	63	66	62
Swaziland	6,4	4,8	91	89	92
Tanzania	106,3	46,8	44	44	44
Uganda	109,7	35,8	-	-	-
Zambia	34,8	16,5	89	86	92
Zimbabwe	59,9	28,3	-	-	-
Total	**805,0**	**430,3**	**average 67%**	**average 66%**	**average 67%**

Table 2.1: Number of primary teachers 1998 (Source: Bob Moon et al. 2002a: Challenging the assumptions about teacher education and training in Sub-Saharan Africa)

According to Moon, it is clear that the 'brick and mortar' institutions of teacher education created in the last century are unable to cope with this scale and urgency of demand (Moon 2000, 2002). Moon suggests strong conceptualisation and planning of teacher training needs whereby the medium and long-term planning for professional development should incorporate the use of new interactive technologies. Through its potential reach and "affordances", ICT can make some aspects of teacher professional development more efficient, and has the potential to extend and transform the very processes of teacher development itself (McCormick & Scrimshaw 2001 in Moon 2002b). ICTs can expand the availability of support for teachers, and the possibilities for discourse and access to new kinds of knowledge and ways of learning through interacting with other teachers and experts, thereby helping in developing teachers' professional identity, personal dignity and self-esteem.

However, as Byron & Gagliardi (1998) noted, the potential of ICTs to transform the educational process on a global level is very far from being realised, and despite the fact that these technologies are constantly evolving, it is unrealistic to expect them to have rapid and universal effect. Even in developed countries where numerous initiatives using the new ICTs have been undertaken at national or state/province/country level, their access and use are still limited at the levels of primary and secondary education. Successful introduction of ICTs into the system

still appears to be constrained by financial, administrative and time demands thus hindering further research into effective means of incorporating these technologies into the curriculum (Byron & Gagliardi 1998; Becta 2004).

In its 2001 report on *Teacher Education through distance learning,* UNESCO (2001) sums up the global need to consider alternative forms of teacher education such as distance learning. The report states that many countries still do not have enough teachers and in some countries, especially developing countries, the expansion needed in the teaching force is far beyond the capacity of traditional colleges. The supply of teachers is also further adversely affected in countries where retention rates are low for newly trained teachers or where significant numbers of teachers are being lost through HIV-AIDS. In addition, teacher quality is an issue in most countries as many teachers are untrained or under-qualified. This situation is further encumbered by the widening range of demands and roles faced by teachers, whereby national governments, international organisations and specific circumstances continually set new goals such as: the achieving of gender parity by 2005 and universal basic education by 2015; inclusive education; education for democracy, peace and social cohesion; multi-grade teaching; increased accountability for achieving learning targets; the development of learners who are self-managing and independent, skilled in critical thinking and problem solving, equipped with life-skills; the preparation of learners who are competent for knowledge-based economies, capable in the use of information technology; and the expansion of teachers' roles to include social work in communities where child-headed households and orphans are common as a result of HIV-AIDS (UNESCO 2001). Despite these numerous demands on teachers, the attention given to teacher education and their continuing professional development has lagged behind that given to other parts of the education system.

The above report affirms that although there is wide recognition that teacher education, training and professional development need to be integrated, in ways that "operationalise" lifelong learning for teachers, the resources allocated to it are usually inadequate and the opportunities too few, such as one week in-service professional development programmes provided once every five to ten year. The report shows that on average countries spend around 1% of their annual education expenditure on the continuing professional development of teachers while business

and industry typically spend 6% on staff development. Worldwide teacher educational and continuing professional development is faced with new challenges and there is an urgent need

- to find ways of using existing resources differently;
- of expanding access to learning opportunities at affordable costs;
- of providing alternative pathways to initial teacher training;
- of drawing on new constituencies of the population to work as teachers;
- of using technologies appropriately to enrich a teachers' context and support practice;
- of stimulating and supporting teachers' active learning; and
- of re-conceptualising the traditional organisation of initial teacher education and continuing development (UNESCO 2001).

In ten case studies carried out in nine countries (Brazil, Burkina Faso, Chile, China, India, Mongolia, Nigeria, South Africa and United Kingdom) in 2001, UNESCO found few established cases of ICT use for teacher education. Despite the many new initiatives begun, there were few completed programmes with experience to report. Many examples of ICT forming part of a conventional programme of initial teacher education were found, and these were taught sometimes as an on-campus subject or in some cases (e.g. Australia) offered as an alternative distance learning mode. But there were far fewer examples to be found of ICT as a core means of delivering or supporting initial teacher education programmes (not just ICT courses), especially in developing countries. Even today there are more examples of on-line use for continuing professional development programmes at diplomas and higher degree level and for short courses. ICT is more often used in providing informal professional development for teachers through on-line activities ('chat rooms', specialist subject conferences, virtual classrooms, networks, professional development websites, peer group discussions, bulletin boards, resource sharing). The advantages of ICT lie in its potential for increased interaction with and between learners, speedier delivery and response time to queries and feedback on assignments, greater access to communities of teachers and quicker lead-in for updating course materials while at the same time needing the establishment of effective quality assurance procedures (UNESCO 2001).

Overall recommendation from stakeholders and international organisation is that new digital technologies are appropriate for use in the African context. They have the potential to "revolutionalise" the quality of training and status of teachers within Sub-Saharan Africa, transforming opportunities for teacher education. Most significant of all is the use of ICT in the poorest parts of the world which if carefully planned for and implemented, could have a significant impact on the self image, confidence, knowledge and professionalism of teachers in the global south. Teachers in poor environments can benefit from the many advantages that ICT is currently affording their richer peers, whilst avoiding the leap-frog expensive mistakes made in more developed countries (DEEP 2004).

Supporters of ICT use in teacher education argue that the existing cost analyses of ICT use for teacher education in developing contexts are likely to be inflated because they are based on outmoded forms and uses of ICT without taking account of a range of important factors including the significant recent development in cost-effective, powerful mobile technologies (DEEP 2004). The DEEP Project argues that school-based professional development permits ICT to simultaneously provide the medium, context and content for teachers' personal and professional development as well as help improve the curriculum, school and classroom practices and students' learning activities. They (DEEP project) further argue that as opposed to ICT teacher training (i.e. off-site courses) or ICT provision in schools (i.e. individual students' IT skills), evidence from the project shows that teachers and students can easily develop a range of ICT skills in the process of using digital technologies for curriculum purposes, provided collaborative and peer learning approaches are exploited. The DEEP research results show that new digital technologies are appropriate for use in the African context as they have the potential to revolutionise the quality of training when carefully integrated within programmes that are pedagogically strong and well supported (DEEP 2004).

Today one can with certainty say that the new technologies will continue to grow worldwide and greatly change how we learn, how communicate with each other, perceive and think. Despite the limited resources required to foster ICT in education Africa can not afford to be lag behind.

3. The Situation of Education in Africa

In his opening speech to the 1999 Conference on *Education for African Renaissance in the Twenty-first Century*, President Thabo Mbeki declared that "if the next century is going to be characterised as a truly African century, for social and economic progress of the African people, the century of durable peace and sustained development in Africa, then the success of this project is dependent on the success of our education systems. For nowhere in the world has sustained development been attained without a well-functioning system of education, without an effective higher education and research sector, without equality of educational opportunity." (Johannesburg, South Africa, 6 December 1999 in UNESCO 1999).

At the same conference the Executive Director of UNICEF, Carol Bellamy remarked that "More than 130 million children of primary school age in developing countries, including 73 million girls, are growing up without access to basic education". She declared that the world can no longer afford such an enormous waste of human potential whereby "nearly a billion people, two thirds of them women, will enter the 21st century unable to read a book or sign their names… much less operate a computer or understand a simple application form. And they will live, as now, in more desperate poverty and poorer health than most of those who can. They are the world's functional illiterates...and their numbers are growing" (Johannesburg, South Africa, 6 December 1999 in UNESCO 1999).

The education systems of most African countries have evolved directly from the institutions and procedures they inherited from the colonial power at independence (Evans 1994). Such that even today approximately 40 years after independence, Africans cannot afford to pursue an isolationist inward-looking policy. In the 1960s, for instance, many Africans continued ex-colonial educational frameworks, and in the 1980s a significant number began to shift and adopt the American educational system without critically examining the latter and observing its relevance to Africa's development.

However, although today there is a "general consensus that education in Africa is in a crisis", with the optimism of post-colonial era being displaced by a deep dismay at

persisting poverty and a profound pessimism about the viability of any strategy of social transformation (Samoff 1999b), Africa should not simply imitate Europe, America or other developed countries in designing and implementing curriculum for schools and strategies for development for their specific nations. External intervention in African affairs has also had its effect on the educational policy. Anthony Lemon cites Zimbabwe as an example which abolished fees for primary schooling in 1980, but was forced to reintroduce them due to the terms of the World Bank Economic Structural Adjustment Programme in 1987 (Lemon 1995 in Ghelawdewos 2004).

Thus, as the World Bank recommended in its 1998 policy study on education in Sub-Saharan Africa, "...each African country should now embrace the task of formulating and implementing an internally coherent set of policies in the education and training sector." According to Evans (1994), Africa's educational and economic development, therefore, depends on the ability of African governments to consider and develop:

(1) cross-cultural transfer to the local needs of African societies;

(2) strategies for economic development that are deliberately designed to guarantee Africa's independent path and foster already existing regional cooperative endeavours such as Southern Africa Development Conference (SADC) and Economic Community of West African States (ECOWAS);

(3) Africa's potential as provider, and not recipient, of cooperation, communality and spirituality on top of the legacy of ancient civilization; and

(4) conflict resolution, peace and stability as preconditions to educational development and economic progress (Ghelawdewos 2004).

Education is important not only to a society's elite but to all its members. It is argued that knowledge is not static, thus, education must enable learners not only to acquire information and skills but also to learn how to learn. Thus education must be a lifelong process, continually renewed and revitalised. Information technology has accelerated globalisation. Africa's underdevelopment is in large part a function of global rules that facilitate the flow of capital and restrict the movement of labour. For Africa, the challenge of globalisation is to employ the new technologies to Africa's advantages and to achieve this, Africa's education must enable Africans to be not only effective consumers and managers of production but also to be imaginative and

creative producers. “If no Africans experiment with sub-nuclear particles, or write new computer programs, or devise new approaches to dysentery, malaria, and AIDS, how can Africans assume responsibility of their own direction?” (Samoff 1999b). Africa needs to prepare its next generation to innovate, invent, create, explore and extend its education needs through collaboration and negotiation. Education needs to focus on learning how to learn and favouring innovation and experimentation. Samoff further remarks that curricula are shaped by national examinations and revolve more around information to be acquired than around developing strategies and tools for acquiring that information, generating ideas, or drafting critiques (Samoff 1999b).

3.1. Creative and innovative education

According to Samoff, Africa has seen important experiments and innovations like Nyerere’s *Education for Self-reliance* in Tanzania in the late 1960s which *shifted emphasis to primary and adult education (*Nyerere 1967: *Education for Self-Reliance),* where schools were to become community institutions, intimately connected with the patterns and rhythms of the local setting. Likewise Botswana sought to integrate learning and local setting by creating community schools in which learners and teachers were also to be producers (Gustafsson 1985 in Samoff 1999b). In pre-service and in-service teacher education, countries like Zimbabwe explored how to draw effectively on the local setting to develop lessons and materials for teaching science where laboratories did not exist or were poorly equipped. More recently innovative community-based non-school education programs have emerged across Africa, often with the support of a local or international non-governmental organisation (Samoff 1999b).

Despite little resources, several African institutions of education have intellectually explored ideas and constructs with contacts and influences around the world. Ghana’s Pan-African e-network holds debates around the world, while the research projects scholars at the University of Dar es Salaam explored problems and refined the methods of oral history. African researchers have established several continent-wide organisations such as the African Association of Political Science, founded in

Dar es Salaam in 1973 which has brought scholars together and publishes a journal, two networks which link education researchers in West and Central Africa, and in Eastern and Southern Africa and research institutions and centres such as the Council for Development of Economic and Social Research in Africa in Dakar and SAPES Trust in Harare (Samoff 1999b).

3.2. Education in rural Sub-Saharan Africa

According to Acacia (2000) many of Africa's rural areas impoverished and exist below subsistence levels. They have no access to basic infrastructure essential for economic growth, education and development. Basic infrastructures such as electrical communication, essential pillars for education growth, are not even planned for many deep rural communities in Africa. Consequently many, especially the youth, leave their rural homes in pursuit of employment and better life opportunities in urban areas.

Education for All Global Monitoring (2002) reports that 70% of the world's poorest people live in rural areas. The supply of education for rural people is generally inadequate. Urban African schools are much better equipped than rural ones, especially in regard to electricity and water supplies. Rural schools do not offer the full number of primary grades, and teach curricula that are ill adapted to rural circumstances. Rural children also receive less parental supervision and help with homework than do urban ones. School attendance in rural areas can be low due to the opportunity costs of attending school in terms of time lost to working in the fields or the home. School attendance can also fluctuate with respect to seasonality of opportunity costs, to agricultural and economic conditions, and to health and nutrition problems. Since the bulk of out-of-school children and those receiving insufficient schooling live in rural areas, there is a need to focus attention on the needs of rural children and adults. This means that implementation of any ICT policy should include the rural remote even if this might entail higher than average unit costs.

Country	Rural	Urban
Ghana	18	4
Lesotho	35	5
Malawi	77	86
Sierra Leone	43	11
U. R. Tanzania	62	29
Zambia	29	9

*As a percentage of the total number of teachers in the schools surveyed in this study.
Source: Bennell and Akyeampong (2006).

Table 3.1: Unqualified primary school teachers by location (source: UNESCO 2006 – EFA Report 2007)

3.3. The situation of teachers in Sub-Saharan Africa

Teachers play a central role in EFA achievement, and their future supply is a critical issue with respect to both education quality and financial stability. The impact of class size on educational outcomes is an important indicator of education quality (UNESCO 2005 - EFA 2006). In general the ratio is below 20 pupils per teacher in the vast majority of countries in North America and Western Europe, Central and Eastern Europe, and Central Asia, regions where student enrolment is high. Pupil/teacher ratios (PTR) in Sub-Saharan Africa are much higher, usually exceeding 40:1 and rising to almost 70:1 in some countries like Chad, the Congo and Mozambique. High PTRs make it difficult to provide primary education of good quality. PTRs also increase in countries which have eliminated or reduced school fees like Benin, Cambodia, the Congo, Ethiopia and Uganda.

It should, however, be noted that the number of teachers remains problematic in the very countries that need to increase the coverage of their primary school systems most significantly. In other words teacher numbers are generally too low and PTRs generally too high in the countries furthest from attaining the UPE goal. Thus,

maintaining current enrolment rations while moving to a PTR of 40:1 by 2015 generally requires a faster growth rate of teacher numbers than most of these countries experienced between 1998 and 2002. According to the above report, the numbers of additional teachers needed to increase gross enrolment ratios to 100% and achieve a 40:1 PTR by 2015 are so high that this is probably impossible in several (Sub-Saharan) countries. As already observed, the HIV/AIDS pandemic further accentuates the issue of teacher shortages in Africa (UNESCO 2005 - EFA 2006). Figure 3.1 below illustrates the current growth rates of teacher numbers and expected PTRs in Sub-Saharan Africa by 2015:

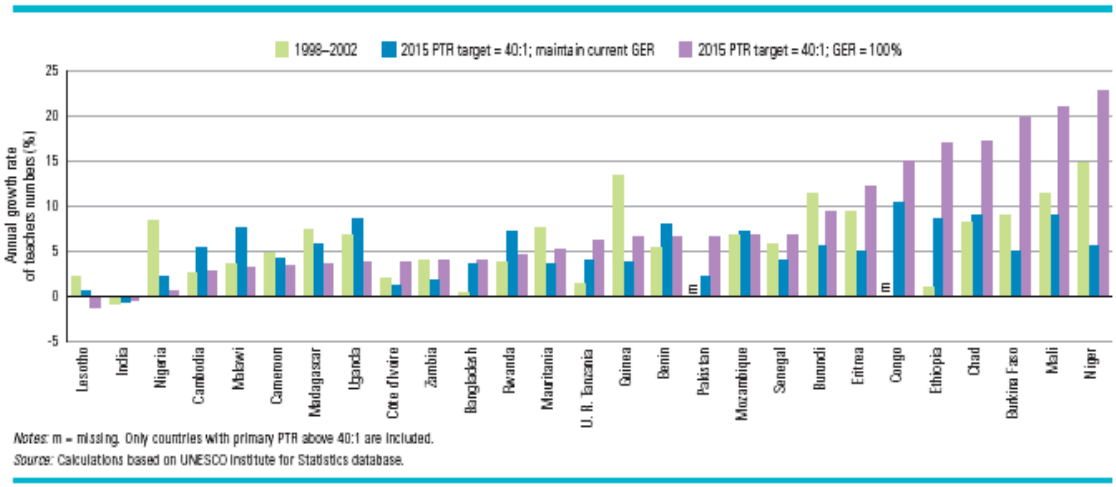


Figure 3.1: Current and projected annual growth rates of teacher numbers, 1998-2002 and 2015 (Source: UNESCO 2005- EFA Global Monitoring Report 2006)

The EFA Global Monitoring Reports (2005, 2006) also indicate that large proportions of primary school teachers (in most developing countries) lack adequate academic qualifications, training and mastery of content. New data from the 2006 EFA report indicate that in only 25% of the approximately 100 developing countries with data available in 2002, all or almost all primary teachers received at least some pedagogical training. Furthermore, more than 20% of primary school teachers lack training in more than half the countries in Sub-Saharan Africa.

However as figure 3.1 above shows, some countries have made efforts to improve the teacher-training situation. For example Niger in order to meet the increased demand for primary education and keep costs sustainable, hired large numbers of volunteer teachers without pre-service training, and then provided them with in-service training to upgrade their qualifications. Mozambique adapted a policy of

simultaneously lowering the minimum required primary teacher-training standards from nine to seven years of schooling and introduced an accelerated teacher-training programme thereby increasing the proportion of trained teachers from 33% to 60%. Rwanda increased (without lowering standards) its proportion of trained teachers from 49% to 81% by reorganising teacher-training institutions, opening new teacher-training colleges and subsiding two church-based training institutions which together educate 1,500 new primary teachers per year. This is still insufficient, however, as concurrently the primary PTR grew from 54:1 to 60:1 (UNESCO 2005 - EFA Monitoring Report 2006).

	Primary net enrolment ratio (%)		Education expenditure as a % of GNP		Education expenditure as a % of government budget		Primary pupil/teacher ratio	
	1998	2002	1998	2002	1998	2002	1998	2002
Niger	26	38	m	m	12.9	15.9	41:01	42:01
Ethiopia	36	47	4.3	4.6*	13.8**	m	46:01	65:01
Guinea	45	66	1.8	1.9	25.8	25.6**	47:01	45:01
U. R. Tanzania	46	68	3.0	m	21.1***	24.4***	38:01	53:01
Lesotho	65	86	10.2	8.4	25.5	18.4	44:01	47:01
Madagascar	65	79	1.9	2.9	10.2	m	47:01	52:01

Notes: m = missing; * = 2001, ** = 2000, *** = World Bank data.
Sources: Statistical annex, Tables 5, 10A and 11; World Bank database (2004).

Table 3.2: Primary net enrolment ratios, education expenditure and teachers, 1998 and 2002 (source: UNESCO 2005- EFA Global Monitoring Report 2006)

Judging from table 3.2 above, countries in Sub-Saharan Africa face particular challenges if they are to achieve the goal of Universal Basic Education by 2015. Over 40 million children of primary school-age are without any experience of school and the numbers are growing. Four out of every ten primary-age children in Sub-Saharan Africa do not go to school (UNESCO 2001); and of those who do, only a small proportion reach a basic level of skills. The number of primary school-age children in the region grew from over 82 million in 1990 to 106 by 2000 and is projected to rise to 139 million by 2015 (UNESCO 2000b). Setting these statistics against those of the existing teaching force, burdened by poor qualification and the HIV/AIDS pandemic, the situation of education in most Sub-Saharan African countries is alarming and Africa's prospects of achieving the EFA goals by 2015 look dim.

Reports show that despite support by ministries of education and international organisation (e.g. World Bank; UNESCO, DFID), policy development in relation to

teacher education in Sub-Saharan Africa remains weak. Demands and needs far outstrip the present "production" of teachers which is still largely provided by conventional teacher institutions. Thus projects like DEEP urge for school-based models of teacher education to complement existing provision offered by the bricks and mortar teacher training institutions. UNESCO's World Summit on the Information Society December 2003 observed that "ICT now offers the capacity to reduce many traditional obstacles, especially those of time and distance, and for the first time in history makes it possible to use the potential of these technologies for the benefit of millions of people in all corners of the world...."(WSIS December 2003).

According to the Education for All Global Monitoring Report 2006 statistics, the share of government expenditure devoted to education ranges from about 10% to 30% (figure 3.2). However, while government expenditures on education in high income countries in North America and Western Europe rarely reach 15%, more than half of the countries in sub-Saharan Africa, with data available, surpass this level. Education accounts for one-quarter or more of total government budget in Botswana, Guinea, Mexico, Morocco, for example. Thus, while some countries like Botswana and Guinea, allocate a small proportion of their GNP to education, they give high priority to it in their government budget (UNESCO 2005).

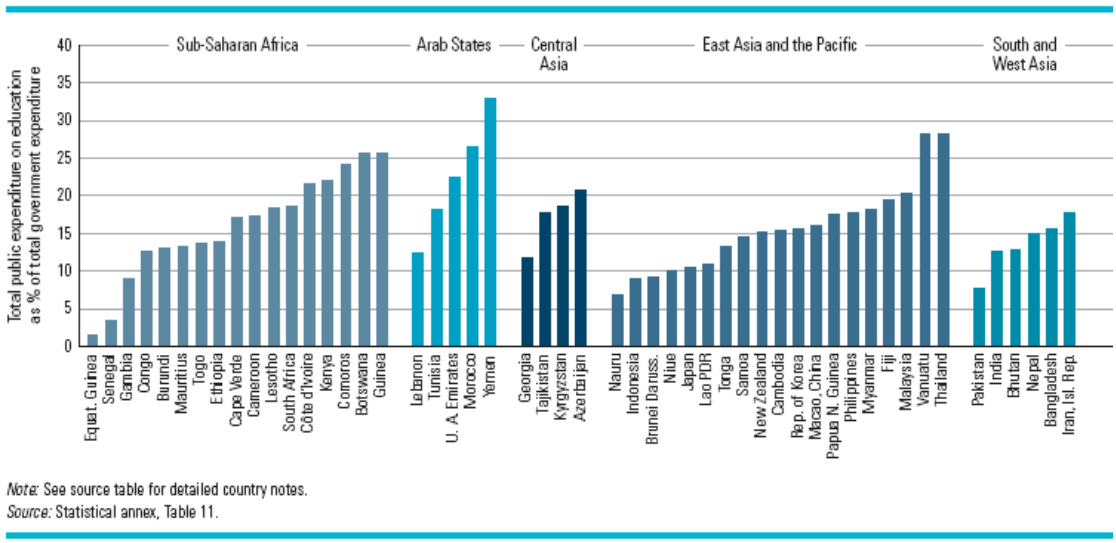


Figure 3.2: Public expenditure on education as percentage of total government expenditure, 2002 (source: UNESCO 2005- EFA Global Monitoring Report 2006)

Low income countries further face the problem of misallocation of the meagre resources. The report indicated measures taken by some governments to solve the

problem of misallocation of funds. Such is the case of Uganda which through mass information managed to reduce the amount of money wasted in a public programme on improving primary education; as a result, misuse of funds was reduced from 78% in 1995 to 18% in 2001 (UNESCO 2005 – EFA Report 2006).

To improve the quality of ICT-enhanced school-based teacher education in developing countries, the report issues the following suggestions:

- ICT should be appropriate to local setting and conditions;
- opportunity to integrate ICT activity into daily routines and practices;
- use of ICT-supported peer and team learning;
- focus on ICT for curriculum and classroom purposes, not ICT skills;
- availability of relevant content in appropriate language medium;
- provision of local, national and international professional e-networks;
- assessment practices relevant to ICT-enhanced learning;
- user evaluation of the relevance of ICT hardware, software and related curriculum uses for learning;
- strong vision of the potential of ICT for learning from national ministries and educational policy makers;
- visible political determination for a plan for ICT access by schools and their communities, ensuring synergy across and between adjacent services (e.g. education, healthcare, agriculture);
- research and development that strengthen exemplification of the way ICT can be effectively used by teachers and students.

4. ICT in Education in Africa

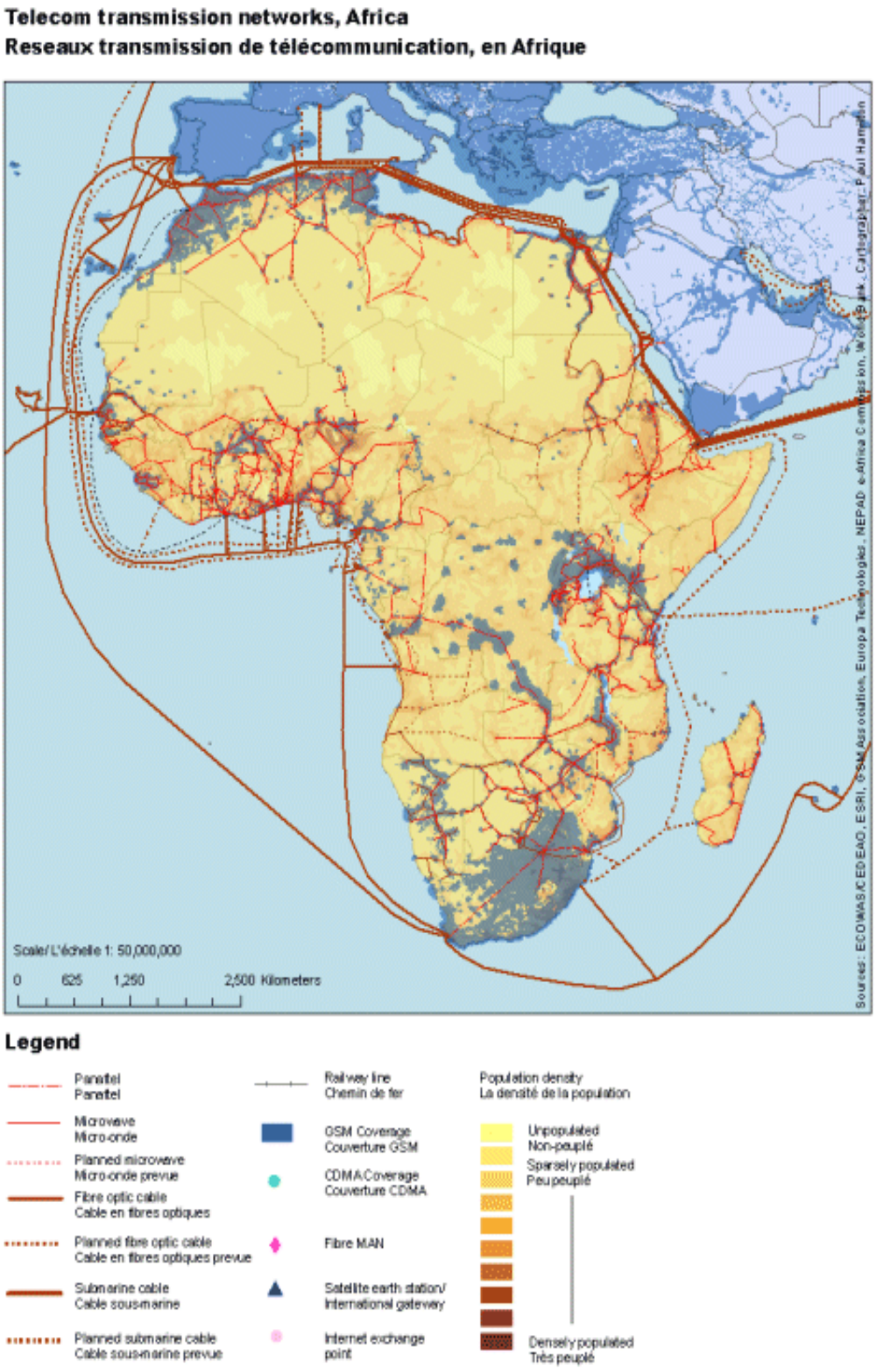


Figure 4.1: Fibre infrastructure and future plans. (*Source: Paul Hamilton, Acacia Atlas, IDRC* http://www.fibreforafrica.net/index.shtml)

Technology, such as radio and TV is not new to education in Africa however, the new Information and Communication Technologies offer new types of teaching and learning experiences. Being interactive, the new technologies create environments in which students can learn by doing, receive feedback, and continually refine their understanding and build new knowledge. "The new technology allows wealth producing activities to be undertaken in ever quick and cheaper ways but so far the benefits of this accrue to a privileged few, and so increasing the gap between rich and poor and at an increasing rate. This has become known as the digital divide....' (T)he digital divide compounds existing inequalities between people within and between countries and the disparities in access are not random but correlate strongly with income, education, ethnic origin, location and gender'" (Perraton & Creed 2000 p.15).

ICTs are currently being used widely to aid education in many developing countries and it appears that there is increasing demand for their use in education by policy makers and parents. In his study on "*Computers in secondary school in developing countries: costs and other issues*", Cawthera remarks that increasing computer usage could be the way to reduce costs. He notes that parents, students and teachers want ICT in schools and are prepared to pay for this and work for it, however, provision for training in the use of computers is very low and there is little integration of ICT in the curriculum. There is need to build on and complement this desire in ways that will enhance training and therefore skills, time and contacts are needed in order to harness provision at the basic level (Cawthera 2001).

Much as there is a lot of encouragement and demand to use ICT in education in Africa, and despite the fact that a number of attempts have been made to bridge the digital divide at various levels across many sectors, Africa remains encumbered by structural factors inherent in the system. These include the lack of infrastructure, the exorbitant cost of bandwidth, the economic foreign levels of debts and reduced government spending on public goods sectors like education, health and infrastructural development (Cawthera 2001).

Furthermore, given the fact that there are enormous contextual, cultural and sociological differences within the African continent, language and cultural

differences, localised contexts and access to resources, it means ICT education will be affected by these. There are also enormous differences in teaching requirements within the group of the educators (subject focus, age group of students) and differences in levels of formal training, both in teaching and ICT skills. As such, the target market of African educators is enormously broad and a strategy to develop African teacher capabilities in ICT cannot be so generalized as to ignore the different requirements of different sub sectors within target groups (Cawthera 2001).

For example, use of local languages and cultural references needs to be considered. Whereas operating systems and basic software are available in all major world languages, very few are produced in Africa. From a language perspective, although this may not cause a problem in large African cities where English, French, Portuguese or Arabic are spoken, it would be a problem in rural areas where exposure to these languages is likely to be lower (SchoolNet Africa 2004).

Teacher training is likely to change in its forms and methods, partly as a result of ICT. The flexibility of ICT-based learning will lead more and more teachers in training to exercise flexibility in their courses and course provision. The traditional institutions might no longer be the obvious and automatic choice for their planning. Students may be able to choose from on-line generic and specialized courses from around the world. The only constraint will be accreditation, forcing the trainee teachers to fulfill some local requirements for teaching certification (SchoolNet Africa 2004).

In implementing ICTs in education in Africa, one has to note that from a context perspective, products from the developed world might include examples that are not culturally relevant in either a rural or urban African context, and this might cause confusion and reduce the courses' impact on the African learner. For example the Intel “teach to the future” program was developed in U.S.A. A detailed process of adapting the materials to African context was undertaken particularly in South Africa, yet during the evaluation educators remarked that more African examples would have been helpful, as they did not always find the US example relevant (Cawthera 2001).

However, there are technological developments that offer promising new opportunities. For example, use of satellites to transmit digital network data can allow countries with poor telephone infrastructures to leapfrog the need to update those infrastructures before Internet access can improve. All the benefits of web technology can be available via local area networks (Intranets) where institutional access to the external web is a problem for financial, cultural or quality control reasons. However, these developments are unlikely to massively increase access in the short term in many contexts because of basic resource limitations.

Due to the meagre available resources in African countries and because of the high costs of ICT training and equipment , policy-makers at the school level need to decide at the start of any planned investment whether the purpose is: (a) to develop students' ICT skills such as word-processing or using spreadsheets – in which case, ICT specialists can be employed, or (b) to use ICTs to achieve more effective teaching in schools, such as music or art and design software, data logging in science and geography or using digital cameras in technology classes to record each stage of design and development. In this case subject teachers will have to acquire ICT skills or ensure that pupils are enabled to use the technology through other support (Leask 2003).

4.1. Internet in African universities

The benefits of the Internet in African universities cannot be over emphasised. The Internet enables information exchange in regions where interaction at higher levels of learning is scarce. Scarcity of textbooks and poorly equipped libraries and laboratories usually delays research "(M)any graduate students have in the past abandoned their thesis or research projects on the grounds of inadequate materials or shortage of faculty supervisors" (Kwabena 1997). Thus Internet in Africa is seen as a solution to getting up-to-date learning resources and references.

One of the biggest challenges to Internet use and ICT in general is networking with African universities and formulating strategies capable of strengthening them to chart new ways of collecting and disseminating information. African universities through

partnerships with universities from the West were provided with university and library websites. Mbarara University of Technology and Science of Uganda, for example, designed a website in "cooperation" with the Universities of Bergen and Wisconsin. The situation today is such that most institutions have e-mail but many are unable to provide meaningful Internet access. The Association of African Universities (AAU) research in 1998 found that 52 of the 232 academic and research institutions had full Internet connectivity while 180 had access that was not adequate (www.aau.org).

4.2. Women education and ICT use

Although there is hardly any gender-related statistics in this field, there is evidence in Europe and North America that "targeted programmes to increase the number of female students in tertiary level computer courses do have a positive effect on women's participation in the courses involved" (Derbyshire 2003). However, in Africa where the overall technology use faces great constraints, there is "no information on overall trends in women's participation in tertiary level computer courses" (Derbyshire 2003). This chapter will try to highlight on efforts being initiated in this field.

A research carried out in Francophone Africa in 2004-05 on "*Gender Digital Divide in Francophone Africa: data and indicators*", found evidence of gender digital divide. Research in six countries in the study (Benin; Burkina Faso; Cameroon; Mali; Mauritania and Senegal) revealed that "women have one-third less chance than men to benefit from the expected advantages of the African information society" (Mottin-Sylla 2005 p. 61). It is argued that without specific provisions and measures, there is a high risk of duplicating the gender inequalities (against women) observed in other areas and sectors during the process of ICT appropriation and the introduction of innovations. Gender digital divide refers to gender disparities in terms of access, control and content of information and communications technologies (ICTs), as well as the necessary capacities to use them (Mottin-Sylla 2005). In the study, the composite indicator of the gender digital divide was calculated as an average of its four components: control, content, capacities, and connectivity and its overall value

proved “that currently women had 35% less opportunities than men to benefit from the African information society” (p. 41). With regard to control, content and capacities: women had only a third of the opportunities available to men. Whereas in terms of connectivity i.e. access (physical) and accessibility (social), the disparities were real but less significant. Findings showed that gender inequalities seem less significant in the rural areas than in the urban and peri-urban areas. Gender inequalities were also lower among the youth than amongst adults and the elderly; and lower amongst those who had received schooling (secondary and higher) than among those who received little or no schooling.

Findings from the Imfundo 2003 report on gender disparities indicated that even in major universities in Sub-Saharan Africa (except South Africa), access to computers and the Internet was very limited (Derbyshire 2003). However, there was indication that distance learning was a particularly woman-friendly form of education as it required little or no attendance, and when combined with a high degree of flexibility in learning schedules, distance learning appeared to enable mature women to pursue an education at the same time as raising a family and/or working.

Research findings further indicated that there was a major and significant evidence of gender disparity in Africa with regard to access to education. In Sub-Saharan Africa a gender gap exists in education that increases in severity with each level of education. In Africa, children who do not attend school (the majority of whom are girls) are deprived of opportunities to acquire the levels of literacy and confidence that might enable them to access and use ICTs in a non-school context. With regard to access to specialist computer education, results showed that globally girls' enrolment and achievement in science and technology courses at school and tertiary level is lower than that of boys. Although African girls have the lowest rates of participation in the world, it is the same pattern in Europe and North America where number of girls choosing to study computing at tertiary level is considerably lower than number of boys. Evidence on access to computers in schools and colleges indicated that when computers are shared amongst a large number of school students without any regulation (which was the case in Africa), boys tended to dominate access, tended to be quicker and more confident in gaining access to computers and

more assertive in maintaining access. Thus there is a need to develop, implement and monitor Fair Use policies to ensure equitable access to computers (Derbyshire 2003).

However, with regard to access to education through open and distance learning, findings showed that education opportunities through open and distance learning (largely print media, radio and face-to-face meetings) are one of the few educational areas in Africa where women are currently well represented. Distance learning is often seen as a particularly woman friendly form of education as "home based study in combination with flexible learning schedules" mean that women (most often) can undertake study at the same time caring for a family and work. However, the authors noted that if there is a critical difference in access to computers, as is often the case in Africa where study centre or public access computer facilities seem likely to provide the only option for most distance learning students, this appears to compromise the two aspects of open and distance learning that are viewed as attractive to women i.e. little or no attendance requirement and flexible learning schedules.

The above research further indicated that from all contexts men and boys tended to have more confidence in using computers than women and girls, however, as Mottin-Sylla's 2003 study also indicated, there was some indication that in younger age groups this difference was less significant than in older age groups. At school level, boys were often observed to be more active in computer-related discussions, made more spontaneous comments, and were asked more questions by teachers. Likewise, at tertiary level women seemed to have less computer experience and less confidence at the start of courses than male students.

Research in Europe indicates that prior experience of word-processing and data entry work (which is often more common amongst women), does not appear to "count" as experience or build confidence in the same way as prior experience with computer games (most common among men). Research in this context suggests that women's and girls' lower confidence derives from the way in which computing has come to be defined as a male "technical" skill. Women are usually described as being outside the technology culture and are therefore considered to be less competent in this field. However, there is little evidence that women and girls' lower confidence reflects

lower ability or achievement. Thus lack of confidence and anxiety amongst all female age groups concerning the use of computers may be overcome through appropriate tuition and support. On role of teachers/tutors, further evidence from Europe and North America indicates that some teachers assume that boys will have more aptitude for computing, offer boys more encouragement and expect less of girls. Studies have also found male teachers to be more self-confident in using computer technology and female teachers to rate their skills lower on a self-assessment scale. Also, there are fewer female role models for girls as male teachers of information technology greatly outnumber female teachers and technicians. As far as learning styles are concerned, evidence shows that women and girls often prefer to work in collaboration, as opposed to competitive or individual tasks. Female distance learning students have shown more interest than their male counterparts in support and connectedness in dealings with other students and academic staff. There is, however, hardly any research on the gender digital divide in OECD countries and none in Africa.

With regard to the *impact of technology*, a study from Africa on computers in schools (Mar Gadio 2001 in Bloome 2002) concluded that girls benefited more than boys because of a more academic focus to their use of the Internet. The Internet has a positive impact on girls' self-esteem because of the ways in which it opens up to them information and insights not available in other ways.

The Education for all Global Monitoring Report 2006 indicates that globally, women predominate among teachers, their proportion being highest in pre-primary education and somewhat lower at the primary and secondary levels. However, in general the proportion of women teachers is lowest in Sub-Saharan Africa where men outnumber women teachers at both primary and secondary levels. For instance in Benin, Chad and Togo, less than 20 % of primary teachers are women and often in Sub-Saharan Africa less than 20 % of all secondary teachers are women. Female teachers are fewest in countries where overall enrolment levels are lowest and gender disparities in favour of boys are highest. Gender disparities persist in primary school participation and at higher levels of education, and women's share of the teaching force is particularly low in tertiary education where teaching is predominantly a male occupation as figures 4.2 and 4.3 below indicate (UNESCO 2006-EFA 2007):

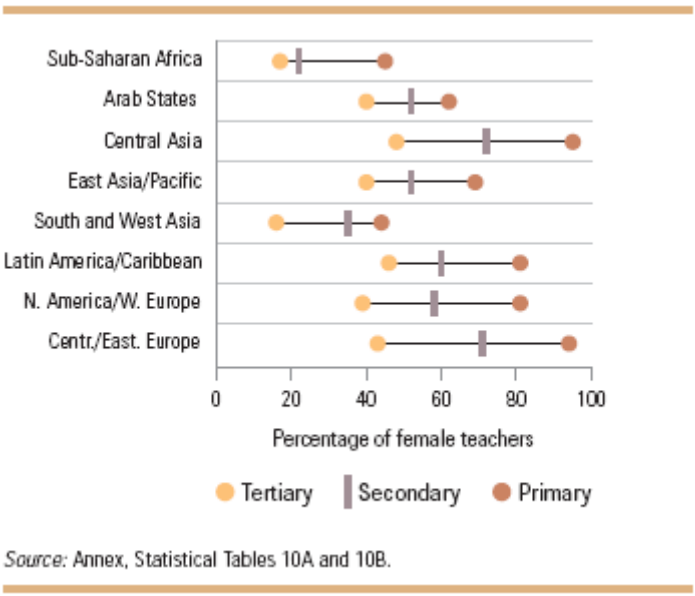


Figure 4.2: Percentage of female teachers in primary, secondary and tertiary education, regional medians 2004 (source UNESCO 2006 – EFA Global Monitoring Report 2007)

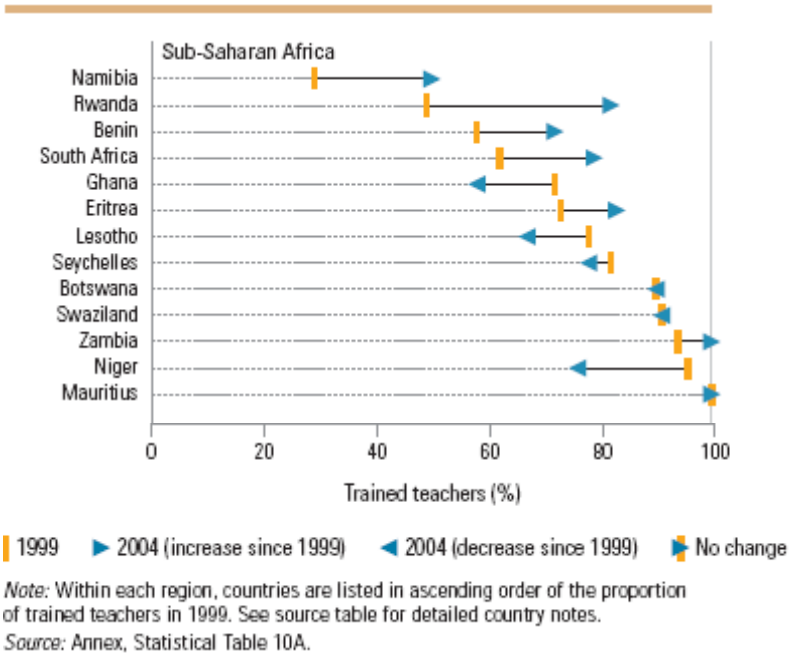


Figure 4.3: Changes in percentage of trained primary teachers between 1999 and 2004 (source: UNESCO 2006 – EFA Global Monitoring Report 2007)

It is argued that ICTs could have a significant influence on gender empowerment and would reduce gender disparity especially in Africa's education (Van Ark et al. 2002 in Obayelu & Ogunlade 2006). There is evidence that on the African continent women still lag behind men in utilising ICTs, although efforts are being made to narrow this gap. In Northern Africa, during the past twenty years, women's education attainment levels have risen significantly due to modernization, investment

by the state in education, and political reforms. Girls' enrollment in primary and secondary education, in North Africa, is close to female education in other regions of Africa, but many countries (i.e. Northern Africa) still have comparatively low female primary and secondary enrollment. Female and male literacy rates in Northern Africa indicate that achieving basic literacy is still a struggle for both men and women. Yet, gender gaps are evident, particularly in Algeria, Morocco, Egypt and Tunisia. Little gender data are available on Internet use for specific countries in Northern Africa. However, women's current participation in ICT is presumed to be low. ICT use is growing in the region, but currently few users exist (Moghadam 1998).

In Sub-Saharan Africa women are marginalized in education and in the use of ICT. Women have the smallest chance for education, and those who receive it are generally from the more privileged families. Of those few women who do go to the University, math and computer science majors are at 20% of the total. Women currently constitute about 43% of the labor force, yet many women work in the informal labor markets as either non-paid employees or self-employed. However, many women's groups and organizations are fighting for equality in education and ICT access. An example is Uganda's WOUGNET (Women of Uganda network) which was initiated by several women organisations to develop the use of ICTs as tools to share information and address issues collectively (http://www.wougnet.org/).

South Africa has the highest levels of female education at all stages as well as a much larger percentage of women participating in the economy (40%) and in the political arena (30%). In South Africa female enrollment in primary and secondary schools is now at 99% as of 1996 compared with 95% for males. However, women's access to tertiary education is at about 7%; which figure denotes slightly less than half of the total enrollees (Nua Surveys 2000). Women in South Africa are positioned relatively well to take leadership roles in the Internet economy, at least compared with women in other African countries. Statistics have indicated that women in South Africa constitute 51 % of all Internet users in the country; this proportion is higher than in all other African countries (United Nations 2000). Within this context more women in South Africa are under-represented in the ICT work place, mirroring the current reality for women across the globe. However, it should be noted that in South Africa, the lower representation of women in certain

high technical jobs has as much to do with race as it does with gender. Whites clearly dominate ICT jobs in all categories and males within that group have the advantage.

There is, therefore, the need for greater concentration on the use of ICT for gender empowerment in Africa. In response to this need, the United Nations Millennium Declaration 2000 resolved to ensure that globalisation becomes a positive force for all the world's people and to promote gender equality and empowerment of women as effective ways to combat poverty, hunger and disease, and to stimulate development that is truly sustainable. It further resolved to ensure that the benefits of new technologies, especially ICTs, are available to all women (World Bank 2003). ICTs can provide options for women to overcome illiteracy. ICT create opportunities for entrepreneurship which enable women to work from home and care for their families, thereby enhancing and enriching their quality of life (Wyatt & Henwood 2000).

4.3 ICT in HIV/AIDS Education

In many countries of Sub-Saharan Africa, the AIDS epidemic has spread to the general population, with up to half of all new HIV infections occurring among youth under age 25 (YouthNet 2004). It is suggested that since most youth attend school at least for primary education, school-based programs are a logical place to reach young people. Therefore understanding the importance and technique of teacher training in sexuality education in Africa is particularly urgent (YouthNet 2004). The 2001 UN General Assembly Special Session on AIDS sought to ensure that by 2005, at least 90% of the world's youth have access to information and education necessary to reduce their vulnerability to AIDS. Teachers are a crucial link in providing valuable information about reproductive health and HIV/AIDS to youth. But to do so effectively, they need to understand the subject, acquire good teaching techniques, and understand what is developmentally and culturally appropriate. Teacher attitudes and experiences affect their comfort with, and capacity to teach about, reproductive health and HIV/AIDS. The pre-service setting offers an opportunity for future teachers to explore their own beliefs and concerns about these topics, while in-service training allows those already teaching to assess their views and increase their competence and confidence (YouthNet 2004).

Teachers are often the main adults other than family members with whom young people interact on a daily basis and in this era of HIV/AIDS, teachers play an even more critical role of being a source of accurate information and a person with whom young people can raise sensitive and complicated issues about sexuality. Teachers are the gatekeepers of information; they can thus be instrumental in imparting knowledge and skills to young people. Teachers can function as role models, advocates for healthy school environments, guides for students in need of services, resources of accurate information, mentors, and effective instructors. However, to meet these expectations in the AIDS era, teachers need skills and knowledge as well as support from the educational system and the broader community. Research has shown that teacher training when incorporated into a broader school district intervention can influence students' behaviours. For instance a survey from a project in Soroti district in Uganda, which included teacher training on RH/HIV (reproductive health and HIV) in the existing structures of the school district, using a health educator, showed that after two years, students (aged 13 to 14) whose teachers had received the training reported a significant decline both in having sexual intercourse in the past month and in the average number of sexual partners, while the control group did not have similar reductions. Thus "to have an impact on behaviour, the quality of delivery of the curriculum and (teaching) strategies must be of sufficient quality and intensity" (YouthNet 2004).

Acute shortage of qualified teachers has been identified as one of the biggest challenges to achieving the EFA objectives (UNESCO 2006). With approximately four million more teachers needed in Sub-Saharan Africa to meet the UPE goal by 2015 and thousands still dying of HIV/AIDS, there is a need not only to improve in-service and pre-service teacher training, but also to provide for new teaching skills to tackle the HIV/AIDS problem.

According to the UNESCO-IICBA, the situation of teachers in Africa is "devastated by the effect of HIV/AIDS…" whereby "countries like Botswana, Malawi, Tanzania, Uganda, and Zimbabwe are witnessing high mortality rates among their younger teachers [and] regular absenteeism due to secondary illnesses, care giving for friends and families" (UNESCO-IICBA 2006 p.3). This dramatically contributes to the crisis

of teacher supply in these countries. As statistics in table 4.1 indicate, in the best-case scenario, Kenya, Tanzania and Zambia would each lose 600 teachers to AIDS while in the worst-case scenario these countries would each lose 1,500 to 3,000 teachers to AIDS in 2005 alone (UNESCO 2005 – EFA 2006). Thus Africa needs to invest in teacher training designed to prepare new teachers as well as upgrade and equip in-service teachers with new skills. ICTs are widely seen as having the potential of providing training to a large population of teachers both cost- and time-effectively.

	Eritrea			Kenya			Mozambique			U. R. Tanzania			Zambia		
	medium	low	high	medium	low	high	medium	low	high	medium	low	high	medium	low	high
Total teacher mortalities due to AIDS	35	7.0	130	1 620	700	3 020	675	340	1 150	1 290	605	2 010	1 030	580	1 500
% total attrition	12.4	2.1	30.9	18.0	7.5	29.6	33.2	16.6	43.1	19.9	9.3	31.0	40.4	23.3	48.8
Annual teacher mortality due to AIDS	0.3	0.07	1.5	0.8	0.4	1.8	1.4	0.7	2.3	1.1	0.5	1.9	2.1	1.2	3.1
Teacher-years of absenteeism due to AIDS	37	7	130	1 590	690	2 930	730	370	1 240	1 290	610	2 200	1 090	605	1 580
% of total teacher-years	0.4	0.1	1.5	0.8	0.4	1.8	1.5	0.8	2.9	1.1	0.5	2.3	2.2	1.3	3.9

Table 4.1: Impact of HIV/AIDS on education in five Sub-Saharan countries, 2005 (source: UNESCO 2005 – EFA Global Monitoring Report 2006)

It is assumed to be easier and more cost effective to develop ICT learning materials for HIV/AIDS preventive education in local language which would enable dissemination in the communities and across boarders. The Internet provides a platform for communication and information sharing for groups of people with a particular interest, and enhances access to HIV/AIDS information. It is assumed that ICT networks in public health and education would improve communication and dissemination thereby creating awareness and facilitating prevention of the epidemic (Unescap 2005).

Since 2000 the World Links program in collaboration, with its other sister initiatives WorLD and World Links 501, has been exploring the impact of using ICT for HIV/AIDS education (Bloome 2002). World Links works with teachers and students and their surrounding communities by exploring issues of HIV/AIDS prevention and care through using the Internet, email and CD-ROMs. Participants in the project work through five modules (Cultural exchange, Basic facts of HIV/AIDS, the Importance of HIV/AIDS, the Challenge of HIV prevention, and Social action). Students and teachers explore myths and misunderstandings, conduct research,

discuss how HIV can be prevented in their lives and communities, as well as working with parent-teacher associations. Sources of education material include existing on-line material provided by UNAIDS, CDC and WHO. Efforts are also made to adapt high-quality and locally produced print-based HIV/AIDS material for electronic dissemination via CD-ROM and the Internet. However, although these projects have turned out to be successful in their time, they are pilot projects with a limited duration. Once they terminate, funding stops and they tend to stagnate. Furthermore, rural areas remain outside such funding due to high costs in connectivity (Bloome 2002).

The Education International organisation (EI) calls for major changes in the fight against HIV/AIDS through education, which should include the inclusion of teachers' unions in policy making and the mapping out of the HIV and AIDS training programmes, immediate institutionalisation of long term and wide scale pre- and in-service training on HIV/AIDS for the teaching community and focusing pre- and in-service training on life skills. "(F)or if the teacher in the classroom is the ultimate agent for change... teachers need tools to do their job properly and with self confidence" (Education International 2006 p. 2). In their 2005 survey on 'HIV and AIDS Prevention through School Programmes' in eight countries in Africa (Kenya, Uganda, Tanzania, Malawi, Guinea, Burkina Faso, Cote d'Ivoire and Namibia), with focus on the positioning of HIV and AIDS within pre-service and in-service teachers, the EI found out that there was very limited or no in-service training. In January 2006, a new programme for HIV/AIDS education was initiated by the Education International, the WHO and the Education Development Center with the aim of fusing the HIV/AIDS Prevention Programme and the EFA Programme. The new programme (EFAIDS) aimed at combining EFA-related efforts and the need to move HIV prevention beyond grass-root training into areas such as advocacy and research. In other words, the need to combine the efforts of teachers' unions in advocating for Education for All at national level with their commitment to HIV/AIDS prevention in school locally was realised in EFAIDS (Education International 2006). As the EI research showed, even in countries with a long experience in HIV/AIDS education like Uganda, HIV/AIDS is not incorporated in the school curricula except for some scientific definition.

5. ICT-based teacher education in Sub-Saharan Africa

While it is globally acknowledged that ICTs have produced rapid changes in all fields and in all societies in the last ten years, there is probably no comparison as to how their effect has caused fundamental change in the education field in Africa. African institutions have over-night found themselves in a global academic arena where teachers and students are in partnerships with international institutions, in on-line discussions and research programs. Educational institutions have had to undergo a rapid adjustment from being the classical conservative bodies to being trendy, modern and up-to-date. Perhaps nowhere else has this adjustment been more rapid than in the teacher education sector. Teacher education institutions globally are faced with the challenge of not lagging behind in "the swirl of technological change" (UNESCO 1998).

According to the NEPAD's (New Partnership for African Development) eSchool Initiative and Teacher Development programme, all high school graduates in Africa should be fully computer literate in the next five years, while primary school leavers should be computer literate in the next 10 years (NEPAD 2003). Presently, NEPAD is in the process of connecting 600 000 schools in Africa via a satellite network (NEPAD 2003). It is no wonder then that with such goals and expectations, there is a great need not only for qualified teachers in ICT skills but also to meet this demand in numbers.

However, as Byron and Gagliardi (1998) while all countries in the world have been affected by the influence of ICTs in various domains of daily life, it continues to be a very uneven "revolution" widening the disparities existing between the industrialized countries of the North and the South. In the poorest parts of the developing world, the means of obtaining, processing and disseminating information may remain very dependent on more traditional methods in the absence of the most basic infrastructure and devices for utilizing the "new technologies".

In many African countries, ICTs are still in the early stages of development, in education, commerce, industry and particularly in society. Communities and regions in Africa in general have very limited resources in terms of computer facilities. Most

of these facilities are located in higher institutions and even so, they are very limited. Thus, there is a great need to develop an organic strategy for the growth and development of education and teacher-education that takes advantages of ICTs. As the SchoolNet Africa report notes, the vision is not simply of ICTs, but of better education facilitated through the adoption and promotion of ICTs (SchoolNet Africa 2004).

Several developments in teacher education in Africa have taken steps in promoting use of ICT. In October 1999, UNESCO established the International Institute for Capacity Building in Africa (IICBA) with the major aim of promoting capacity building in teacher education in Africa. IICBA is working mainly with teachers' colleges and faculties of education to improve the quality of teacher education in Africa through distance education degree courses and short targeted courses. Through negotiated agreements at country level, teachers' colleges and faculties of education participate in these programmes. Presently degree programmes are operational in Cameroon, Ghana, Liberia, Ethiopia, Madagascar, and Sudan (www.unesco-iicba.org). Distance education degree programmes offered through this program include:

- The Post-graduate Diploma in Distance Education (PGDDE) of the Indira Gandhi National Open University (IGNOU);
- The Master of Art in Distance Education (MADE) of the Indira Gandhi National Open University;
- The Postgraduate Micro-programme in Education of Montreal University (in French);
- The M. Ed. (with special emphasis on ICTs) of Montreal University (in French);
- The M. Ed. in Critical Practitioner Inquiry Methodology of Umea University, Sweden;
- The Advanced Certificate in Educational Management (ACEM) of the University of South Africa (UNISA);
- The M. Ed. Teaching of Mathematics of the University of South Africa (UNISA);
- The M.Ed. ICTs for the Sudan University of Science and Technology from University of Pretoria (UP).
- The MEd in Teaching Math and Science (Skylight) of Addis Ababa University (AAFU)

- The BEd in Education of the University of South Africa (UNISA)
- The BInf in Library Science and Information of the University of South Africa (UNISA)

In addition to the above, the IICBA has developed a Teacher Education Network (TEN) to facilitate the sharing of experiences, research and development of new knowledge and skills among African teacher education institutions. Through cooperation of Ministries of Education in Africa, the Commonwealth Secretariat, UNESCO, SIDA, and GTZ, a Network was created which aimed at supporting African education institutions in employing modern curricula, teaching methods, and information and communication technologies. The mission was to be accomplished through the achievement of the following objectives:

1. Link teacher education institutions Africa wide to each other and to key institutions internationally.
2. Establish an electronic and paper library in the form of core texts, CD-ROMs and the Internet.
3. Update curricula in primary and secondary teacher education institutions in Africa.
4. Improve mathematics, science, technology and language teaching among teacher educators and their students.
5. Network with teachers' associations in Africa with the objectives of ensuring that these associations focus on the improvement of the quality of teaching-learning processes.

Recently, the UNESCO launched a new high-priority Initiative on Teacher Training in Sub-Saharan Africa (TTISSA) for the period 2006-2015. The initiative aims at improving the quality and teacher training capacities in 46 Sub-Saharan countries. So far 17 countries are participating in the first four-year cycle of the initiative as initial reference countries and these include: Angola, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Madagascar, Niger, Nigeria, Sierra Leone, United Republic of Tanzania, and Zambia. TTISSA is supposed to link and create synergies from the other core initiatives: the Literacy Initiative for Empowerment (LIFE) and the Global Initiative on Education and HIV and AIDS (EDUCAIDS) (UNESCO 2006).

Despite these initiatives, extensive searches and enquiries carried out by the SchoolNet Africa show that “very few African teacher training institutions appear to be offering pre-service ICT training” (SchoolNet Africa 2004). There is a need for both in-service and pre-service training of teachers in ICT skills which does not only concentrate on the technical skills (computer skills) but also - and more importantly - on pedagogical skills.

5.1. Teacher training and ICT use

Larose et al. (1999) argue that regardless of the quality of ICT equipment available to teachers in the school environment and independently of the quantities of courses which they have taken during undergraduate studies, the level of transfer of acquired competencies and learning to practice is very weak. Larose et al. maintain that in teacher training, the major impact of education remains at the level of the “private” use of these technologies and not in their integration into daily teaching practices (Ololube 2006).

Results of Ololube's study carried out in Nigerian teacher education institutions, indicate a statistically significant relationship between the lack of ICT integration and the poor standard of teacher education programs. Ololube notes that computer education introduced into the Nigerian secondary school system in 1988 has largely been unsuccessful as a result of teachers' incompetence. Other empirical studies (Yusuf 2005b in Ololube 2006) have recognised that teachers' lack of ability and willingness to use ICT and integrate it into their teaching is largely caused by the poor quality of professional ICT development they receive. The fact that teachers trained through these programs are not well equipped technologically to carry out their duties effectively is due to the fact that the existing curriculum designed for training of pre-service teachers in Nigeria does not include the practical usage of ICT materials such as computers and their software. Students hardly come in contact with ICT instructional materials (Ololube 2006).

Jung (2005) looked at different efforts around the world of effective use of technology in teaching and learning and presented these in four categories. Jung suggests that 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 as a complementary means to the teacher training process (Collis & Jung 2003 in Jung 2005). In using ICT as main content focus of teacher training, the HOW to use ICT category is the most popular and was used in early ICT teacher training programmes in the 1990s. This approach addresses issues such as selecting appropriate ICT tools and supporting students in the use of these tools, employing ICT to promote learning activities, developing new methods of facilitating learning and evaluating student performance.

The second form is to use ICT as part of teaching methods; this approach integrates ICT into teacher training to facilitate some aspects of training. Jung cites two cases: *Captured Wisdom,* a resource developed in the U.S for k-12 teachers, school administrators and adult literacy educators. In this case, teachers are provided with examples of ICT-pedagogy integration in their training process i.e. “examples of real educators and learners using successful practices of technology to support instruction and learning in their classrooms”. Another example is SATIR, a bilingual Canadian initiative, which provides tools and resources to help school administrators successfully integrate ICT into the curriculum in their school. The project focuses mainly on the development of ICT-pedagogy integration skills of educators by sharing successful cases and practical ideas rather than on the basic skill development (Jung 2005 p. 96). UNICEF's “Teachers Talking About Learning” designed for international collaboration between teachers in developing countries using the Internet and television is also a good example of this form of ICT use in teacher training. Teachers Talking About Learning provides access to teacher training material and useful links and promotes discussions among teachers.

These three case examples employ ICT as part of training the methods and promote teachers' ICT-pedagogy integration in the classroom by demonstrating examples and allowing discussions among teachers throughout the whole training process. Participants are asked to use ICT to learn about ICT skills and develop ICT-

integrated pedagogies, thereby actively experiencing ICT skills as learners (Jung 2005).

The third form is applying ICT as core technology for delivering teacher training. Here ICT is used as the major way of providing the learning experience of teacher training. The content of this approach does not focus on ICT skills itself but rather covers a variety of ICT applications. A good example of this approach is the LearnLink project, supported by USAID and AED, which has implemented computer-mediated professional development programs to improve training and support services for teachers in developing countries. Among these are:

- culturally appropriate Mayan language instructional materials, and courseware to improve teachers' professional skills in Maya languages in Guatemala;
- computer-assisted teacher training courses and communications network to facilitate interaction among teacher trainees, teacher trainers and inspectors in Morocco and Namibia;
- the Connect-ED project in Uganda which focuses on multimedia-assisted teacher training and digital library resources;
- the US-Brazil Learning Technologies Network, which is an Internet-based learning environment and clearinghouse on the role of ICT in education and which promotes interactive collaboration between teachers in the two countries.

In the fourth form ICT is used to facilitate professional development and networking. Many Internet- and web-based communication technologies are being used to support teachers' on-going professional development and networking. These provide on-line resources for teachers and facilitate teachers' networking. In doing so, they enhance continuous professional development activities of teachers, connecting teachers to larger teaching communities and allowing for interaction with expert groups. Examples include the UK Virtual Teacher Centre, Korea's EduNet, the US Teachers Network, WorLD (World Links for Development), Schoolnet SA which provides support to educators and learners, Singapore's Clearinghouse, Swedish schoolnet and European schoolnet.

Jung observes that the best ways to develop teachers' ICT skills and promote ICT-pedagogy integration in their teaching is the provision of ICT-based training environments with on-demand access to materials, peers, and networks of experts where expertise and advices can be obtained and active discussion can take place in relation to technology or pedagogy. Although there are possibilities and challenges in adopting ICT in teacher training and professional development, teacher training approaches need to adopt cost-effective strategies as most nations have limited resources for teacher training and must make decisions based on cost-effectiveness. Suggestions drawn from experiences include: maximizing use of computer facilities in training centres, outside training hours, open computer labs for a fee e.g. the Connect-ED project in Uganda, standardise hardware and software and share web-based resources and training materials with other training institutions (Jung, 2005).

Support and investment is another important factor in ensuring successful adoption of ICT in teacher training and this can be achieved by providing a variety of both formal and informal teacher-trainer training systems so that trainers could take advantage of the methods which suit them best.

5.2. Research studies and initiatives in ICT in teacher education

In its report summary the Information for Development Program states that, despite evidence of increasingly widespread use of ICTs in education initiatives around the world, there is little guidance available for policy makers and donor staff specifically targeted at countries contemplating the use if ICTs to help countries meet the education-related MDGs. Furthermore that “despite rhetoric related to the ‘digital divide’, especially in Africa, scattered and typically uncoordinated initiatives utilising ICTs to benefit education throughout the continent, and interest in using ICTs to help meet the education-related MDGs, there is no consolidated documentation of what is actually happening in Africa in this area. In addition, there exists no comprehensive baseline data of the state of ICT use in education in Africa, against which future developments can be compared” (*Infodev* 2006 p.1)

The same source states: “Much relevant data collection has already occurred, but the results are scattered across a number of publications and databases (many of which are not widely known), held within individual organisations, not easily accessible to the education community, and/or, where public, not widely disseminated. Examples of useful resources in this area include the Imfundo KnowledgeBank, which is no longer on-line, and publications such as *Towards a Strategy on Developing African Teacher capabilities in the Use of Information and Communications Technology (ICT*), and *Mkusanyiko on School Networking*” (*InfoDev* 2006 p.1).

There are, however, some initiatives in the field of ICT in African education which are worth talking about, in particular those projects and organisations which are carrying out research studies in ICT in teacher education, such as SchoolNet, DEEP, Imfundo and UNESCO or did so in the past.

5.2.1. Initiatives and research studies

SchoolNet Africa

Created in 1999, SchoolNet Africa works with learners, teachers, policy makers and practitioners through country-based schoolnet organisations across Africa and aims to improve education access, quality and efficiency through the use of ICTs (SchoolNet Africa 2004). One of the often cited studies on ICT and teacher education in Africa is the SchoolNet Africa (SNA) 2004 extensive study *‘Towards a Strategy on Developing African Teacher Capabilities in the Use of Information and Communication Technology (ICT).* The study examined how teachers are taught about ICTs, identified ICT courses and programmes and recommended ways in which ICT capability could be integrated into teacher training programmes. While there are few initiatives to train teachers in ICT skills, the SNA study identified 61 courses targeting teachers in Anglophone Africa. Findings of the study revealed that:

- there are very few African teacher training institutions offering any form of pre-service ICT training;
- even those countries with national ICT policies have not developed a coherent strategy to develop teachers' ICT skills;

- there is little sharing of experience between countries and no moves towards a united African framework for teaching ICT;
- Africa lacks accreditation systems to acknowledge ICT skills obtained by teachers or rank courses by quality; and
- that many ICT teacher education projects have been created with time-limited donor funding so it is doubtful whether they will remain sustainable.

Despite the fact that most African teacher training institutions are too under-resourced to meet existing expectations of ICT training with its demand of extra infrastructure, development of teacher trainer ICT skills and training materials, SNA observed that many educationalists have yet to realise the transformational potential of ICTs. A shortage of public funds is the fundamental challenge to building skills in ICTs in African education. Given so many other spending priorities, as long as ICTs are considered non-essential, they will continue to struggle for attention (SchoolNet Africa 2004). Thus SNA recommends:

- an integration of ICTs at the pre-service teacher training level by building ICT capacity at teacher training institutions;
- production of content within training courses relevant to the cultures and languages of Africa;
- ensuring that content is supported by user communities excited about using it and that it is rigorously evaluated;
- greater effort to ensure sustainability of existing initiatives;
- improved collaboration and information sharing between countries;
- providing accreditation to teachers who have undergone recognised ICT training; and
- increasing motivation of acquiring a qualification through better pay or promotion possibilities (SchoolNet Africa 2004).

The study emphasises the need for teachers to train and familiarise with ICTs so as to be able to integrate them in their teaching practices.

The DFID and the Imfundo Initiative

From 2001-2004 the UK Prime Ministerial initiative created partnerships that used ICTs to support educational activities in Africa. The Imfundo Initiative worked in cooperation with African Ministries of Education in strengthening their teacher education support systems by capacity building and improve communication structures. Imfundo operates in Sub-Saharan Africa and has programs in Ethiopia, Ghana, Kenya and South Africa.

Although their 2003 study was not as extensive as the above, DFID research project *"Understandings of education in an African village: the impact of information and communication technologies'* revealed interesting facts regarding the use of ICTs to improve learning in rural Africa. The study, carried out in a Ghanaian village, showed what happened when residents were given their first chance to collect and show digital images of their lives. The study not only highlighted attitudes towards ICTs and the community's problematic interaction with currently available schooling, but also explored the implications of technological change for development initiatives. This ethnographic research in the community exposed a bleak picture of demoralisation and under-resourcing of education. Findings revealed that teachers posted to the village felt disappointed and uncommitted, and were often absent. Pupils were mostly unable to follow lessons, due to problems such as the lack of understanding or coverage of previous work and difficulty in understanding English, the language of instruction. Corporal punishment was frequent. Many children, especially girls, dropped out or attended infrequently because they and their families saw few real returns to basic schooling (Pryor & Ampiah 2003). The research also revealed that it was not the lack of schools that was affecting enrolment and retention, but the decision of families not to invest in 'worthless' goods. The quality of the schooling available was not worth the effort and commitment needed from parents and children.

Furthermore, the DFID report noted that in this village successful education was equated with examination passes and migration to towns; parents felt that schools and teachers were responsible to the state, not to them. Migration not only interrupted children's schooling, but also meant that people did not necessarily wish

to invest in the community where they lived and this caused a lack of clarity over whose responsibility children's schooling is. As a result of migration traditional matrilineal family structures (descent traced through mothers and their blood relatives) have been disrupted which means that the responsibility for children's care and education is often blurred. However, the report also showed that villagers embraced ICT opportunities provided by the project, developed positive images of their way of life, valued local knowledge and took pride in links to a prestigious global community (Pryor & Ampiah 2003).

Although the research is not optimistic about the capacity of ICTs to bridge the digital divide either globally or within low income countries, it gives suggestions of practice within a context where technology is available. Thus it observes that accessible village information technology centres, powered by solar power and satellite communication technology, might catalyse community spirit and inspire culturally appropriate virtual learning environments (VLEs) based on user participation and interaction. Greater access to ICTs could also enable schools to tackle parts of the curriculum, such as health education around HIV/AIDS, which information is sometimes difficult to deliver by conventional methods. ICTs could also enable dispersed families to keep in touch and farmers to access vital marketing information as well as motivate teachers to stay in the profession and further their own education even when living in rural areas (Pryor & Ampiah 2003).

However, the project notes that realising this dream would require Ghanaian education planners to:

- link community and school development initiatives more closely;
- do more to make school management committees representative and encourage greater participation of women;
- ensure that experimental and pilot work in using ICTs in schooling prioritises teacher training;
- realise that 'media literacy' is about helping people to actively create and work with, not just passively consume, media products; and
- explore how the public and private sectors might work together with the donor community (Pryor & Ampiah 2003).

Thus with regard to developments in ICTs, and the belief that teacher training even in the poorest African countries are slowly being equipped with computers, and that some of these teachers will be exposed to ICTs, another study commissioned by the DFID, the Imfundo initiative, set out to identify software appropriate for use in an African context. Imfundo was set up in response to requests from African educators to assist them in identifying training materials to develop key ICT skills namely: computer literacy, the use of e-mail and the Internet, word-processing, spreadsheets, presentations and website creation. Complementing previous studies on software providing materials in particular subject areas, Imfundo looked at appropriate and available software tools and applications that could be useful for teaching educators and teachers ICT literacy. A large number of software packages were evaluated on the basis of their cost, user-friendliness, interactivity, content and teaching approach.

Findings from this study revealed that:

- there was little suitable ICT skills training software for African educators;
- there was almost no educational content on the Internet that had been produced in Anglophone Africa – with the exception of South Africa;
- most software packages intended for educators were from donor projects or private sector foundations: very few packages had been developed by the private sector and that even when the packages became available, they did not reflect the needs of the African lifestyle.

The study further observed that although there are areas in Africa where most schools will have computer networks installed in a few years' time, rural schools in the poorest parts of the continent will probably have nothing even twenty years from now. Moreover available training courses often encourage people to see the technology as something to be learned about, not something to be learned to use creatively. ICT literacy training has a tendency to be repeated in an ever-worsening cycle of cascade training, that is, training is passed on and if initial training is not good, there is a danger it will become increasingly worse as it is transferred, so bad ICT literacy training ends up being repeated (James et al. 2004).

In regard to these findings the authors pointed out that:

- there is little point providing new teachers with detailed knowledge about already out of date systems;
- stimulating materials that can demonstrate to educators and learners how technology can create a more interesting learning environment;
- there is need to tackle 'technophobia' of older learners as educators are likely to need more guidance than the children they teach.

However, the authors further noted that Internet download speed is critical for African educators. And considering that documents or images that are 5 megabytes (MB) in size could, at the time of study, take hours to download through a dial-up modem and telephone connection, with a high likelihood of the download process being frequently interrupted, there is little sense in teaching computer skills to school educators if access to ICTs is a long way off for them (James et al. 2004).

DEEP – Digital Education Enhancement Project

Between March 2001 and May 2003, research was carried out at various locations in and around Cairo in Egypt, and the Eastern Cape Province in South Africa, by a joint team of representatives from the Programme Planning and Monitoring Unit (PPMU) Egypt, the University of Fort Hare (UFH), South Africa, and the Open University (OU) UK.

In the course of the project, 48 teachers (two per school) in 24 selected primary schools (12 in Cairo, 12 in the Eastern Cape) followed specially devised professional development programmes that were to enable them to integrate a range of ICT-enhanced activities into their teaching of literacy, numeracy and science. Teachers were to be supported through workshops and school visits, a range of multimedia resources, as well as through a web environment. The implementation of the programmes, together with an investigation into the impact of these ICT related activities on participating teachers, students and their communities were investigated through researcher observation, field-work and monitoring carried out jointly by the partner institutions. The local co-ordinators in Cairo and the Eastern Cape were each assisted by a small team of specialists at various points throughout the project. This

project became known as the Digital Education Enhancement Project (DEEP). The research involved over 2000 primary school students (DEEP 2004).

In the project, teachers worked in pairs to implement and evaluate a short, curriculum-focused, school-based professional development programme, using a range of new technologies including hand-held computers. Activities focused on the teaching of literacy, numeracy and science. ICT was used by schools as a whole as well as by many of the communities in which project teachers lived and worked.

Some of the findings from the project indicate that:

- all project teachers quickly developed confidence in using desktop/laptop and hand-held computers for a range of purposes;
- development of basic computer skills was largely unproblematic;
- the majority learnt to use a variety of digital software and other technology devices in a short-time frame;
- frequency and type of use of software and peripherals varied considerably within and between contexts.

The project also indicated that ICT use enhanced teachers' professional knowledge and capability by extending subject knowledge, enabling planning and preparation for teaching to be more efficient and developing the range of teachers' existing pedagogic practices. The majority of the teachers were highly motivated to succeed in using ICT for their own and for their students' learning, despite numerous challenges. The nature of the use of ICT varied according to context, particularly with respect to teacher access to adjacent technologies, geographical location, local educational and cultural practices, home language and teacher subject specialists. ICT facilitated new forms of teacher-to-teacher co-operation.

Research findings indicated no significant correlation between teachers' prior use of ICT and the ICT-enhanced classroom practices they developed during the programme. That is, some of the most sustained and effective practices were developed by teachers with no previous experience of ICT and/or no prior experience of using ICT for teaching. Findings indicated no gender disparity as there were more

women participants than men, and successful outcomes were equally visible for both men and women.

The fact that after four months of training, all the participating teachers considered ICT important or very important for learning and felt confident in their use of ICTs, even though 16 of the 24 teachers had never used a computer before, is an indication that teachers and schools in poor environments could benefit from the advantages of ICTs. Thus the study suggested that mobile digital devices originally aimed at the business market could be exploited by teachers and students for a range of professional and learning experiences. Since new technologies had positive effects on areas central to UBE (Universal Basic Education), including attendance, motivation and the quality of student learning, the use of ICTs might have a significant impact on the self image, confidence and professionalism of teachers.

5.2.2. Initiatives fostering teacher education programmes

UNESCO's Teacher Training Initiative for Sub-Saharan Africa (TTISSA)

TTISSA is a UNESCO initiative launched for the period 2006-2015 with the major aim of assisting Sub-Saharan African countries in restructuring their national teacher policies and teacher education. TTISSA is concerned with increasing the number of teachers and improving the quality of teaching in the participating countries. There are presently 17 countries participating in the initial four-year cycle namely: Angola, Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Congo, Democratic Republic of Congo, Ethiopia, Ghana, Guinea, Madagascar, Niger, Nigeria, Sierra Leone, United Republic of Tanzania, and Zambia.

In the case of Ghana, TTISSA looked at approaches to teacher training with minimum cost through ICT-enhanced ODL (UNESCO - TTISSA 2006). The initiative recommends that new technologies in teacher training should involve the use of the following: interactive radio, computers (on-line and off-line approaches, websites, Internet and use of other software), satellite delivery and interactive video. The initiative sees the advantages of new technologies as:

- being the efficient use of scarce resources and personnel as they have the capacity for sharing and making more efficient use of scarce existing resources and personnel;
- increasing access in that they are able to reach people in isolated areas and increase access to education and training for disadvantaged groups or those under-served, thus democratising educational provision;
- and being able to achieve significant economies of scale if operated for reasonable large numbers.

The TTISSA study on Ghana also identified cases of good practices of motivating teachers. Motivating strategies were:

- offering a diploma in Basic Education programme by distance learning to unqualified teachers in the Ghana education service to solve teacher shortage in rural areas;
- government's financial support for free tuition for all teachers on distance education programmes;
- study leave with pay for teachers pursuing further studies in programmes related to school education;
- involvement of teachers and teacher unions in education policy planning and formulation through the Teacher Education Forum;
- establishment of teacher incentive policy to retain teachers and attract more qualified candidates to teaching (housing scheme loan, car scheme loan, free accommodation in rural areas, 20% basic salary increment for teachers serving in rural areas);
- Best Teacher Award Scheme for all categories of pre-tertiary institutions, financial support for trainee teachers in public training colleges (tuition fee, book allowance, district sponsorship scheme).

In its review on “Good Practice in ICT and Special Educational needs for Africa”, the TTISSA initiative reports statistics from studies across Africa which show that children with special needs face major challenges. The study investigated how good practice and experiences from global use of Assistive Technology (AT) could be shared with African governments. However, very little was found regarding ICT at teacher training level for special needs teachers (UNESCO-TTISSA 2006).

Kenya Technical Teachers College Learning Resource Centre

The Learning Resource Centre (LRC) project at Kenya Technical Teachers College was initiated in 2002 as a learning centre where "lecturers and students come to teach, learn, and undertake research" (Janssens-Bevernage et al. 2005). LRC has an ICT unit, documentation unit, 24-hour Internet access and working space. The LRC offers flexible modes and innovative methods of learning. Training includes basic ICT skills which may be taught / learned with the assistance of self-study CD-ROMs or through workshops which concentrate on specific education-related themes and tasks such as efficient Internet search, the pedagogical rationale for ICT integration, problem-solving learning and innovative instructional methods such as flexible learning and information literacy. The "flexible learning" approach was built on key principles of adult learning such as flexible and open learning while placing both curriculum and literacy issues higher than those of software and technology. Lecturers attend workshops when they feel ready and are offered unlimited access, but it is part of the curriculum for students to attend.

Experiences from the LRC project showed that lecturers (teacher educators) and student-teachers (pre-service and in-service) went through three stages when learning how to integrate ICT into their work:

- awareness – staff and students are attracted by the Internet access and use basic skills to browse for personal searches and e-mails
- guided integration – learners (both lecturers and students) attend workshops, experiment with software application, and develop strategies to integrate ICTs to their learning and teaching
- realisation - ICT based work becomes central and learners are involved in high level thinking, decision-making and problem-solving. At this level some old practices become obsolete (Janssens-Bevernage et al. 2005).

The LRC focused from "learning how to use" to "using to learn", thus allowing learners to set priorities in their learning. Whereas training in basic skills is available to all some participants, mostly lecturers, prefer to focus on very little ICT skills necessary (e.g. save and print) for Internet browsing and downloading learning

materials they need, which they rework with existing books and notes and have this typed by assistants. They do not feel the need to learn how to use some software but rather use the available technology intensively to integrate the results into daily work, and acquire basic ICT skills as they become more confident and independent learners (Janssens-Bevernage et al. 2005).

Lessons learned from this project indicate that it is essential to localise training materials and programmes to include a large number of local examples that are subject-related so that users can refer to practical examples for ICT-integrated teaching and learning.

The project also investigated how KTTC (Kenya Technical Teachers' College) members perceived changes in organisational culture, including interrelations and teacher/learner attitudes. Conclusions were that the provision of Internet facilities as part of a comprehensive capacity building programme tailor-made to the needs of the learner contributed to a perceived change in culture at KTTC. Access to Internet enhanced a reading culture, broke down barriers between young and old, established a sense of community, enticed a student-centred approach, and made learning and teaching more exciting.

The project further suggests that in providing training for teachers, there is a need to mainstream ICT appropriately in all subject curricula. ICT should be made a priority, thereby modernising training and the curricula. This gives learners the opportunity to become critical thinkers, problem solvers, information literate citizens, knowledge managers, and team members proficient in collaborating with others. The authors further recommend that ICTs should be mainstreamed in all subjects, that is, they should be infused in the whole curriculum throughout the entire teacher education and professional development programmes for both pre-service teachers and in-service teachers. "Unless teacher educators model effective use of technology in their own classes, it will not be possible to prepare a new generation of teachers who effectively use the new tools for teaching and learning" (Janssens-Bevernage et al. 2005).

Connect-ED – Connectivity for Educator Development

In 2000, the United States Agency for International Development (USAID) implemented the Connect-ED activity whose primary objective was to enhance primary education through the use of new information technologies in the education system in Uganda. This included development of an on-line curriculum for student teachers, establishing computer laboratory and Internet connectivity, and providing computer skills training to tutors at the PTCs (Primary Teachers' Colleges) and students in the Faculty of Education at Kyambogo University in Uganda (Cisler & Yocam 2003).

According to the project report, almost none of all the 80 tutors and lecturers at Kyambogo University and the eight PTCs spoken to had had any computer experience before the labs opened. Only a few had gone to Internet cafes where they paid for access as well as assistance in opening a mail account and inputting a message. At the beginning of the project only one or two machines existed in primary teachers' colleges but these were restricted to administration areas.

Courses offered through Connect-ED included a basic course which was followed by Microsoft word, the Internet, excel, powerpoint, inspiration, typing tutor. Many participants reported uses of word processing for notes, class schedules, test scores, and other college-associated chores. They expressed interest in using powerpoint more. The Connect-ED project identified individual accomplishments and small projects, for instance one of the participants entered a BBC poetry contest and won a t-shirt, a lecturer joined a mailing list on environmental education, wrote a paper and submitted it for an upcoming conference. Publicizing these examples inspired other tutors to be creative. The lab and its services were seen as crucial for professional development. Having the curriculum on CD-ROM was a breakthrough and those who had access to Internet found it transformational since libraries are generally poorly stocked.

However, student teachers found it was competitive to participate in the PTC courses and many were excluded. Those chosen, out of thousands of students in Kyambogo University, felt privileged to be in the training. Very few of the participating students

had had any previous access to computers and neither did they know anyone with a personal computer. Some of their perception regarding computer skills included: personal enhancement that would lead to more job opportunities thus leaving the rural town; saving time in preparing lessons; keeping track of grades; taking notes and presenting material in class; be “part of the more modern world”; be more literate; and more knowledgeable than if they had not taken the courses.

For future training it was recommended that tutors and student- teacher trainers get more training to use technology in progressive teaching methods such as project-based learning, collaboration, critical thinking, and constructivism (Cisler & Yocam 2003 p. 10). Furthermore, teachers should be encouraged and allowed more time to spend in the labs with the project technical assistant (PTA) so as to form a professional support network. Senior lecturers at Kyambogo University needed further training in multimedia development and more technical assistance in the labs. Availing teachers with more contact time with technology in the labs would enable them to practice what they have learned and to explore. Those with new skills should be identified and acknowledged with rewards (e.g. certificates).

5.2.3. Initiatives supporting teacher networks and collaboration

Teachers Net East Africa

Teachers Net is a portal for teacher's colleges in Kenya, Tanzania and Uganda initiated by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and developed by the Learning Resource Centre (LRC) in Nairobi, Kenya. The aim of the project is to integrate ICT in educational programmes through the provision of Internet access as part of a comprehensive capacity building programme and the establishment of a 'learning community'.
The objectives of the web portal are:

- to create a virtual network for all teachers' colleges in Kenya, Tanzania and Uganda;
- to promote the use of Internet in teachers' colleges in the described sub-region;

- to share information on ICT projects and resulting active learning strategies in the institutions;
- to serve as a "meeting place" for discussions among the members;
- to serve as a platform on-line and /or distance learning courses; and,
- to create a convenient space where educational institutions can market their programmes.

However, at the time of this study their website had not been activated and none of the participants, neither students nor teachers, had accessed it.

GTZ – German Technical Cooperation

GTZ (Gesellschaft fuer Technische Zusammenarbeit) supports the NGO "kabissa – Space for Change in Africa" in the development of a manual for assisting African NGOs in the application of ICT to increase their reach and effectiveness. GTZ also supports the establishment of a network of African Universities in the field of crisis prevention and conflict resolution, which is coordinated by the University of Bochum. However, GTZ also acknowledges that, "in order to improve schools and raise the quality of education, it is necessary to address the educators first" (Werner Wasmuth, GTZ 2004). In 1995 GTZ implemented the "Crystal Network for Training and Learning Media" whose website www.crystal-elearning.net aimed at providing expert know-how through knowledge partnerships between authors, publishers and universities in the North (developed countries) and the communities of experts in the South (developing countries). Crystal eLearning aims at blending local contextual knowledge with technical and vocational education training (TVET) content from the North. Workshops have been conducted in South Africa, Ethiopia and India in order to build up competencies for publishing, instructional design and elearning.

5.2.4. Initiatives from the private sector

A number of initiatives from the private sector are engaged in assisting in the integration ICT into teaching and learning in Africa. In 2003, Microsoft Partners in Learning programme signed Memorandums of Understanding (MoUs) with 10

countries in WECA (West, East and Central Africa). This entailed training several thousand teachers and trainers across the region in ICT skills and integration of technology into teaching. Microsoft is currently localising in Uganda, South Africa and Senegal and the company anticipates reaching over 500,000 students. Microsoft joined NEPAD's Information Society Partnership for Africa's Development (ISPAD) Initiative as a foundation partner and platinum member in December 2003 and is an active participant in the e-Schools Initiative. Microsoft is part of a consortium of industry partners (Hewlett-Packard; Cisco; Oracle; AMD) to support 25 schools in eight African countries (Cameroon, Kenya, Lesotho, Mauritius, Mozambique, Nigeria, Rwanda and Senegal) with a PC lab per school, software, teacher training, networking, connectivity, maintenance and support. It is estimated that more than 20,000 students and 1,000 teachers have already benefited from the Microsoft consortium's efforts with the e-Schools Project. The goal of the programme is to create an ICT solution that more than 600,000 schools across Africa can eventually model to bring technology to their schools (Microsoft Press release 2006).

Intel® Teach has designed programmes intended to assist educators in integrating ICT in teaching and learning. Intel® *Teach to the Future* is one the official professional development programmes of SACE (South African Council for Educators) and is designed to address the challenges faced by educators in effectively applying computers and the Internet to enhance learning. Participating educators receive extensive training and resources to plan projects that promote effective use of computers and the Internet (ICT) in the classroom. One of the goals of programme is to give educators the opportunity to collaborate with other educators and discuss ideas for planning projects and using technology in their classroom. Educators will also have the opportunity to develop a specific project based on learning outcomes they would like to teach in the future. The goal is for educators to have a project that they can take back to their classrooms, one that allows them to raise the level of excellence in their classroom and meet important learning outcomes.

5.3. Criteria for successful practices of ICT use in teacher education

According to Carlson and Gadio (2002), designing and implementing successful teacher professional development programmes which employ ICT is neither easy nor inexpensive. Research shows there are more cases of inadequate and ineffective training programs than there are successful stories, that successful stories are not automatically transferable to other situations, and that the total body of experience and knowledge in this field is in its infancy. It is also usually under-funded and while some people may know more than others in this area, there are few if any true "experts." Therefore, there is a need for humility, innovation, a willingness to fail, on-going evaluation, sharing of both positive and negative experiences, and constant revision of teacher professional development programs related to technology (Carlson & Gadio 2002).

Literature search within the framework of this study showed that there are no defined criteria for 'best practice' or successful practices of ICT use in teacher education. However, numerous studies (UNESCO; SITE; *infoDev*; EU) have recommended guidelines to be followed when applying new technology to teacher education which, with some variation, basically enumerate the following indicators for good practices:

- ICT Policy at a national and institutional level with a budget that shows government support and commitment
- ICT Infrastructure which ensures connectivity of both Internet and telephone as well as access to computers and other ICT facilities for both teachers and the teaching and administrative staff
- ICT Curriculum : applying ICT in education by offering computer courses as a subject; training of instructors in computer literacy and encourage instructors in using ICT in classroom e.g. preparing presentations and making handouts
- Encourage teaching and learning processes through use of ICT as a tool not just as a curricular subject, but apply various educational software in the teaching-learning process; encourage students to apply ICT in classroom activities and in their assignments; foster tele-collaboration and communication between students and teachers and other schools (UNESCO 2002).

The Society for Information and Teacher Education (SITE 2002) recommends three basic principles to follow in preparing teachers in using technology in classroom:

- technology should be infused into the entire teacher education programmes;
- technology should be introduced in context;
- and, students should experience technology-supported learning environments in their education programme (SITE 2002).

According to SITE (2002), the basic principle of infusing technology in the entire teacher education while restricting it to a single course will not prepare students to be technology-using teachers. SITE's second principle differentiates between general and professional computer literacy. General computer literacy involves learning how to use traditional operating systems, word processors, spreadsheets, database and telecommunication tools, while professional literacy is best learned in context and involves learning to use technology to foster the educational growth of students (SITE 2002). Through exposure to regular and pervasive modelling by their professors and lecturers pre-service students should learn different uses of technology. Students need to integrate ICTs into their course work, so that in the future they will be better able to explore and use them creatively in their own field experience and teaching. SITE's third basic principle emphasises use of technology-supported learning environments in teacher education programmes where technology is used in new, innovative, and creative forms to support traditional forms of teaching and learning as well as to transform learning. According to SITE (2002) a programme like PowerPoint may enhance traditional teaching methods but not necessarily transform the learning experience. But when the multimedia is used to teach topics that have been previously addressed in lectures, the learning experience is transformed by technology. Pre-service students should be exposed to both uses of technology in their programmes.

SITE proposes six actions to be taken into consideration when applying ICT in teacher education:

- identify and make public positive models of technology-infused teacher education programmes through dissemination of expertise and publishing of technology-based materials, and encourage development of coalitions of teacher education programmes that share expertise and resources,

- encourage and support collaboration of teacher education programmes with technology-rich K-12 schools that can serve as authentic environments for teacher education,
- establish national centres for technology and teacher education such as a *Clearinghouse for Teacher Education Tools* which would serve as a means of disseminating software and materials developed specifically for teacher education,
- support innovation models of faculty development that emphasise technology-facilitated teaching and learning by encouraging collaborations of teacher education colleges and experienced teachers in schools so as to enhance understanding of how to use technology in classes and prepare pre-service teachers to integrate these practices in their field experience,
- support models of technology infusion that involve pre-service teachers in field-based activities as both learners and facilitators of technology innovation while assisting practising teachers in exploring new ways to use technology,
- and, fund development of promising teacher educational materials for both content specific and other areas of teacher education such as foundations and curriculum.

UNESCO's Planning Guide (2002) enumerates conditions essential for effectively implementing and empowering ICTs to improve learning which include:

- students' and teachers' access to digital technologies and the Internet in their classrooms, schools and teacher education institutions,
- high quality, meaningful, and culturally responsive digital content available for teachers and learners,
- teachers must have the knowledge and skills to use the new digital tools and responses to help all students achieve high academic standards (UNESCO 2002).

The *InfoDev* in its Guide *Knowledge Map: Teachers, Teaching and ICTs* emphasises that teacher training and continued, on-going professional development are essential if benefits from investments in ICTs are to be maximized (*InfoDev* 2005). Whereas the existence of ICTs does not transform teacher practices in and of itself, ICTs can

enable teachers to transform their teacher practices, given a set of enabling conditions (UNESCO 2002). Thus successful practices in ICT in teacher education must not only avail their student-teachers with knowledge and skills in ICT skills; they should also enable them to use these skills in everyday teaching and learning activities (*InfoDev* 2005).

According to *InfoDev* (2005), successful professional development models can be divided into three phases:

- pre-service, which should focus on initial preparation on pedagogy, subject mastery, management skills and use of various teaching tools (including ICTs);
- in-service, which should include structured face-to-face and distance learning opportunities building upon pre-service training and directly relevant to teacher needs; and
- on-going formal and informal pedagogical and technical support, enabled by ICTs, for teachers, and should target daily needs and challenges.

Essentially recommended for an effective teacher professional development, is a "hands-on" instruction to foster ICT use, collaboration between teachers and an on-going professional development which should include methods of evaluating and modifying pedagogical practices.

By drawing examples from successful ICT use in education and the recommendations from international bodies, Unwin (2004) in his paper: *Towards a framework for the use of ICT in Teacher Training in Africa* proposes six fundamental principles of good practice for successful implementation of teacher training programmes (Unwin 2004). Unwin emphasises that in implementing ICT in teacher training, there should be a shift from 'Education for ICT' to the use of 'ICT for Education'. Thus, the focus is not primarily on acquiring the basic ICT skills, but on the deeper processes associated with how ICT can be used to transform educational practices. The second principle is the need for ICTs to be integrated across the curriculum whereby technology is not restricted to a single course or a single area of education but should be present in the students' entire teacher education experiences so that they can learn how to incorporate technology in their own learning. Thirdly,

that despite the limited resources, there is a need to combine pre-service and in-service initiatives and teacher training, whereby facilities provided for pre-service teachers should be made available to in-service training of existing teachers. The fourth principle stresses the internationally recommended need for relevant, locally produced content and software and the training of people in Africa in appropriate content development. In order to reduce duplication of effort and promote sharing of experiences, his fifth principle stresses the need for real partnerships between governments, the private sector, civil society, academic institutions and global organisations which would enable realisation of the other mentioned principles and increase co-ordination of the many ICT initiatives in teacher training in Africa. Last but not least is the need to build sustainability into programmes from their inception in order to ensure long-term running and maintenance (Unwin 2005).

In their study of ICT use in teacher education in Africa, SchoolNet Africa emphasises as most important initial awareness-raising in teacher training institutions (SchoolNet Africa 2004). Thus, for ICT capabilities to be integrated into teaching practice, training institutions should understand the potential that ICT has to transform education efficiently and effectively as compared to the existing system, and start to explore alternative pre-service teacher training programmes using technology. Training institutions have to realise that technology modules should not be taught separately but rather should become core to the teaching process of every subject. In order to ensure effective pre-service training, SNA recommends three major activities:

- development of appropriate training materials,
- retraining of teacher trainers,
- provision of adequate ICT access at training institutions.

According to Carlson and Gadio (2002), the key to successful teacher professional development programmes is a modular structure, corresponding to different levels of teacher experience and expertise using technology, adapting materials to teachers' comfort level and starting points, whereby teachers new to technology can be exposed to the full series of professional development modules. In addition, they recommend that the basic principles of adult learning also should be incorporated into the training program, that is, the program should be highly social and

cooperative, with opportunities to share experiences and combine instruction with discussion, reflection, application, and evaluation. In this way technology enables a more collaborative approach and maximises peer-to-peer sharing of the challenges, frustrations, advantages, and successes of using technology to teach and learn, thereby also illuminating failures and examples of best practices in use of technology.

With regard to content of professional development programmes, Carlson and Gadio (2002) suggest that designers of a teacher professional development programme for use of technology need to determine current teacher competency levels in this area. According to Carlson et al., there are ongoing discussions and divergent views regarding the content required for teacher professional development in the use of technology. Many differ in economic, social, cultural and educational realities and therefore require different approaches. However, some minimum guidelines and suggestions for the content of teacher professional development in use of technology are warranted. Among those they cite as useful guide for determining the content of teacher professional development programmes are the "Recommended Foundations in Technology for All Teachers" from ISTE – the International Society for Technology and Education. These standards were developed through a multi-year consultative process with thousands of teachers who were using technology in their practice (mostly from USA and Canada).

Experience from the World Links program suggests that at least 80 hours of professional development are required before teachers can really begin to integrate technology into their teaching. Teachers generally are reluctant to change their teaching styles and habits, are cautious of time-consuming activities and many require additional motivation and incentives to participate actively in professional development activities. Thus some incentives (extrinsic and intrinsic) which have been successful in the past are suggested here, e.g. certification by the ministry of education, recognition and time allocation by supervisors as well as the prospect of reduced isolation and increased professional satisfaction, enhanced productivity and becoming a trainer (Carlson & Gadio 2002).

Burniske and Monke's (2001) *Breaking Down the Digital Walls: Learning to Teach in a Post-Modem World* has recommendations for teachers on how they can improve their skills and knowledge in the use of technology in their classrooms. These can be summarised as follows:

- teachers need to be critical – teachers should not just embrace or adopt technology as a panacea, but rather they should seek appropriate place and time for computing and the pedagogical rationale for using it;
- teachers need to reflect on teaching practices – i.e. look for ways that technology can help to catalyse pedagogical reform toward more student-centred, interactive, constructivist learning as opposed to traditional methods of "chalk and talk" teacher-orientated, one-way instruction;
- teachers should have access to technical assistance – teachers need not be technical experts at hooking up computers, configuring servers or loading software, but should seek training opportunities and time to learn how to use technology especially the Internet;
- they should join communities of teachers e.g. in same school, country or network of teachers on-line sharing experiences, frustrations, lessons, encouragements, problems, and solutions;
- teachers should consider which existing teaching/curricular activities may need to be dropped to integrate technology into the classroom;
- teachers need to recognise their need to acquire new skills and knowledge from others;
- finally teachers need to project more forcefully into students' learning, assist students to reflect on their learning and help them to evaluate information, develop information-reasoning skills, and acquire a deeper understanding of their subject matter (Burniske and Monke 2001 in Carlson & Gadio 2002 p. 129).

It is further recommended that teacher professional development (TPD) in use and application of educational technology should be implemented as part of a broader educational reform program that combines teacher professional development and local content development. TPD should not be isolated from other elements of instructional aspects such as curriculum reform, physical/technological infrastructure, examinations, and research. TPD in use of technology to improve

teaching and learning need to be multifaceted, modular, authentic, collaborative, "incentivised", iterative and ongoing, allocating sufficient time and financial resources, cost-effective, and it should be evaluated and revised. TPD is a critical element of any initiative to introduce technology into schools to improve teaching and learning. Failure to invest sufficient resources in teacher training will result in failure of school-based technology activities, while success lies in ensuring that teachers acquire the skills and knowledge needed to use ICTs effectively (Carlson & Gadio 2002).

5.4 Barriers to ICT-based teacher education

The use of ICT in teacher education is, however, still limited in developing countries. Even in developed countries which are better resourced in technology, ICT implementation is still constrained by administrative, training and time factors, among others. In their 2004 report, *A Review of the Research Literature on Barriers to the Uptake of ICT by Teachers*, BECTA (British Educational Communications and Technology Agency) categorised barriers to ICT use into two groups: external barriers and internal barriers. External barriers included: lack of access to resources; lack of time; lack of effective training; technical problems; whereas internal barriers included: lack of confidence; resistance to change and negative attitudes; no perception of benefits. Findings showed that although student teachers in their study had good ICT skills in terms of their own personal use, they were unable to transfer these skills to using ICT in the classroom.

Gunter et al. (2001; 2004) observe that although pre-service teachers are exposed to technology during their training, many training programs hardly provide the comprehensive instructions teachers need for integrating technology in their teaching later. There is still a need for a greater variety of technology integration modelled throughout their content courses. The authors also observe that the amount of success that pre-service teacher will have integrating technology into their curriculum is not only dependent upon skill, but also upon learning effective integration strategies (Gunter et al. 2004).

In the Dutch 1999 report *"Impacts of ICT in education: the role of the teacher and teacher training",* the major concern of European ministries of education was that teachers did not receive the appropriate training in ICT use (Jager & Lokman 1999). Thus it was urged to stress "teachers' role in the process of educational innovation and implementation of ICT" and recommendations were made to support this process.

By the end of the 1990s, most research findings in OECDs (Organisation for Economic Co-operation and Development) suggested that ICT was significantly under-used by student and beginning teachers (Murphy 2000). The problem was attributed to a number of causes: lack of resources in schools and in initial teacher training institutions or lack of access to these, lack of ICT experience and training at pre-service level and lack of confidence in computing skills of both students and teacher trainers, lack of opportunity and encouragement to use computers during school placement and predominance of other classroom pressures.

At the turn of the century, there was a realisation world wide that effective use ICT by student teachers was vital if the new technologies were going to be successfully used in the education of children in schools. Studies in the UK identified three main obstacles that limited ICT uptake by student teachers: student access to computers, the ICT policy adopted by initial teacher training providers as well as lack of encouragement for students to use ICT in teaching practices (Murphy 2000). A study comparing ICT use by student teachers in 1997 and in 2000 found that in 2000, student teachers on the whole appeared to be more confident and competent in the use of ICT than in the 1997; however, female and younger students lagged behind their male and older peers. Findings showed that the desire for more training was higher in 2000 than 1997 which might be taken as an indication that students felt not well equipped to use ICT in their teaching (Murphy, 2000).

A recent study in Singapore (Teo 2006), based on the observations of ICT-mediated lessons and face-to-face interviews with teachers, ICT heads-of-department and school principals, identified six major barriers to teacher ICT-integration: (a) inadequate appointment of technical support staff, (b) inadequate appointment and training of student ICT helpers, (c) lack of sufficient time for teachers to prepare for

ICT-mediated lessons, (d) insufficient collaboration among teachers in preparing ICT-mediated lessons, (e) lack of support provided by school leaders in addressing teachers' ICT concerns, and (f) insufficient training, demonstrations or advice for teachers on how to incorporate ICT into classroom instruction.

5.4.1. Lack of access and connectivity

The biggest problem for African institutions is access to the Internet. The University of Makerere in Uganda, for example, pays $28,000 per month for its access to the Internet as compared to the United States where universities on the average pay only $500 per month. In general, African universities pay much more for Internet than comparable universities on other continents. According to Bob Hawkins, "the average African university pays 50 times more than the amount a Northern American university pays for Internet access" (in Waldick 2005). Furthermore, the bandwidth available to an African university is less than that available to a single home in North America, despite the high demand. Tables 5.1 to 5.3 show bandwidth data for several African countries and institutions.

Country	Total National Bandwidth	Bandwidth Per Capita
South Africa	398,512 Kbps	9.1 Bps
Mozambique	2,088 Kbps	1.2 Bps
Tanzania	12,000 Kbps	0.3 Bps
Uganda	9,250 Kbps	0.4 Bps
Nigeria	15,000 Kbps	0.1 Bps
Ghana	4,096 Kpbs	0.2 Bps

Table 5.1: Bandwidth in five Sub-Saharan Africa countries (Source: International Development Research Centre) http://www.foundation-partnership.org

Institution	Bandwidth Utilization: Kbps up/Kbps down
University of Dar es Salaam (Tanzania)	256/512
Makerere University (Uganda)	1,280/2,500
Eduardo Mondlane University (Mozambique)	384/1,000
Bayero University (Nigeria)	64/128
Obafemi Awolowo University (Nigeria)	128/256
University of Ibadan (Nigeria)	56/200
University of Jos (Nigeria)	64/128
University of Ghana	512/1,024

Table 5.2: Current bandwidth utilisation in selected universities (Source: Bandwidth Task Force) http://www.foundation-partnership.org

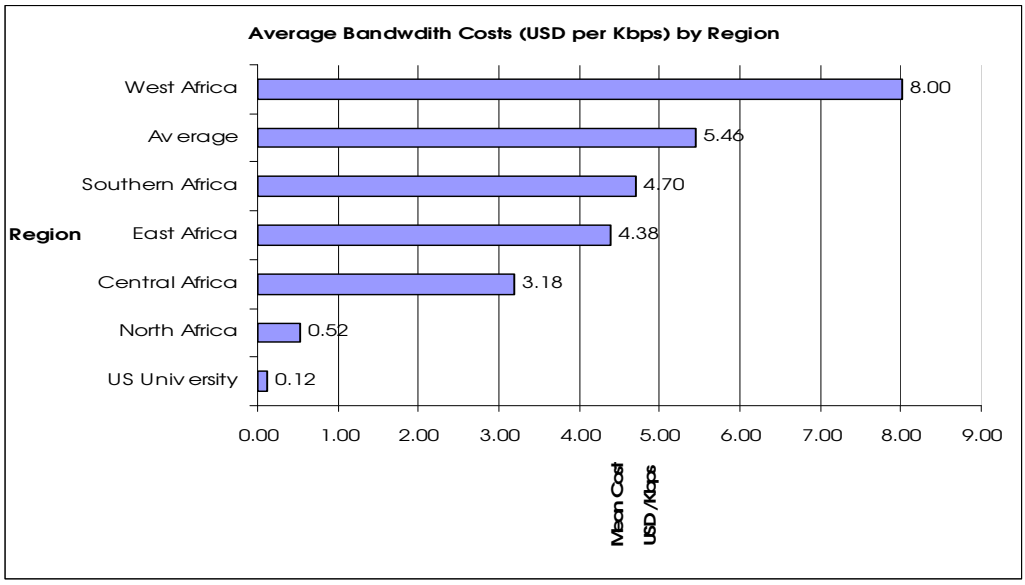


Table 5.3: Average bandwidth Cost per region (Source: Hawkins 2005 – the World Bank)

According to the AAU, despite governments' commitments and policies, the status of ICTs in African universities is at a growing disadvantage compared to their counterparts in Europe, North America, and non-African developing regions. This is due to the factor that the information infrastructure of African higher education is poorly developed and inequitably distributed. The AAU report categorised obstacles to ICT implementation in African universities in three groups some of which are listed below:

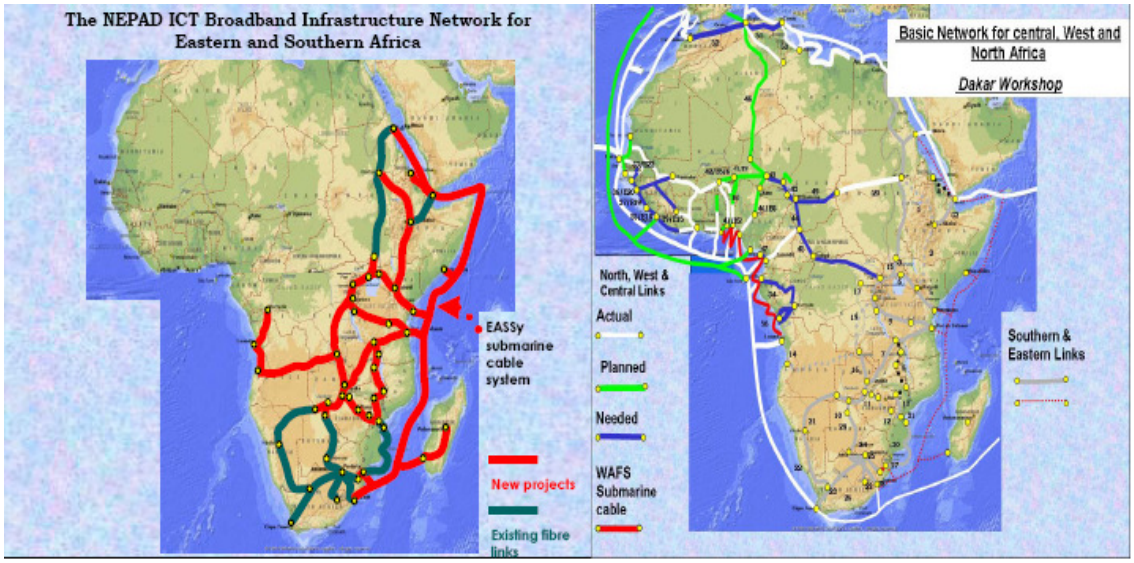
- external obstacles included among others, poor telecommunications infrastructure; social and political instability in some countries; high Internet Service Providers (ISP) fees; inadequate and irregular funding
- internal obstacles included poor organisational self-awareness and response to change; lack of coherent institutional plans and strategies for introducing ICTs in universities; insufficient computer facilities for staff and students
- human resource-related obstacles included lack of trained technical and support staff; inadequate external and internal training programmes for critical skills to manage and support ICT functions; absence of systematised plans for integrating technology into teaching and learning; inability of institutions to ensure the retention of skilled staff due to poor remuneration (www.aau.org)

The SchoolNet Africa study summarised key barriers to successful implementation of technology at pre-service level in Africa as follows:

- lack of comprehensive Pan-African framework that covers the development of local technological models and local teacher training content since many ICT organisations have limited funding and work independently;
- lack of coherent individual government policies such as is the case in European case studies where several countries work together to develop a common strategy;
- lack of adequate government funding to implement policies, as often ICT programme for teachers is low in terms of spending priorities;
- lack of sustainability built into initiatives;
- lack of motivation and incentives for teachers in terms of accreditation such as better pay and/or promotion;
- lack of contextual relevance of course content;
- lack of quality of course content;
- and, lack of resources and capabilities in training colleges in terms of ICT infrastructure, trained teacher trainers, training materials, ICT maintenance and support, adequate time.

The biggest challenge for universities in Africa is how to make more bandwidth available and how to manage the limited bandwidth resources that are available in

the most efficient way. According to INASP (International Network for the Availability of Scientific Publications), effective management and optimisation of bandwidth is a key feature of increasing bandwidth availability for research and education. The findings of the African Tertiary Institution Connectivity Study (ATICS) and information on the African Virtual University (AVU) showed that there is a high demand for bandwidth amongst most African institutions with the average percentage of time, where links are at 100% capacity, over 60% (Hawkins 2005). However, as an INASP commissioned survey revealed, 59% of African universities did not manage their bandwidth, although the effective management of bandwidth is seen as a key component of networked resource use (Gwyn 2005).



Figures 5.1a &b : Africa's fibre infrastructure (source : NEPAD 2003)

Africa's main fibre route is provided by SAT-3/WASC (South Atlantic 3/West Africa Submarine Cable) (see figure 5.1b) which goes from Portugal down the west side of the continent to South Africa becoming the SAFE (South Africa Far East) cable that crosses the Indian Ocean to India. Presently the prices charged for international bandwidth in African countries are entirely controlled by the SAT-3 consortium 36 members, 12 of which are African, along its route that have been granted the national monopoly.

SAT-3 connects 36 countries states along its route; and the 12 African client states include Senegal, Ivory Coast, Ghana, Benin, Nigeria, Cameroon, Gabon, Angola, South Africa, La Reunion, Mauritius and Namibia. All routes in Africa are managed

by South Africa's Telkom. SAT-3 prices are so high that African customers have opted to buy satellite capacity.

There are, however, proposed fibre projects on the continent, and among these are the EASSy project (Eastern African Submarine System cable), NIGAL gas pipeline fibre from Warri (Nigeria) to Algeria via Niger, Reseau Bouncle Nord connecting North African countries with West Africa with a circular route, Infinity West African cable, Glo-1 (Lagos to London) and West African Festoon System (WAFS) connecting countries from Angola to Nigeria.

One of NEPAD's objectives is to ensure that all African countries are connected to one another and to the rest of the world by a broadband cable system, and one of the strategies of achieving this is through the EASSy project (Eastern African Submarine System). EASSy is a new 9,900 km long submarine cable on the east coast of Africa to run from Port Sudan in the north to Durban in the south (see figure 5.1a). It is expected that EASSy will be operational by the last quarter of 2007. The cable will have nine landing stations positioned along the east coast. EASSY is being sponsored and initiated by the NEPAD, NGOs, Internet service providers and regulators. It is planned that through the consortium of EASSy, all landlocked countries will be connected to the submarine cable thus enabling a broadband ICT infrastructure network for Eastern and Southern Africa.

Other alternatives suggested to reduce bandwidth costs include adopting successful strategies from other developing countries. An example is Ecuador which formed a consortium to negotiate lower prices. As a result Ecuador’s universities have achieved more than 70% savings in international bandwidth costs. African universities are prime targets of Internet service providers and as individual consumers they are charged extremely high prices. Therefore, forming regional consortia such as UbuntuNet Alliance, a regional research and education network, and Bandwidth Consortium (another regional network managed by the African Virtual University), can help to reduce bandwidth costs significantly (Waldick 2005). NEPAD is making an effort to help African universities gain control of the cost involved in on-line access by facilitating a coalition of African universities that will be better positioned to negotiate lower bandwidth prices (Walker, 2005). Moreover,

forming alliances enables universities to purchase more volumes of bandwidth and the greater the volume of bandwidth, the lower the marginal cost of bandwidth (Hawkins 2005).

Despite the many criticisms regarding expenditure on bandwidth in poorly functioning university infrastructures, advocators of ICT believe that "with the proper bandwidth you might be able to teach 10,000 more students via distance learning, as opposed to hiring 24 more professors…bandwidth also allows access to other learning resources, for example, all the courses of MIT (Massachusetts Institute of Technology) and other learning resource to be on-line and adapted to meet the needs of African universities" (Walker 2005, p.2).

5.4.2. Lack of training

The SchoolNet Africa study (2004) mentioned in section 5.2, examined how African teachers are taught about ICTs during their teacher training and after, in their teaching practice. Their study revealed that there is evidence of a number of teacher training initiatives involving ICT at both pre-service and in-service levels in Africa. However, these initiatives are mainly on a small scale, regional and fragmented with little sharing of experience across national boundaries. Findings from their research revealed that there were no pre-service teacher training courses in computer-integrated education outside South Africa except the Connect-ED programme in Uganda. The study further revealed that lack of training at pre-service level was closely related to lack of experience and skills among teacher educators; lack of access to technology in pre-service training institutions; lack of access to ICT training content, that is, modules and programmes suitable for teaching teachers to use ICT; and lack of good quality research and good examples documented and available to aid the development of new pre-service training programmes or improve existing ones. SchoolNet Africa emphasised the need for resources and capabilities in ICT training in teacher education in African institutions.

However, as Baartman (2001; 2003) observes, training, knowledge and attitude toward ICT use is highly dependent on exposure to these technologies. Comparing

the Netherlands and Zimbabwe, he notes that although in the Netherlands basic computer skills are seldom taught in formal classroom situation and computers are considered as a tool to support other subjects and activities, tertiary level students are already skilled and experienced users of computers. In Zimbabwe, however, 60% of first-year students of computer science have no basic computer skills (Baartman 2001; 2003).

5.4.3. Lack of training resources and educational content

Research studies cited in section 5.2, SchoolNet and Imfundo, reveal that lack of training resources and educational content is a major handicap to the implementation and integration of ICTs in teacher training. Most computers available in Africa are not powerful enough to run complex software applications because they are second-hand or refurbished. Moreover they are very few operating systems and basic software produced in Africa and those products from developed countries might include examples not culturally relevant in an African context. SchoolNet Africa notes that most often emphasis has been focused on technical solutions to ICT integration in teacher education and less on pedagogical issues.

Most of the content of ICT training materials used have been developed outside of Africa, imported and adapted without having been tried in African curricula. There is, therefore, a lack of course materials linked to curricula and which can provide novel solutions to African problems of access, language and cultural relevance, and there is need to monitor, evaluate and update available content (Pryor & Ampiah 2003; SchoolNet Africa 2004).

English remains the dominant language of publication for African producers, despite the fact that English first-language speakers comprise no more than 0.007% of the whole African population (Boldi et al. 2002 in Czerniewicz et al. 2005). Lack of local content has been identified as an essential issue to increase access to ICT for the majority of African institutions (Czerniewicz et al. 2005). It has been observed that digital content relates closely to literacy and literacy occurs most effectively

when it involves content that speaks to the needs and social conditions of the learner (Warschauer 2003c in Czerniewicz et al. 2005).

5.4.4 Lack of funding

Another major barrier to ICT integration in teacher education is the lack of sustainability of initiatives once external donor funding has ended. Most of the projects are pilot projects, demonstration projects or experimental projects initiated neither by African governments nor local communities and therefore their existence is dependant on external financing (Butcher 2003). ICT courses and projects for teacher education identified in the SchoolNet such as the Intel Teach to the Future, Connect-ED and EDN, were pilot projects and their continuity after funding was unclear. Funding becomes a vicious cycle unless it is carefully monitored and strategic partnerships can be developed between partners in the public, non-government and private sectors. The challenge is to ensure that poor quality courses do not become ubiquitous because they are cheap and conversely, and good quality courses do not disappear because they are expensive to maintain. The biggest problem here remains the sustainability of these programmes with regard to their funding as well as the challenge to maintain their standards of content and delivery of those programmes which enjoy continued funding (SchoolNet Africa 2004 p. 53).

Furthermore, many of the organizations working in building teacher ICT capacity in Africa are currently working independently with little pooling of resources or expertise. Many of these organizations have insufficient funds and resources to be exhaustive or to create best-of-breed course materials on their own. Pooling of resources and expertise in this sector would help to get greater leverage from the money that is spent on developing teacher training programmes in ICT (SchoolNet Africa 2004).

In their Imfundo report, James *et.al* (2003) assert that in the donor community there is evidence of "re-inventing the wheel" when it comes to developing ICT skills software and manuals, and a number of ICT projects on the African continent seem

to develop their own ICT training courses with little consideration for what has already been developed.

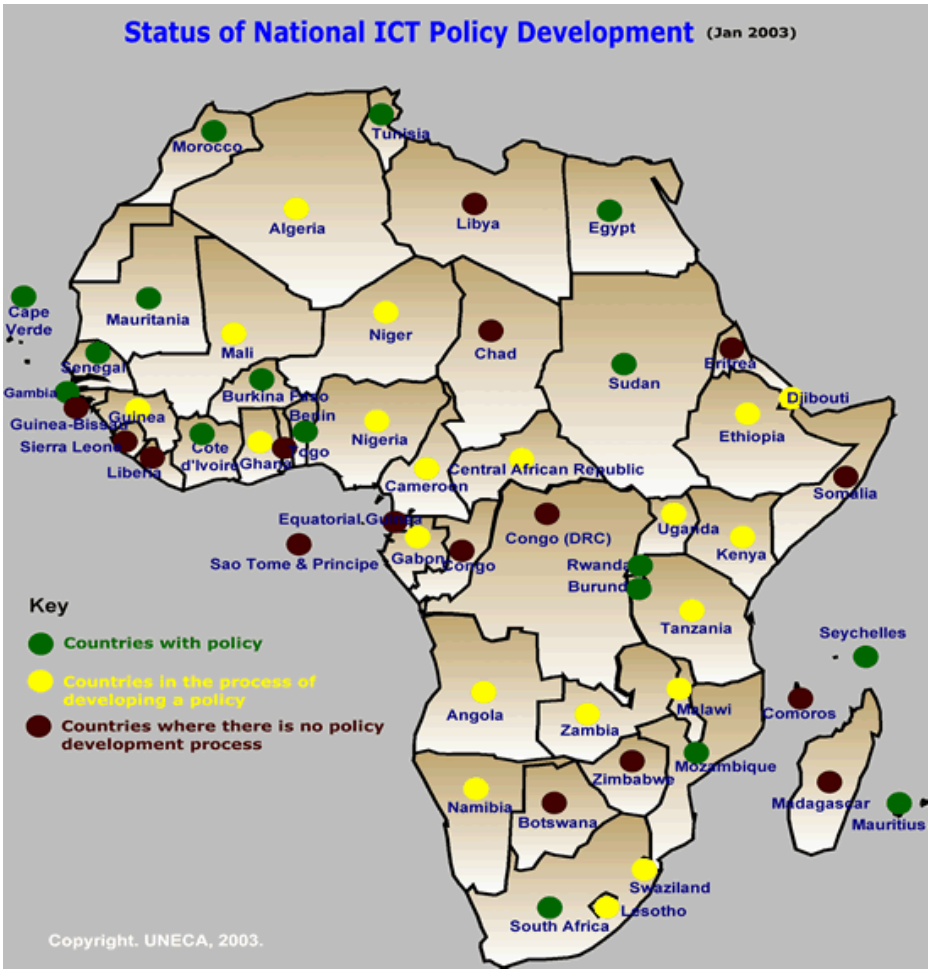


Figure 5.2.: National ICT Policies in Africa by 2003 (source: United Nations Economic Commission for Africa – UNECA http://www.uneca.org/disd/ict/nici_status.htm)

Shortage of government funds to implement ICT policies still remains a challenge. The above figure (5.2) shows that almost one third of African countries had not developed national ICT policies by 2003. Even where governments have developed policies related to ICT in education, implementation remains a problem. Many African education ministries are desperately short of funds to allocate to existing educational requirements. Thus, although most education ministries view ICT as an important new field for education development, ICT programmes for teachers are low in terms of spending priorities.

6. ICT use in teacher training: a case study

In the preceding parts of my work, I have tried to give an account on theoretical approaches and empirical studies in the field of ICT use in teacher education, starting with a global view and then focussing on ICT in teacher training in Africa. The primary purpose of my own empirical study was to explore ICT use in the training of pre-service and in-service in depth and at a more concrete level by way of a case study. My analysis is therefore likely to be more fine-grained than many of the studies I cited. This might counterbalance the fact that due to its character as a case study, it will be difficult to generalise the results to all African teacher education institutions.

Prior to my own research, I started to be involved in a project that was carried out at our Department of Educational Psychology at Cologne University. In the course of the project, a web portal was developed (http://www.portal-education-africa.org) which was to be a platform for teachers and researchers as well as for stakeholders from industry and policy to exchange information on the topic of education in Africa. In this context, the implementation and use of ICT in education played a very important role. In order to facilitate communication with and among African partners, the portal is maintained in the three major official languages of Africa: English, French and Portuguese. There exists, of course, also a German version.

The contacts that were established via the portal and in the context of the project served as a starting point for my own research. In 2004, a questionnaire had been sent out to the African universities which had contacted the portal to receive information on their ICT situation. Results from this study helped me to identify universities that might be able to participate in my research, as one of the prerequisites for participation was that the university's students should have access to the Internet.

Based on these results, 16 universities from Cameroon, DR Congo, Kenya, Senegal, Rwanda, Tanzania and Uganda were approached to participate in my research. Of these 16 universities, six agreed to participate. These were universities from Cameroon, Kenya, Rwanda and Uganda. Their pre-service and in-service teacher

students were asked to fill in an on-line questionnaire on ICT use in their training. Follow-up telephone interviews were conducted with lecturers from the participating universities to provide more in-depth information.

6.1. Research methodology

6.1.1 The questionnaire

The questionnaire which I used to investigate ICT use in teacher education in African Universities was designed on the basis of other studies on ICT use in teacher education (Williams et al. 1998; UNESCO-Bangkok 2003; Angeli & Valanides 2004).

Basically, it consists of four parts:

A: Demographic questions

This part contains questions related to professional status, gender, location of school, teaching subjects.

B: ICT training and course evaluation

In this part, students were asked which kind of ICT-related training they had received in the past. They also were to evaluate two of their ICT courses; one with which they had been content and one with which they had been less satisfied. These were the courses I considered to be good and poor examples of ICT use in teacher training.

C: ICT skills and access

In the third part of the questionnaire, students were to self-assess their ICT skills with respect to 10 different computer applications (word, excel, power point, for instance). They were also asked to indicate what kind of ICT resources they used and where they could access them.

D: General self-assessment in ICT

In the last part, students' attitudes towards ICT were explored. They are also asked to indicate their major difficulties in developing ICT skills.

6.1.2 Participants and data collection

The online questionnaire was open for six months covering the semester beginning in February 2006 and ending in July of the same year. The questionnaire was in English but the French-speaking participants had the option to request a translation, if there was need. This option was not used, however.

6.2. Data analysis

6.2.1 Description of the sample

As can be seen from table 6.1**,** N=186 questionnaires were filled in; 83 of the respondents were female and 103 male. Of the 186 students, 98 identified themselves as teachers and 88 as teacher-students.

	female	male	total
teachers	51	47	98
teacher-students	32	56	88
total	83	103	186

Table 6.1: participants of the study

The respondents' educational goals are given in table 6.2

Educational goal		%
Diploma	34	18.3
Bachelor Degree	63	33.3
Master Degree	51	27.0
PhD	28	14.8
other	10	5.3
total	186	

Table 6.2.: Respondents' educational goals

The majority of the respondents (131) resided in urban areas as compared to 55 students who lived in rural areas.

6.2.2 ICT training and access

In the questionnaire, students were asked if they had received training on ICT use in the course of their studies. They were also asked to indicate the duration of the respective courses. Categories were (1) two weeks, (2) one month, (3) one semester, (4) 12 months and (5) never. In table 6.3, the numbers of students who had indicated that they had never received any training with respect to the different computer applications are given.

ICT training	N of students N=186	
	No training	%
word processing	94	50,5
spreadsheets	119	64,0
presentation tools e.g. Powerpoint	133	71,5
research	135	72,6
email, chat	144	77,4
education networks, forums	162	87,1
statistics	155	83,3
elearning	158	84,9
databases	141	75,8
programming	159	85,5

Table 6.3: Numbers of students with no training experience

Table 6.3 indicates that there is much room for improvement concerning the use of ICT in teacher education in Africa. Only a minority of the respondents had the chance to attend any of the ICT-related courses shown in table 6.3. It is probably safe to conclude that this is due to the fact that most of these courses are not offered in the universities which took part in the survey, or at least they are not offered regularly. The only exception is a course on text processing (MS WORD); only 94 (50,5 %) of the respondents indicated that they had not received any training in this area which means that roughly 50 % of the students did receive training in word processing.

The lack of sufficient access to ICT resources is also reflected in the students' answers to questions regarding actual use of ICT. When asked how often they used ICT resources for learning / teaching (everyday / once a week / once a month / rarely / never) more than half of the students indicated that they never used these resources to support learning processes, with word processing being the only exception (see table 6.4).

ICT use in learning / teaching	N of students N=186	
	No use	%
word processing	79	42,7
spreadsheets	122	65,6
presentation tools e.g. Powerpoint	130	69,9
research	106	57,0
email, chat	120	64,5
education networks, forums	140	75,3
statistics	144	77,4
elearning	147	79,0
databases	139	74,7
programming	152	81,7

Table 6.4: ICT use in learning / teaching

The lack of ICT use in learning and teaching reflects almost exactly the lack of training in the different areas of ICT (see table 6.3). It does therefore not come as too much of a surprise.

When the students were asked in which of their subjects ICT was used, the answers given in table 6.5 were obtained.

ICT use in subjects	N of students N=186	
	N	%
Computer class	68	36,6
Mathematics	13	7,0
Science	22	11,8
Social sciences	16	8,6
Languages	20	10,8
Art	6	3,2

Table 6.5: ICT use in different subjects

Most of the students who used ICT did so in their computer class, but there is some, however limited ICT use also in other subjects.

When asked in which location students made use of ICT, 111 students (59,7 %) referred to the computer laboratory, 41 (22,0 %) mentioned the library and 10 (15,4 %) the classroom.

However, ICT applications are also accessed outside the institutions which the students attended. 141 students (75,8 %) indicated they went to Internet cafes, 69 students (37,1 %) attended ICT training courses outside their institutions, and 25

students (13,4 %) used ICT applications at home. Interestingly, 87 students (46,8 %) declared that they made use of ICT in doing their assignments.

To sum up: it seems that training in and use of ICT in teacher education in the universities which took part in the survey still is at a relatively low level. Text processing using WORD is the most widely trained and used ICT application, but even there, only half of the students indicate they received training in this at their home institutions and actually make use of it. Somewhat more than half of the students have access to ICT applications in their computer laboratories, while almost 80 % of the students also visit Internet cafes to use ICT applications. It is of interest to note that despite the limited access to ICT applications, almost half of the students indicate that they use these applications for their assignments.

6.2.3 Self-assessment of ICT skills

Since I assumed that students would differ with respect to their ICT skills and that this might have consequences for the way they evaluate good and poor examples, I had asked them to assess their own level of ICT skills with respect to ten different computer applications. Categories for self-assessment were (1) excellent, (2) very good, (3) good, (4) fair and (5) no capability. The corresponding mean values are given in table 6.6.

	Mean	SD
1 word processing	3,44	1,52
2 spread sheets	4,10	1,24
3 presentations tools	4,19	1,23
4 research	3,99	1,41
5 email, chat	4,04	1,37
6 education networks	4,50	1,02
7 elearning	4,49	,99
8 statistics	4,55	,98
9 databases	4,44	1,01
10 programming	4,63	,87

Table 6.6: mean values of ICT skills indicators (N=186)

As can be seen from table 6.6, self-assessment of skills in word processing is highest, followed by self-assessment of skills in Internet research, while self-assessment of programming skills is poorest. It is noteworthy that only skills in word processing are assessed as being "good" (3). With respect to all the other computer applications, skills are rated as "fair" (4) or even worse (5).

In order to obtain a more global indicator of ICT skills, I computed for each student the mean values of self-assessments across computer applications. Correlations between the global ICT skills indicator and the single ICT skills indicators are given in table 6.7.

ICT skills	Global indicator
1 word processing	,73(**)
2 spread sheets	,83(**)
3 presentations tools	,85(**)
4 research	,88(**)
5 email, chat	,85(**)
6 education networks	,79(**)
7 elearning	,85(**)
8 statistics	,77(**)
9 databases	,81(**)
10 programming	,69(**)

Table 6.7: Correlations between global indicator for ICT skills and single ICT skills (N=186, ** = $p < 0.01$)

Correlations between global indicator for ICT skills and single ICT skills are all highly significant ($p < 0.01$). However, the correlation between the global indicator and the self-assessment of skills in word processing is smallest. This may indicate that skills in word processing are less representative for general ICT skills than all the other single indicators. Nonetheless, also this correlation is highly significant; to take the global ICT indicator as an assessment of the individual student´s ICT skills seems therefore to be justified.

The mean value for the global indicator of ICT skills was calculated to be 4,24, with a standard deviation of 0,94 (N=186). Looking at the individual global indicators, I found that there are 73 students (= 39,2 % of the total sample) with a value of 5,00, i.e. a third of the sample believes that they do not have any skills in any of the computer applications mentioned.

Since I was interested to find out how self-assessment of ICT skills related to previous training experience and to the evaluation of good and poor examples of ICT courses, I divided the sample into three groups. Students with a global indicator of less than 3,5 were assigned to group 1 (skilled students, N_{high}=41), students with a global indicator higher than 3,5 but less than 5,0 were assigned to group 2 (students with some skills, N_{med}=72), and students with a global indicator of 5,0 were assigned to group 3 (low skill students, N_{low}=73).

On the average, skilled students assess themselves as having good computer skills while low skill students assess themselves as having no computer skills (table 6.8).

Global ICT skills	N	percent	M	SD
(1) skilled students	41	22,0	2,72	,54
(2) students with some skills	72	38,3	4,33	,43
(3) low skill students	73	39,2	5,00	,00

Table 6.8: skilled and low skill students (N=186)

6.2.4 Differences in previous training experiences

In section 6.2.2., I analysed students' previous training in ICT. In the table 6.9, training experiences of skilled students and low skill students are compared. More specifically, the numbers of students who had indicated that they had never received any training with respect to the different computer applications are given for each of the two groups.

Students with no training	Skilled students (N=41)		Low skill students (N=73)	
	N1	%	N2	%
word processing	6	6,4	70	74,5
spreadsheets	10	8,4	71	59,7
presentation tools e.g. Powerpoint	11	8,3	73	54,9
research	12	8,9	73	54,1
email, chat	14	9,7	73	50,7
education networks, forums	22	13,6	73	45,1
statistics	22	14,2	72	46,5
elearning	21	13,3	73	46,2
databases	16	11,3	72	51,1
programming	22	13,8	73	45,1

Table 6.9: Numbers of students with no training experience

Cross tabulating groups by duration of training yielded significant χ^2 –values for all ten computer applications, i.e. there is a strong relationship between group membership and duration of training. As can be seen from table 6.9, roughly half of the low skill group has not had any training experience in any of the computer applications.

It may look surprising that in the low skill group, almost 75 % of the respondents indicate that they have not had any training in word processing, compared to the roughly 50 % for the other computer applications. This has to do with the fact that for all the students, word processing was the best trained computer application. It can be seen from table 6.9 that in absolute numbers, the low skill no-training groups are almost of the same size across the different computer applications while for the whole set of students (skilled and low skill students) word processing has the least numbers of no-training answers (94 for word processing compared to 119 to 159 for the other computer applications; see table 6.3).

In the skilled group, students received remarkably more training. In this group, only 6,4 % of the students indicated that they had not had any training in word processing and even with respect to the other computer applications, the percentage of "no training" students is never higher than 15 %.

Whilst skilled and low skilled students did differ with respect to their training experiences, all of them expressed an interest in developing their own skills and knowledge in ICT. The corresponding question was answered by 165 students in the affirmative, only one student responded with "maybe" and 20 with "no".

6.2.5 Students' attitudes toward using ICT

I assumed that not only students' knowledge and skills would be of importance for their involvement in using and evaluating ICT, but also their attitude towards ICT. The questionnaire contained ten statements that students were to use to describe the way they handle ICT resources (table 6.10). Students were asked to indicate their agreement on scales from 1 (strongly disagree) to 5 (strongly agree).

01. Through ICTs I can interact with teachers / student teachers from different colleges, faculties, countries
02. I'd like to know more about computers
03. Computers scare me
04. I only know the basics of computers
05. I use ICT effectively but don't know how to teach pupils to use it
06. Using ICT, I manage information more effectively
07. Using ICT helps me with my learning
08. I find it easy to select appropriate ICT resources for my teaching
09. I find using ICT time consuming
10. Systems are slow; I'd be quicker using a book

Table 6.10: Attitude towards ICT

As can be seen from table 6.10, some of the statements would indicate a positive attitude towards ICT (e.g. statements 1 and 7) if agreed to, whilst others would indicate a negative attitude (e.g statements 3 and 10). Interestingly, correlation analyses showed that all the intercorrelations between statements turned out to be positive although some of them were quite small.

In order to obtain a more homogenous subset of attitude items, I performed a principal components analysis on the intercorrelations of the original ten statements. There were two eigenvalues greater than one which suggested a two-factor solution. The two components explain 58,7 % of the variance. The Varimax-rotated solution is given in table 6.11; loadings smaller than 0,30 were not printed.

	Component	
	1	2
1 can interact	,653	
2 like to know more	,679	
3 scare me		,735
4 only basics	,385	,484
5 use but cannot teach	,451	,536
6 manage information	,856	
7 helps with learning	,864	
8 easy to select resources	,803	
9 time consuming		,790
10 systems slow		,777

Table 6.11: Principal components analysis of attitude statements

There are five statements which clearly indicate a positive attitude towards ICT if agreed to; these are statement numbers 1, 2, 6, 7 and 8. Two statements seem to be

ambiguous (4 and 5) while the rest (3, 9, 10) seem to indicate a negative attitude if agreed to. I used the average of the five positive statements to compute an ICT attitude score for each student.

There is a clear difference in attitude between students skilled in ICT use and those with low skills in ICT use (table 6.12); the skilled students' attitude towards ICT use is significantly more positive than that of the low skill students ($t = 6{,}70$, $df = 112$, $p < 0{,}01$).

Attitude towards ICT	N	M	SD
ICT skilled students	41	3,71	,92

Table 6.12: attitudes towards ICT in ICT skilled and low ICT skill students

6.2.6 Training experience, attitude towards ICT and ICT skills

I was interested in finding out how training experience, self-assessment with respect to ICT skills and attitude towards ICT use were interrelated. As an indicator of training experience in ICT use, I chose their training in word processing since this seemed to have been the best trained computer application. As to the length of the training, categories in the questionnaire were (1) two weeks, (2) one month, (3) one semester, (4) 12 months and (5) never. I recoded these values, assigning numbers 1 to 4 to the categories 1 to 4 respectively and the number 0 to category 5. The resulting values can be considered to be on an ordinal scale. Non-parametric correlations (Spearman's Rho) are given in table 6.13.

	training	ICT skills	attitude ICT
training	1,00	-,67 (**)	,44 (**)
ICT skills	-,67 (**)	1,00	-,50 (**)
attitude ICT	,44 (**)	-,50 (**)	1,00

Table 6.13: Correlations between training, ICT skills and attitude towards ICT (N=186)

All the correlations between training experience, self-assessment of ICT skills and attitude towards ICT use are highly significant ($p < 0,01$). Negative correlations arise because for training and attitude, high numerical values indicate longer trainings and more positive attitudes, whilst for ICT skills, good skills are represented by low numerical values. The correlational analysis reveals that students with good training experiences tend to assess their ICT skills highly and also tend to have a positive attitude towards ICT. As all the data were collected at the same time, it is impossible to say anything about causal relationships between the three variables. It is plausible, however, that they boost each other mutually.

6.2.7 Evaluation of good and poor examples

In the questionnaire, students were asked to evaluate two courses which they had attended, one with which they had been content and another one with which they had been less satisfied. I expected that this would give me some idea of what students considered to be good and poor examples of ICT use in teacher education.

	N=71	%
Word processing	47	66,1
Introduction to computers	7	9,8
Internet search	6	8,4
Educational kits	3	4,2
Spreadsheets	2	2,8
Video impressions	1	1,4
Powerpoint	1	1,4
Programming	1	1,4
Database	1	1,4
Statistics	1	1,4
Web design	1	1,4

Table 6.14: Frequencies of good examples

	N=59	%
Spreadsheets/Excel	20	33,8
Database	8	13,5
Word	7	11,8
Pointpoint/ presentations	6	10,1
Internet	5	8,4
Programming	5	8,4
Access	4	6,7
Introduction to computers	2	3,3
Online teaching kits	2	3,3

Table 6.15: Frequencies of poor examples

The frequency of courses that were mentioned as good examples are given in table 6.14; and the frequencies of courses that were mentioned as poor examples are given in table 6.15.

As can be seen in table 6.14, the course that was most often mentioned as a good example for ICT use in teacher education was a course on word processing. The situation with respect to poor examples is not as clear. Although courses on spreadsheets / Excel are mentioned most often, a number of other courses are also mentioned.

Students were asked to use two sets of Likert scales to evaluate each course. The first set contained four items which evaluate a course from a cognitive point of view (see table 6.16), while the items of the second set focus on motivational aspects of the course in question (table 6.15). Agreement with the statements was to be indicated on a scale from 1 to 5 where 5 indicated strong agreement.

For this course, please indicate to what extent you agree with the following comments:

- The context of the coursework was empowering to me
- The method courses are/were relevant and prepared me well for the real classroom
- Many of the ICT teacher preparation courses integrated examples and experiences I can relate to
- The courses provide opportunities for me to improve my knowledge in

Table 6.16: Course evaluation, cognitive aspects

I found this ICT teacher training course
1. Relevant – I acquired knowledge and skills to prepare me for teaching using ICT
2. Exciting – I was inspired to find creative ways to work with the computer
3. Validating – I was encouraged to value my background and experiences as a teacher /
4. Empowering – I had meaningful interactions with instructors and peers
5. Methodic – I was taught processes and procedures to follow

Table 6.17: Course evaluation, motivational aspects

All the students evaluated a good as well as a poor example. This came somewhat of a surprise to me because my previous analyses had shown that roughly 40 % of the sample had indicated that they had had no training in any of the computer applications. I therefore checked who had actually made reference to a specific course when asked for his evaluation.

	Evaluation		total
	none or 1 course	2 courses	
(1) skilled students	12	29	41
(2) students with some skills	37	35	72
(3) low skill students	72	1	73
total	121	65	186

Table 6.18: number of evaluations of good and poor examples

As can be seen from table 6.18, there were 65 students who made reference to a specific course for the good as well as for the poor example (2 courses). Of the low skill students, there was only one who had indicated two specific courses. For the following analyses, I therefore entered only those students who had made reference to two specific courses when evaluating good and poor examples.

Mean values for the evaluations of good and poor examples are given in table 6.19. Differences between means for good and poor examples were tested using t-tests for dependent samples.

Evaluation	Good examples	Poor examples	
context was empowering	3,77	2,95	**
relevant	3,26	2,35	**
examples I can relate to	3,15	2,46	**
improve my knowledge	3,57	2,97	**
relevant	3,66	3,02	**
exciting	3,94	3,02	**
validating	3,40	2,78	**
empowering	3,26	2,78	**
methodic	3,54	2,86	**

Table 6.19: Evaluations of good and poor examples (** = $p < .01$, N=65)

As was to be expected, good examples received higher ratings than poor examples. Differences between good and poor examples were highly significant ($p < .01$) with respect to cognitive aspects as well as with respect to motivational aspects of the courses.

6.2.8. Evaluation of good and poor examples: what matters?

I assumed that the evaluation of good and poor examples of ICT use in teacher education was not independent of the knowledge and the skills and the attitudes of the students who were asked to perform the evaluations. I therefore computed an evaluation index for the good as well as for the poor examples, using the mean value for each set of evaluation statements. This index I correlated with the indices for training, ICT skills and attitude towards ICT (table 6.20).

	Evaluation good examples	Evaluation poor examples
training	,07	,08
ICT skills	-,13	-,11
attitude ICT	,39 (**)	,22

Table 6.20: Correlations between evaluations of good and poor examples and indices for training, ICT skills and attitude towards ICT (N=65)

Somewhat to my surprise, the evaluation of good and poor examples hardly correlated with the indices for training, ICT skills and attitude toward ICT. The only correlation which is significantly different from zero is the one between the evaluation of good examples and attitude towards ICT. One has, however, to bear in mind that correlations are based on the data of those students who made specific reference to the courses they evaluated. At the same time, this is the group of students who had assessed themselves as having good or at least fair ICT skills. It may therefore be concluded that students who possess ICT skills are able to evaluate good and poor examples of ICT use in teacher education fairly independently of their training experience and their degree of ICT skills.

6.3. Follow-up study with teacher trainers

Between September and December 2006, I carried out a follow-up study with teacher trainers. The study was intended to target trainers in the institutions which had participated in the online study, but due to communication handicaps, only one institution – the University of Kyambogo in Uganda - participated in this study. Seven teacher trainers were interviewed, three of them female and four male.

The first two interviews were conducted via the telephone but when an opportunity arose to travel to Uganda, an arrangement was made to have the rest of the interviews face-to-face. The interviews were in-depth and lasted one hour per participant. The interviews were designed

- to encourage tutors/lecturers reflect on use of ICT in their practices,
- to explore the values they perceived in this use,
- to find out if and how ICTs were effective in enabling their teaching and students' learning, and
- to identify advantages and disadvantages in using ICT.

The interviews were conducted via telephone as well as face-to-face interviews; below are some of the questions asked in interview:

a) In your opinion, what is the added value of using ICT in teacher training?

b) In what way do students profit from using ICT in their studies?

c) What do you suggest to improve the use of ICT in teacher education?

d) Do you think there could also be some drawbacks using ICT in teacher education? If so,

Which ones?

e) If you look back at the time during which ICT was introduced in your institution, are there any significant changes?

f) Has ICT been integrated in the whole curriculum?

g) Have there been any changes in teaching methods?

h) Have you used ICT in your teaching? If so, please name software and courses.

i) What factors encourage ICT use in teaching?

k) Do you think ICT can enhance learning and teaching?

l) If 'best practice' refers to successful ICT uses, what would you describe as 'best practice' in ICT teacher education in your institution?

m) Are you participating in any networks or partnerships: at an institutional, departmental or individual level?

n) How are Internet resources being employed in teaching?

o) Are there any distance/open learning programmes offered at the university?

Results showed that all the teacher trainers interviewed regarded ICTs as having a significant added value in teacher training, although it was optional and not integrated in the curriculum. When asked what in their opinion was the added value of ICTs in teacher teaching, the lecturers cited some of the following benefits:

- ICTs enable gathering, organising, and finding information;
- ICTs encourage and enable students to do independent research work and to do course work on their own;
- ICTs widen teachers' knowledge horizon;
- as ICTs are interactive they make learning and teaching very interesting, holding students attention and supplementing learning resources such as textbooks.

Furthermore, as there is too much and too many to teach, ICTs help cover the curriculum much faster. According to one female lecturer:

> *"ICT eases teaching, instruction is much faster, it gives students flexibility in learning and also with lecturer/teacher flexibility in giving instructions. To*

me I find it much faster to train when it is aided with computer applications and other packages I could have prepared earlier on. For example in Agriculture there are many things we cannot find in the lab so with ICT we can get the outside into the classroom instead of taking the students; it is much cheaper... you go and photograph different areas of interest, digitise it and bring it to the students. This content is got from different parts of the country and sometimes different parts of the world."

Since the introduction of ICT, significant changes in learning and teaching were observed. Students' learning was said to have become much easier. Students could now use the Internet as a second library. Students are faster with their assignment, express ideas from different sources, and do not have to rely on lecturers most of the time for their knowledge. Students no longer hand in hand-written assignments and lecturers find it easier to read and probably "award better marks". To quote one lecturer:

"Although in this place facilities are inadequate, the few students that we handle especially at post graduate level, benefit in a number of ways; first of all we give them the skills, train them because in this place we have quite a number of students that go out as teacher educators, teacher trainers and there are also those who end up in schools really to teach not necessarily teachers but other students at different levels, primary, secondary and other level. Because of that, the acquisition of the skills, they are in position to prepare some of the resources and materials they need in the classroom like lesson plans, or making schemes of work and other related issues including teaching learning aids. Secondly, those who are in position to have connectivity access to the internet are able to acquire more instructional materials as well as resources, useful websites to broaden and enrich on their content as well as collaborating with colleagues and are also in a position to apply some of the skills they have. The only problem is that most of the acquired skills here may not be applied in the field because of lack of adequate facilities."

There was awareness among the lecturers that the successful implementation and use of ICT in teacher training would probably also require a change in attitude among the main stakeholders:

"I think given the fact that ICT is a new phenomena here and has not spread out, the first thing is to ensure the community around here is sensitized enough so that they are able to see the university potential of ICT. I'm talking about attitudinal change. Many people may not realise the potential of ICT which means they stick to the traditional way of doing things in other words there is need to integrate ICT in our daily lives, professional lives so that if you have a computer like we do here, we would not merely use them as super-type-writers or that kind of thing. And there is need to ensure that there is much more collaboration instead of people working in isolation; to empower the people out there to keep in touch with colleagues so that there is that kind of exchange... what we can call collaborative efforts to share experiences, to share resources and also to keep abreast with ongoing dynamics as a medium of communication and collaboration."

Nevertheless, they all agreed that improving the technical facilities would make integrating ICTs in teacher training much easier. As one teacher expresses it:

"The big problem is of labs and computers. The computer to student ratio is so low sometimes when I do my lectures I have three people per computer and some of the students are still waiting by the end of the two-hour lesson, one comes and says "madam I didn't have a chance to touch" and I feel bad. We don't have enough machines and labs and most of the time we leave students disappointed really, they feel they haven't learnt anything and since there are very few facilities out there even after they leave here I think they forget the skill or the skills are not put to use."

All lecturers had accessed on-line resources either as a support to their teaching or for learning. Some had even acquired more qualifications through on-line programmes. On-line programmes and resources mentioned included: Harvard University; British Council; iearn; Global Learning Portal; UNESCO; University of Sussex; African Virtual University, Eric Digest.

Although most of the respondents had not noticed any change in teaching methods, there are some who reported they had introduced creative methods in their teaching with the help of ICTs:

> *"I use ICT (laptop; projector) in smaller classes for example in classroom practice. I record a video of a teacher teaching a class and use this in the lecture. This has tremendous effect than just using theory. Students watch the video and then comment applying theory they have acquired. I find this a very effective way of teaching."*

All the lecturers expressed the need for training and saw this as the biggest challenge. Some mentioned the case of primary teacher colleges which did have computers but no training staff, and the University could not afford to send them the required number of trainers. Another teacher expressed the fear of most student-teachers when they joined the teaching profession that:

> *"Secondary schools depending on their financial standards are equipping themselves with ICTs and some like Busoga College Mwiri may have up to 100 computers in a school. However, there is a problem of the university producing teachers who are less competent in ICT skills as their schools if they are posted in secondary schools whose ICT programmes are better than the university. For example a student from an upcountry school who academically performs well and graduates from our university but had never been exposed to ICTs, gets posted to first class government school where computers are used in teaching".*

7. Conclusions

As stated in the beginning of my dissertation (p.1), "(T)eacher education institutions may either assume a leadership role in the transformation or be left behind in the swirl of rapid technological change. For education to reap full benefits of ICTs learning, it is essential that pre- and in-service teachers are able to effectively use these new tools for learning. Teacher education institutions and programmes must provide the leadership for pre- and in-service teachers and model the new pedagogies and tools for learning." (UNESCO 2002, p. 3). Improving teacher education is part of world-wide effort to improve education in general with the objective to provide Education for all. Children who receive an education fare better with respect to many aspects of life than those who do not. At the same time, Education for All can be seen as part of a still broader framework that aims at improving living conditions globally and in particular in those countries which suffer from poverty. This framework was established by the Millenium Developmental Goals, agreed upon at the Summit United Nations Millenium Meeting in September 2000.

The Millenium Developmental Goals and the objective of providing Education for All also constitute the framework for my dissertation on ICT in teacher education in Africa.

To lay a theoretical groundwork for the empirical part of my thesis, I first gave an overview of theoretical approaches that seem to be of relevance to the field of ICT-based learning. These are basically "Western" (as opposed to "African") approaches, but from my point of view, they are sufficiently general to also be applied to African education. They might, of course, need to be fine-tuned to African learning environments.

In the section "Integrating theory into practice" I argue that the use of ICT in education also makes possible and even requires a new paradigm in teacher education, a paradigm which puts ICT into the centre of teacher education. This is particularly true for any kind of distance education, and distance education might be one of the ways to cope with the grave problem of lack of trained teachers in Sub-Saharan Africa.

In chapter 3, I take a look at the situation of education in Africa with special emphasis on education in rural Sub-Saharan Africa and on the situation of teachers. Rural areas in Africa are particularly disadvantaged with respect to education because they are impoverished and basic infrastructures such as electrical communication are not even planned for many deep rural communities. While the large-scale implementation of ICT in these regions will meet with enormous problems, the construction of ICT-supported study centres might be a possible venue of facilitating access to education in these regions.

Teachers in Africa face a grim challenge. Pupil to teacher ratios usually exceed 40:1 and in some countries like Chad, the Congo and Mozambique, the ratio approaches 70:1. Traditional teacher education will simply not be able to provide the schools with the number of teachers sufficient to improve the situation. School-based models of teacher education, supported by ICT, might help to improve the situation.

In chapter 4, I examine the role of ICT in education in Africa. In particular, I focus on the situation of women in education and on the impact of HIV/AIDS on education. In Sub-Saharan Africa, women are not only disadvantaged with respect to their access to education, there is also a gender gap with respect to the use of ICT. Special efforts need to be made to reduce these inequalities between men and women.

HIV/AIDS has had a devastating effect on education and on teachers in particular. More teachers die each year of AIDS than can be replaced by the traditional teacher training institutions. AIDS prevention is therefore a major issue, and ICT might play an important role in this.

Chapter 5 is dedicated to the topic of ICT-based teacher education in Sub-Saharan Africa. While expectations are high concerning the impact of ICT on teacher training and education in general, most teachers' ICT competences are still very low. However, there are a number of Pan-African and international initiatives which aim at improving teacher training with respect to ICT use. Some of the research results look promising, and all of the initiatives foster the hope that even under very difficult

circumstances, it is possible to introduce ICT into teacher education. Nonetheless, as pointed out in the last section of this chapter, there are still formidable barriers to a large scale use of ICT in teacher education.

In chapter 6, I present the results of my own case study on the use of ICT in African teacher education. It should be clear from the very beginning that in a strict methodological sense, my data are not representative for Africa, not even for a particular African country. However, they are in line with the results reported in chapter 5 on ICT-based teacher training in Sub-Saharan Africa.

In my study, I asked pre-service and in-service teachers of the universities from Cameroon, Kenya, Rwanda and Uganda to fill in an on-line questionnaire on ICT use in their training which I developed for this purpose. Follow-up telephone interviews were conducted with lecturers from the participating universities to provide more in-depth information.

Of the 186 students who responded, 88 were still in their pre-service training while 98 indicated to be in-service teachers. This might be due to on-going teacher education and professional development in ICT. Most of the in-service teachers were from primary schools which could be an indication of the role played by project programmes in implementing ICTs in teacher education (SchoolNetAfrica 2004; UNESCO 2004; Connect-ED 2005).

As expected there were more respondents from urban areas (131) than from rural areas (55). This correlates to the unequal opportunities of access and connectivity and general distribution of resources of ICT which exist between rural and urban regions.

Nevertheless, findings indicated evidence of gender equality in use and access of ICTs in these institutions with female to male participation of 83:103. This is also reflected in the interviews with lecturers (3:4). Although the ratio of female to male participation is not exactly 50:50, the proportion of female participation is higher than in other statistics on gender inclusion in Africa.

My results show a high percentage of students who had never received ICT training in their studies in any of the ten computer applications indicated. As the follow-up further indicates, there is a major need for improving training in both manpower and hardware.

Access to ICT at the universities is still limited: 36.6% of the students in my sample accessed ICT resources in computer classes, 59.7% accessed ICT in computer laboratories at their institutions and 22% used ICT resources in the library. Surprisingly, there was a high percentage of students (75,8 %) who accessed ICT resources outside the campus. Also, there was a relatively large number of students (46.8%) who used ICT applications to prepare their assignments. This may be taken as an indication that ICT is at least to some extent part of the teacher training in these institutions.

When asked to assess their skills in the different computer applications, a third of the students indicated that they believed they had no skills in the computer applications mentioned. Results showed that self-assessment of ICT skills were related to previous training experience as well as to attitude towards ICT. Students with sufficient or good training experience tend to assess their ICT skills as being good and also demonstrate a positive attitude towards ICT. Since all the data were collected at the same time, it is not possible to give any causal explanations. It is reasonable to assume that training in using ICT resources increased self-assessment of ICT skills and improved attitudes towards ICT. It is, however, also reasonable to assume that a positive attitude towards ICT motivates students to enrol in ICT training which in turn will increase self-assessment in ICT skills. Finally, the belief that one can handle ICT resources well (in the sense of self-efficacy belief) may foster a positive attitude towards ICT and motivate students to engage in more ICT training. Most likely, a model would be appropriate which allows each variable to increase (or decrease) on the bases of feed-back from the other two variables. However, such a model would need to have data taken over a period of time.

Irrespective of the exact nature of the relationship between training in ICT use, self-assessment of ICT skills and attitude towards ICT, the data show that a large majority of the students would like to improve their ICT skills.

Good and poor examples were to be evaluated with respect to their perceived impact on knowledge acquisition and emotion. The impact of good examples was evaluated as being significantly higher than that of the poor examples. Correlational analyses revealed that the evaluation of good and poor examples was independent of prior training and of self-assessment of skills. There was, however, a positive correlation between the evaluation of good examples and students' attitude.

In addition to the questionnaire data, information was obtained from seven teacher trainers through interviews. All the teacher trainers agreed that the use of ICT has an added value in teacher training, citing the following benefits:

- ICT facilitates gathering, organising, and finding information;
- ICT encourages and enables students to do independent research work and to do course work on their own;
- ICT widens teachers' knowledge horizon;
- as most ICT applications are interactive they make learning and teaching very interesting, holding students attention and supplementing learning resources such as textbooks.

Teacher trainers, however, also agreed that the successful implementation and use of ICT would require that attitudes towards ICT among stake holders become more positive and that improving the technical infrastructure would make integrating ICT in teacher training much easier.

To sum up: the literature reviewed as well as my own case study show that the use of ICT in teacher education is still at a low level; there are many barriers to its implementation on a large scale. However, the use of ICT in teacher education in Africa also holds promises: it could support African countries in their strive for providing Education for All and for reaching the Millennium Developmental goals by helping to improve teachers' education, an endeavour that is particularly at risk on a continent where more teachers lose their lives to AIDS than can be replaced by traditional teacher training institutions.

Bibliography

Acacia. (2000). Information and communications technologies (ICTs) for improved service in the new South Africa. In Herselman, ME. (2003). ICT in Rural Areas in South Africa: Various Case Studies. *Informing Science InSITE,* June 2003. Pretoria: Technikom.

Albion, Peter R. (1999). Self-Efficafy Beliefs as an Indicator of Teachers' Preparedness for Teaching with Technology. *Association for the Advancement of Computing in Education* (AACE), Australia. http://www.usq.edu.au/users/albion/papers/site99/1345.html

Angeli, C. & Valanides, N. (2004). The Effect of Electronic Scaffolding for Technology Integration on Perceived Task Effort and Confidence of Primary Student Teachers University of Cyprus. In *Journal of Research on Computing in Education* Vol.37, No.1.

Association of African Universites (AAU). Guidelines for Institutional Self-Assessment of ICT Maturity in African Universities. http://www.aau.org/english/documents/ICT-GUID.pdf accessed 10.02.2006.

Bandura, A. (1986). Social foundations of thought and action - a social cognitive theory. Englewood Cliffs: Prentice Hall.

Bandura, A. (1997). *Self-efficacy. The exercise of control*. New York: Freeman.

Baartman, D. (2001). Evaluation Report VVOB.intervention informatics education Zimbabwe. Brussels, Belgium: Vlaamse Vereniging voor Ontwikkelingssamen-werking en Technische Bijstand. In Baartman, Désiré. (2003). Are we connected? Miscommunication about Internet connectivity between countries in the North and in the South. *TechKnowlogia*, January-March 2003. http://www.techknowlogia.org/

Baartman, Désiré. (2003). Are we connected? Miscommunication about Internet connectivity between countries in the North and in the South. *TechKnowlogia*, January-March 2003. http://www.techknowlogia.org/

BECTA (British Educational Communications and Technology Agency). (2004). *A Review on Research Literature on Barriers to the Uptake of ICT by Teachers*. UK: BECTA. http://www.becta.org.uk accessed: 25.08.2004

BECTA (British Educational Communications and Technology Agency). (2005). Sustainability and Evolution of ICT-Supported Classroom Practice. UK: BECTA. http://partners.becta.org.uk/page_documents/research/bursaries05/sustainability_evolution.pdf

Bieler, R. & Snowman, J. (1997). Psychology applied to teaching (8th Ed.). Boston: Houghton-Mifflin.

Black, Rhoda, S. & Schell, John, W. (1995). *Learning within a Situated Framework: Implications for Adult Learning*. Paper presented at the American Vocational Association Convention (Denver, CO, December 1995)

Bloome, Anthony. (2002). "Did U Know?" Using ICT to Fight HIV/AIDS. *Bulletin of Medicus Mundi Switzerland* No.85, July 2002. http://www.medicusmundi.ch/ accessed: 07.08.06

Boldi, P., Codenotti, N., Santini, M., & Vigna, S. (2002). Structural properties of the African Web . The Eleventh International World Wide Web Conference, Hawaii. In Czerniewicz, Laura & Brown, Cheryl. (2003). Access to ICT for teaching and learning: From single artefact to inter-related resources. *International Journal of Education and Development using ICT (IJEDICT)*, Vol. 1, N.2 (2005). http://ijedict.dec.uwi.edu/viewarticle.php?id=38&layout=html

Borchers, C.A., Shroyer, M.G., & Enochs, L.G. (1992) A Staff development model to encourage the use of microcomputers in science teaching in rural schools. *School Science and Mathematics,* 92(7), 384-391.

Bransford, J., Lin, X., & Schwartz, D. (2000). Technology, learning, and schools: Comments on articles by Tom Carroll and Gerald Bracey. *Contemporary Issues in Technology and Teacher Education*.

Brown, J.S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18* (January), 32-42.

Butcher, Neil. (2003). Technological Infrastructure and Use of ICT in Education in Africa: an overview. ADEA (Association for the Development of Education in Africa) Working Group on Distance Education and Open Learning, December, 2003.

Butler, D. & Winne, P. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research, 65*(3), 245 – 281. In Jung, Insung. (2001). Issues and Challenges of Providing Online Inservice Teacher Training: Korea's experience. The International Review of Research in Open and Distance Learning, Vol 2, No 1.

Byron I. & Gagliardi, R. (1998). Communities and the Information Society: The role of Information and Communication technologies in education. Ottawa: The Independent Development Research Centre (IDRC).

Candy, P. (1998). Knowledge navigators and lifelong learners: producine graduates for the information society, in: C. Rust (ED.) *Improving student learning: improving students as learners.* (Oxford, Oxford Centre for Staff and learning Development, 26, 19-28.

Capper, J. and Fletcher, D. (1996). Effectiveness and cost-effectiveness of print-based correspondence study. Alexandria: Institute for Defense. In Jung, Insung. (2001). Issues and Challenges of Providing Online Inservice Teacher Training: Korea's experience. The International Review of Research in Open and Distance Learning, Vol 2, No 1.

Carlson, Sam & Gadio, Tidiane, Cheick. (2002). Teacher Professional Development in the Use of Technology. Paris, UNESCO. http://unesdoc.unesco.org/images/0011/001191/119129e.pdf accessed: 24.10.2006.

Casely-Hayford, Leslie & Lynch, Paul. (2003). A Review of Good Practice in ICT and Special Educational Needs for Africa. An Imfundo Knowledge Bank Initiative. http://www.schoolnetafrica.net/fileadmin/resources/SENPHASE1FINAL.pdf

Castro, Claudio de Moura. (2003). Are new technologies better technologies? For whom? Chapter 2, 39-54. In UNESCO. (2003). Adapting technology for school improvement: a global perspective. http://unesdoc.unesco.org/images/0013/001361/136149e.pdf

Cawthera, Andy. (2001). *Computers in Secondary Schools in Developing Countries: Costs and Other Issues*. The Department for International Development (DFID), World Links For Development (WorLD), *The Human Development Network of the World Bank* Serial No. 43. http://www.alle.de/transfer/downloads/MD353.pdf accessed: 31.03.2004

Chiero, R.T. (1997). Teachers' perspectives on factors that affect computer use. Journal of Research on Computing in Education, 30(2), 133-145.

Cisler, Steve & Yocam, Keith. (2003). Connect-ED Evaluation (Uganda) http://www.eduaction.net/connect-edtext.pdf accessed: 17.10.2006.

Collins, A., Brown, J.S. & Newman, S.E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. Pp.453-494. In Resnick, L.B. (Ed.) *Knowing, learning, and instruction: Essays in Honour of Robert Glaser*. Hillsdale, N.J.: Lawrence Erlbaum.

Collis, B. & Van Der Wende, M. (Eds). (2002). Models of technology and change in higher education, Center for Higher Education policy Studies, University of Twente, the Netherlands. In Kirkwood, Adrian & Price, Linda. (2005). Learners and learning in the twenty-first century: what do we know about students' attitudes towards and experiences of information and communication technologies that will help us design courses? *Studies in higher Education*, Vol. 30, no.3, June 2005, 257-274.

Collis, B., & & Jung, I.S. (2003). Use of information and communication technologies in teacher education. In Jung, Insung. (2005). ICT-Pedagogy Integration in Teacher training: Application cases worldwide. Educational Technology & Society, 8 (2), 94-101. http://www.ifets.info/journals/8_2/8.pdf accessed 06.10.06

Czerniewicz, Laura & Brown, Cheryl. (2005). Access to ICT for teaching and learning: From single artefact to inter-related resources. *International Journal of Education and Development using ICT (IJEDICT)*, Vol. 1, N.2 (2005). http://ijedict.dec.uwi.edu/viewarticle.php?id=38&layout=html

DEEP Project Team. (2004). DEEP IMPACT: an investigation of the use of information and communication technologies for teacher education in the global south. Researching the issues http://www.open.ac.uk/deep/FinalReport-print.pdf accessed: 13.10.2006.

Delcourt, Marcia A.B. & Kinzie, Mable B. (1993). Computer Technologies in Teacher Education: The Measurement of Attitudes and Self-Efficacy. *Journal of Research and Development in Education*, v27 n1 p35-41 1993. In Jones, Anthony. (2002). Refusing or ignoring? An investigation of student teachers' perceptions and use of computers. http://www.ascilite.org.au/aset-archive/confs/2002/jones.html

Delannoy, F. (2000). Teacher Training and Thechnology. *TechKnowLogia.* In Carlson, Sam & Gadio, Tidiane, Cheick. (2002). Teacher Professional Development in the Use of Technology.

Dembélé, M. (2004). Competent teachers for African classrooms: looking ahead. IIEP Newsletter, Paris, vol. xxii, No. 1, pp 5-6.

Derbyshire, Helen. (2003). Gender issues in the use of computers in education in Africa. http://imfundo.digitalbrain.com/imfundo/web/learn/documents/Gender%20Report.pdf accessed: 12.10.2006.

Driscoll, M. P. (1994). Psychology of learning for instruction. Boston: Allyn and Bacon.

Dzvimbo, Kuzvinetsa Peter, Barasa, Simiyu Fred & Kariuki, Wangeci Catherine. (2006). The AVU Teacher Education Initiative: An African Response to Challenges of Teacher Development and ICT Opportunities. Association for the Development of Education in Africa (ADEA).

Educational International (EI). Draft Report 2006. *Training for Life: Teacher Training on HIV/AIDS*. http://www.ei-ie.org/efaids/en/publications.htm accessed 10.10.06

Evans, David R., Ed. (1994). Education Policy Formation in Africa: A Comparative Study of Five Countries. Technical Paper No.12. Agency for International Development (IDCA), Washington, DC. Bureau for Africa.

Farrell, Glen M., Ed. (1999). The Development of Virtual Education: A Global Perspective. A Study of Current Trends in the Virtual Delivery of Education. The Commonwealth of Learning, Vancouver, Canada. http://www.col.org/virtualed/ accessed: 20.03.2007.

Fosnot, Catherine. (1996) *Constructivism: Theory, perspectives, and practice*. New York: Teachers College Press.

Garcia, B.G. & McGlynn, D. (1999). Beyond the Learning Tool Paradigm: The Computer as a Medium in a Technology Enhanced Multicultural Education Course. Society for Information Technology and Teacher Education International Conference 1999 (1) pp 314-319, San Antonio.

Ghelawdewos, Araia. (2004). Africa: Education, Development and the Third Millennium. http://www.africanidea.org/african_education.html

Gunter, G.A. (2001). Making a difference: Using emerging technologies and teaching strategies to restructure an undergraduate technology course for preservice teachers. *Educational Media International*, 38:1 (March, 2001): 13-20.

Gunter, Glenda, A. & Evans, Brandi P. (2004). A Catalyst for Change: Influencing Preservice Teacher Technology Proficiency. *Journal of Educational Media & Library Sciences*, Vol.41 No :3 (March 2004) : 325-336.

Gustafsson, Ingemar. (1985). Integration Between Education and Work at Primary and Post-Primary Level – the case of Botswasa. Stockholm: University of Stockholm, Institute of International Education, Working Paper Series No.95, 1985. In Samoff, Joel. (1999b). No Teacher Guide, No Textbooks; No Chairs: Contending with Crisis in African Education. Paper presented at the Annual Meeting of the African studies Association (43rd, Philadelphia, PA, November 11-14, 1999).

Gwyn, Sara. (2005). The importance of bandwidth management and optimisation in research and education institutions. INASP (International Network for the Availability of Science Publications). http://www.interacademies.net/Object.File/Master/4/929/Dakar_sgwynn-bmo-iap-2006-01-31.pdf

Hawkins, Robert. (2005). Enhancing Research and Education Connectivity in Africa: The findings of the African Tertialy Instituion Connectivity Study (ATICS) and information on the African Virtual University. The World Bank.

Harvey, Lee & Knight, Peter T. (1996). Transforming Higher Education. Open University Press, Bristol.

Infodev (Information Development program). (2005). Knowledge Maps: ICTs and Education. *InfoDev* (Information for Development Program). http://www.infodev.org/en/Project.1.html accessed 07.10.2005

Infodev (Information Development program). (2006). Survey of ICT in Education in Africa: How are ICTs currently being used in the education sector in Africa, and what are the strategies and policies related to this use? http://www.infodev.org/en/Project.7.html

Jager, A.K. & Lokman, A.H. (1999). Impacts of ICT in education. The role of teacher and teacher training. Education-line. Paper Presented at the European Conference on Educational Research, Lahti, Finland 22 - 25 September 1999 http://www.leeds.ac.uk/educol/documents/00001201.htm accessed 08.12.05.

James, T., Hesselmark O., Akoh B and Mware, L (2004): Review of basic ICT Skills and training software for educators in Africa' DFID Imfundo Partnership for IT in Education: http://imfundo.digitalbrain.com/imfundo/web/papers/ictreview/?verb=view

Janssens-Bevernage, Anouk; Cornille, Bart & Mwaniki, Nyaga. (2005). Integrating ICT in Teacher Training: Reflections on Practice and Policy Implications - A Case Study of the Learning Resource Centre at the Kenya Technical Teachers College. http://www.idrc.ca/en/ev-93060-201-1-DO_TOPIC.html

Jones, Anthony. (2002). Refusing or ignoring? An investigation of student teachers' perceptions and use of computers. http://www.ascilite.org.au/aset-archive/confs/2002/jones.html

Jung, Insung. (2001). Issues and Challenges of Providing Online Inservice Teacher Training: Korea's experience. The International Review of Research in Open and Distance Learning, Vol 2, No 1.

Jung, Insung. (2005). ICT-Pedagogy Integration in Teacher training: Application cases worldwide. Educational Technology & Society, 8 (2), 94-101. http://www.ifets.info/journals/8_2/8.pdf accessed 06.10.06

Kellenberger, D. (1996). Preservice teachers' perceived computer self-efficacy based on achievement and value beliefs within a motivational framework. *Journal of Research on Computers in Education,* 29(2), 124-140.

Kelly, M.J. (2006). The HIV/AIDS Challenge to Education. In UNESCO (2006). Educational planning and management in a world with AIDS. Version 1, Module 2. Paris, UNESCO.

Kirkwood, Adrian & Price, Linda. (2005). Learners and learning in the twenty-first century: what do we know about students' attitudes towards and experiences of information and communication technologies that will help us design courses? *Studies in higher Education*, Vol. 30, no.3, June 2005, 257-274.

Kozma, Robert, B. (2005). National Policies that connect ICT-based education reform to economic and social development. Human Technology Vol. 1 (2), October 2005, 117-156.

Kwabena, Dei, Ofori-Attah. (1997). African Universities and the Internet: The Challenge of Networking. Presented at *The 12 Annual African Educational Research Symposium, Ohio University, Athens, February 21-22, 1997.* http://www2.ncsu.edu/ncsu/aern/OFOPRE.HTML

Lave, J., & Wenger, E. (1991). Situated Learning: Legitimate Peripheral Participation. New York: Cambridge University Press. In Smith, M. K. (2003). Communities of Practice, *the encyclopedia of informal education*. http://www.infed.org/biblio/communities_of_practice.htm

Larose, F., David, R., Dirand , J., Karsenti, T., Vincent Grenon, V., Lafrance, S. & Judith Cantin, J. (1999). "Information and Communication Technologies in University Teaching and in Teacher Education: Journey in a Major Québec University's Reality". *Electronic Journal of Sociology*. In Ololube, Nwachukwu, Prince. (2006). Appraising the relationship between ICT usage and integration and the standard of teacher education programs in a developing country. *IJEDICT*. Vol. 2, Issue 3 pp. 70-85. http://ijedict.dec.uwi.edu/viewissue.php?id=9 accessed 05.10.06

Leach, Jenny. (2004). DEEP IMPACT: an investigation of the use of information and communication technologies for teacher education in the global south. Researching the issues http://www.open.ac.uk/deep/FinalReport-print.pdf accessed: 13.10.2006.

Learning Resource Centre at the Kenya Technical Teachers College. In Etta, Florence & Elder, Laurent (ed.). (2005). At the Crossroads: ICT Policymaking in East Africa. East African Educational Publishers/IDRC. http://www.idrc.ca/en/ev-93969-201-1-DO_TOPIC.html accessed July 2006.

LearnLink (Digital Tools for Development). A Sourcebook on Access and Applications: Models of Use & Case Studies. http://learnlink.aed.org/publications/sourcebook/home.htm accessed 01.07.06

Leask, Marilyn. (2003). ICTs in school classrooms: planning to avoid costly mistakes. *Insights Education* February 2003, Issue No.1.

Lefever, Samuel C. (2004). ICT in teacher education: What an e-learning environment has to offer. http://netla.khi.is/greinar/2004/009/

Lemon, Anthony. (1995). Educational changes in Zimbabwe: some lessons for a post-apartheid South Africa. *Comparative Education*, Vol. 31, No. 1, March 1995. In Ghelawdewos, Araia. (2004). Africa: Education, Development and the Third Millennium. http://www.africanidea.org/african_education.html

Lewin, K.M. (2002). The costs of supply and demand for teacher education: dilemmas for development. *International Journal of Educational Development*, 22(3-4), 221-42.

Lim, C. & Khine, M. (2006). Managing Teachers' Barriers to ICT Integration in Singapore Schools. 14 (1), pp. 97-125. Chesapeake, VA: AACE. *Journal of Technology and Teacher Education* Vol. 14, Issue 1, January 2006. http://www.editlib.org/index.cfm?fuseaction=Reader.TOC&sourceissue_id=304

Mannisto, Laura; Kelly, Tim & Petrazzini, Ben. (1997). Internet and Global Information Infrastructure in Africa. ITU. http://www.itu.int/ITU-D/ict/papers/witwatersrand/tam_tam.pdf

Mar Gadio, Dr. Coumba. (2001). Exploring the Gender Impact of the World Links Program, November 2001, www.world-links.org. In Bloome, Anthony. (2002). "Did U Know?" Using ICT to Fight HIV/AIDS. *Bulletin of Medicus Mundi Switzerland* No.85, July 2002. http://www.medicusmundi.ch/ accessed: 07.08.06

McCormick, R & Scrimshaw, P. (2001). ICT, Knowledge and Pedagogy. Educational, Communication and Information, Vol.1. No.1. In Moon, Bob; Leach, Jenny & Power, Tom. (2002b). Building teachers' professional knowledge through ICT: experience and analysis across the 'digital divide'. The Open University, United Kingdom. Presented to the European Conference on Educational Research, University of Lisbon, September 11th - 14th 2002.

McGee, Steven; Howard, Bruce & Scott, Lisa Ann. (2001). Designers should provide support by promoting self-regulated learning. *The Center for Educational Technologies®* http://vdc.cet.edu/entries/regulations.htm

Moghadam, Valentine. (1998). Women, Work, and Economic Reform in the Middle East and North Africa. Lynne Rienner Publishers, Inc. Boulder, Colorado. http://gender.ciscolearning.org/Strategies/Strategies_by_Region/Africa/Index.html

Moon, B. (2000). The Open Learning Environment: a new paradigm for international developments in teacher education. In Moon, Bob. (2004). Open Learning and ICTs: A radical solution to preparing teachers to meet the Universal Basic Education (UBE) challenge. The Open University, United Kingdom. http://www.col.org/pcf3/Papers/PDFs/Moon_Bob.pdf accessed: 18.07.2006

Moon, Bob & Dladla, Nhlanganiso. (2002a). Challenging the assumptions about teacher education and training in Sub-Saharan Africa: a new role for open learning and ICT. Presented to the Pan-Commonwealth Forum on Open Learning, International Convention Centre, Durban, South Africa July 29th – 2nd August 2002. http://www.open.ac.uk/deep/Public/web/publications/pdfs/NDladlaBMoon2002-PCF.pdf accessed:18.07.2006

Moon, Bob; Leach, Jenny & Power, Tom. (2002b). Building teachers' professional knowledge through ICT: experience and analysis across the 'digital divide'. The Open University, United Kingdom. Presented to the European Conference on Educational Research, University of Lisbon, September 11th - 14th 2002. http://www.leeds.ac.uk/educol/documents/00002349.htm Accessed: 18.07.2006

Moon, Bob. (2004). Open Learning and ICTs: A radical solution to preparing teachers to meet the Universal Basic Education (UBE) challenge. The Open University, United Kingdom. http://www.col.org/pcf3/Papers/PDFs/Moon_Bob.pdf accessed: 18.07.2006

Moon, B, Leach, J. and Stevens, M.-P. (2006). Open and Distance Learning for Teacher Education in Africa: Innovation and Change, a toolkit for Education Policy Planners and Teacher Educators in Sub Saharan Africa, The World Bank.

Mottin-Sylla, Marie-Hélène. (2005). The Gender Digital Divide in Francophone Africa. Dakar. http://www.genderit.org/resources/africa_gender_divide.pdf accessed: 12.10.2006.

Murphy, Colette. (2000). Effective Use of ICT by Student Teachers – Is It Improving? http://eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/22/7d/4f.pdf accessed: 06.10.06.

Muwanga-Zake, J.W.F. (2001). Experiences of the Power of Discourse in Research: A Need for Transformation in Educational Research in Africa. http://www2.ncsu.edu/ncsu/aern/muwangap.html

NEPAD e-Schools Initiative and Teacher development. (2003). Address by Prof. Peter E. Kinyanjui Programme Commissioner/Coordinator e-Africa Commission, NEPAD *'Africa Regional Conference in Teacher Training on 'Use of ICT in the Classroom' Nairobi, 4-6 November 2003*

Nua Internet Surveys (2000). In Gender Initiative Institute (2004). Cisco Learning Institute.
http://gender.ciscolearning.org/Strategies/Strategies_by_Region/Africa/Index.html

Obayelu, A. Elijah & Ogunlade, I. (2006). Analysis of the uses of information and communications technology for gender empowerment and sustainable alleviation in Nigeria. *International Journal of Education and Development using ICT*, Vol.2, No.3 (2006).

Ogunniyi, M. B. (1996). Science, Technology and Mathematics: The Problem of Developing Critical Human Capital in Africa. *International Journal of Science Education*, Vol. 18, No. 3, 267-284. In Muwanga-Zake, J.W.F. (2001). Experiences of the Power of Discourse in Research: A Need for Transformation in Educational Research in Africa. http://www2.ncsu.edu/ncsu/aern/muwangap.html

Ololube, Nwachukwu, Prince. (2006). Appraising the relationship between ICT usage and integration and the standard of teacher education programs in a developing country. *IJEDICT*. Vol. 2, Issue 3 pp. 70-85.
http://ijedict.dec.uwi.edu/viewissue.php?id=9 accessed 05.10.06

Palincsar, A.S. & Brown, A.R. (1984). Reciprocal teaching of comprehension fostering and comprehension monitoring activities. *Cognition and Instruction*, *1*, 117-175.

Perraton, Hilary & Creed, Charlotte. (2000). Applying New Technologies in Basic Education. *International Research Foundation for Open Learning February 2000*.

Pipa, Norris. (2001). Digital Divide. Cambridge: University Press

Pintrich, & Schunk, D. (1996). Motivation in education: Theory, research and applications. Englewood Cliffs: Prentice Hall.

Pryor, John, & Ampiah, Joseph, Chartey. (2003). Understandings of education in an African Village: the impact of Information and Communication Technologies. DFID,

UK. http://www.dfid.gov.uk/pubs/files/understandedafricaedpaper52.pdf accessed: 31.03.2004.

Putman, A.R. (2001). Problem-Based Teaching and Learning in Technology education. Association for Career and Technical Education. New Orleans.

Renkl, A. (1996). Trages Wissen: Wenn erlerntes nicht genutzt wird. *In Psychologische Rundschau,* 47, 78-92.

Ropp, M. (1999). Exploring individual characteristics associated with learning to use computers in preservice teacher preparation. *Journal of Research on Computing in Education,* 31(4), 402-424.

Sakoana, Thapelo. (2005). Nepad plan to link African schools. South Africa's official Gateway. http://www.safrica.info/what_happening/news/african_union/eschools.htm accessed 26 October 2005.

Samoff. Joel. (1999a). When Research Becomes Consulting. Paper presented at the Annual Meeting of the Comparative and International Education Society (Toronto, Canada, April 14-18, 1999).

Samoff, Joel. (1999b). No Teacher Guide, No Textbooks; No Chairs: Contending with Crisis in African Education. Paper presented at the Annual Meeting of the African studies Association (43rd, Philadelphia, PA, November 11-14, 1999).

Samoff, Joel. (2005). The Pursuit of Effective External Support and Persisting External Influence – Direct, Indirect, and Negotiated. Paper presented at the Nuffic Expert Meeting – A Changing Lsndscape: Making support to tertiary education and research in developing countries more effective. The hague, The Netherlands, 23-25 May 2005.

Scardamalia, M & Bereiter, C. (1985). Fostering the development of self-regulation in children's knowledge processing. Pp. 563-577. In S.F.Chipman, J.W.Segal &

R.Glaser (Eds.). *Thinking and learning skills: Research and open questions*. Hillsdale, N.J.: Lawrence Erlbaum.

Schoenfeld, A.H. (1985). *Mathematical problem solving*. New York: Academic Press.

SchoolNet Africa. (2004). Towards a Strategy on DevelopingAfrican Teacher Capabilities in the Use of Information and communication Technology (ICT). http://www.schoolnetafrica.net/index.php accessed 14.12.2005

Schunk, D. (2000). Learning theories: An educational perspective (3rd Ed) Upper Saddle river, NJ: Prentice-Hall.

Sherman, L. W., (1995). *A Postmodern, Constructivist and Cooperative Pedagogical Strategy for Teaching Educational Psychology Assisted by Computer Mediated Communication*. A paper presentation to the ComputerSupport for Collaborative Learning '95 International Conference. Bloomington, Indiana, Indiana University, 17-20 October, 1995.

SITE (Society for Information Technology and Teacher Education). (2002). SITE position paper: statement of basic principles and suggested actions ('Ames White Paper'). http://www.aace.org/site/SITEstatement.htm accessed 19.06.2006

Smith, M. K. (2003) 'Communities of practice', *the encyclopedia of informal education*, www.infed.org/biblio/communities_of_practice.htm.

Spiro, R., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. *Educational Technology*, *31* (May), 24-33.

Steffens, Karl. (2006). Self-Regulated Learning in Technology Enhanced Learning Environments: Lessons of a European Peer Review.

Strykeer, C. (2000). Teaching Successful Telecourses. Montana State University, Bozeman, MT, National Teachers Enhancement Network. In Carlson, Sam & Gadio, Tidiane, Cheick. (2002). Teacher Professional Development in the Use of Technology.

Swanson, H.L. (1990). Influence of metacognitive knowledge and aptitude on problem solving. *Journal of Educational Psychology*, 82 (2), 306-314. In McGee, Steven; Howard, Bruce & Scott, Lisa Ann. (2001). Designers should provide support by promoting self-regulated learning. *The Center for Educational Technologies®* http://vdc.cet.edu/entries/regulations.htm

Teo, Timothy. (2006). *Attitudes toward computer: A study of post-secondary students in Singapore.* Journal of Technology and Teacher Education Vol. 14, Issue 1, January 2006.

The Cognition and Technology Group at Vanderbilt (CTGV). (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher*, *19* (August-September), 2-10.

The Cognition and Technology Group at Vanderbilt. (1997). *The Jasper project. Lessons in curriculum, instruction, assessment, and professional development*. Mahwah, N.J.: Lawrence Erlbaum Associates.

The Partnership for Higher Education in Africa. (2003). *Securing the Linchpin ICT Teaching, Learning, and Research.* Carnegie Corporation of New York. http://www.foundation-partnership.org/linchpin/profiles.php

The State of the World's Children 1999: Education. http://www.unicef.org/sowc99/

UNESCO. (1998). World Education Report 1998. Teachers and Teaching in a Changing World. Paris, UNESCO.

UNESCO. (1999). Education for All A Framework for Action in Sub-Saharan Africa: Education for African Renaissance in the Twenty-first Century Adopted by

the Regional Conference on Education for All for Sub-Saharan Africa Johannesburg, South Africa, 6-10 December 1999 http://www.unesco.org/education/efa/wef_2000/regional_frameworks/frame_africa.shtml

UNESCO. (2000a). The Dakar Framework for Action: Education for All – Meeting our Collective Commitments. World Education Forum, Dakar, Senegal, 26-28 April. Paris, UNESCO.

UNESCO. (2000b). Education for All: Report from the Sub-Saharan Region. Assessment of Basic Education in Sub-Saharan Africa 1990-2000. Harare, UNESCO.

UNESCO. (2001). Teacher Education Through Distance Learning. Technology Curriculum Cost Evaluation. http://unesdoc.unesco.org/images/0012/001242/124208e.pdf accessed 12.10.06.

UNESCO. (2002). Information and Communication Technologies in Teacher Education. A Planning Guide. http://www.ifip-tc3.net/IMG/pdf/unesco-nikki129533e.pdf accessed 10.04.2005.

UNESCO. (2003). Adapting technology for school improvement: a global perspective http://unesdoc.unesco.org/images/0013/001361/136149e.pdf

UNESCO-Bangkok. (2003). Developing and Using Indicators of ICT Use in Education.

UNESCO. (2005). Education for All – Global Monitoring Report 2006. UNESCO, France.

UNESCO. (2006). HIV and AIDS Education: Teacher Training and Teaching a web-based desk study of 10 African countries. Accessed 17 March 2006 http://hivaidsclearinghouse.unesco.org/ev_en.php?ID=5850_201&ID2=DO_TOPIC

UNESCO (2006). Education for All – Global Monitoring Report 2007. UNESCO, France.

UNESCO International Institute for Capacity Building (IICBA). (2006). Strategic Plan 2005-2008.

UNESCO's Teacher Training Initiative for Sub-Saharan Africa (TTISSA). (2006). Ghana: Particular Issues on Teacher Education and Training in Ghana. http://unesdoc.unesco.org/images/0014/001448/144826E.pdf

United Nations. (2000). The World's Women. Trends and Statistics. United Nations Department of Economic and Social Affairs, August, 2000.

United Nations Economic Commission for Africa (UNECA). (2003). Map showing the Progress of NICI Plans and Policies in Africa. http://www.uneca.org/disd/ict/nici_status.htm

United Nations ICT Task Force. (2003). Tools for Development. Using Information and Communications Technology to achieve the Millennium Development Goals.

United Nations Economic and Social Council – Unescap (2005). Information, Communications and Space Technology for Meeting Development Challenges. Unescap, Bangkok. http://www.unescap.org/61/LDC_7/English/LDC7_2E.pdf

Unwin, T. (2004). Towards a framework for use of ICT in Teacher Training in Africa. http://www.gg.rhul.ac.uk/ict4d/ICT%20TT%20Africa.pdf accessed 20.08.2006.

Unwin, T. (2005). Partnerships in development practice: evidence from multi-stakeholder ICT4D partnership practice in Africa. Paris: UNESCO. http://www.gg.rhul.ac.uk/ict4d/Research.html

USAID. (2006). ICT for Teacher Professional Development in Uganda: Impact & Scalability Assessment. http://www.dot-com-alliance.org/documents/Uganda_Evaluation_Report_Full1.pdf accessed 17.03.07

Van Ark, B., Inklaar, R., and McGuckin, R. H. (2002). *Changing gear: Productivity, ICT and service: Europe and the United States*, University of Groningen and The Conference Board, mimeograph. In Obayelu, A. Elijah & Ogunlade, I. (2006). Analysis of the uses of information and communications technology for gender empowerment and sustainable alleviation in Nigeria. *International Journal of Education and Development using ICT*, Vol.2, No.3 (2006).

Vye, N. J., Schwartz, D. L., Bransford, J. D., Barron, B. J., & Zech, L. (1998). SMART environments that support monitoring, reflection, and revision. Pp.305-346 in D.J.Hacker, J.Dunlosky, & A.C.Graesser (Eds.). *Metacognition in educational theory and practice.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Waldick, Lisa. (2005). Come Together: African Universities Collaborate to Improve Bandwidth. International Development Research Centre (IDRC) http://www.idrc.ca/en/ev-91755-201-1-DO_TOPIC.html

Walker, Kenneth. (2005). Bandwidth and Copywright: barriers to knowledge in Africa. Carnegie Reporter. (3). http://www.carnegie.org/reporter/10/bandwidth/index.html

Warschauer, M. (2003). Technology and Social Inclusion: Rethinking the Digital Divide. The MIT Press, Massachusetts. In Czerniewicz, Laura & Brown, Cheryl. (2003). Access to ICT for teaching and learning: From single artefact to inter-related resources. *International Journal of Education and Development using ICT (IJEDICT)*, Vol.1, No.2 (2005). http://ijedict.dec.uwi.edu/viewarticle.php?id=38&layout=html

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. Cognition and Instruction, 16(1), 3-118. In McGee, Steven; Howard, Bruce & Scott, Lisa Ann. (2001). Designers Should

Provide Support by Promoting Self-Regulated Learning. http://vdc.cet.edu/entries/regulations.htm

Williams, Dorothy; Wilson, Kay; Richardson, Amanda; Tuson, Jennifer & Coles, Louisa. (1998). *Teachers' ICT skills and knowledge needs: Final Report to SOIED*. The Robert Gordon University. http://www.scotland.gov.uk/library/ict/append-title.htm

Woodhill, Gary. (2004). Where is the Learning in E-learning? A critical analysis of the e-learning industry. Operitel Corporation. http://www.e-learningguru.com/wpapers/e-Learning_analysis.pdf

World Bank. (2003). ICT and MDGs: A World Bank Group Perspective. December 2003. http://info.worldbank.org/ict/assets/docs/mdg_Complete.pdf

World Summit on Information Society (WSIS). Geneva 2003. http://www.itu.int/wsis/docs/geneva/official/dop.html

Wyatt, S. & Henwood, F.(2000). *Technology and In/Equality*. London: Routledge. In Obayelu, A. Elijah & Ogunlade, I. (2006). Analysis of the uses of information and communications technology for gender empowerment and sustainable alleviation in Nigeria. *International Journal of Education and Development using ICT*, Vol.2, No.3 (2006).

YouthNet. (2004). Teacher Trainng: Essential for School-Based Reproductive Health and HIV/AIDS Education. Focus on Sub-Saharan Africa. http://www.coreinitiative.org/pub/marriedYI3.pdf accessed 21.10.06

Zimmerman, B.J. (1989). Models of Self-regulated learning and academic achievement, In Howard, B.C; McGee, S; Hong, N.S.; Shia, R. (2000). The Influence of Metacognitive Self-Regulation on Problem-Solving in Computer-Based Science Inquiry. American Educational Research Association. New Orleans.

Website consulted regularly:

EFAIDS:

http://www.ei-ie.org/efaids/en/about.htm

Educational Psychology websites:

http://www.edb.utexas.edu/csclstudent/Dhsiao/theories.html#construct

http://chiron.valdosta.edu/whuitt/interact.html

http://tip.psychology.org/index.html

http://tip.psychology.org/lave.html

http://www.edb.utexas.edu/csclstudent/Dhsiao/theories.html

http://www.edb.utexas.edu/csclstudent/Dhsiao/theories.html#construc

Imfundo:

http://www.dfid.gov.uk/research/imfundo.asp

Microsoft press centre:

http://www.microsoft.com/emea/presscentre/default.mspx

South Africa:

http://www.safrica.info/what_happening/news/african_union/eschools.htm

SchoolNet South Africa:

http://www.school.za/atwork/intelttf.htm

SchoolNet Africa:

http://www.schoolnetafrica.net/

The DOT-Com Alliance eNewsletter:

http://www.dot-com-alliance.org/newsletter/article.php?article_id=41

The Partnership for Higher Education in Africa:

http://www.foundation-partnership.org/pubs/bandwidth/index.php

UNESCO:

http://www.unesco-iicba.org/index.php?option=com_frontpage&Itemid=1

http://www.unescobkk.org/index.php?id=782

World Bank Education section:

http://go.worldbank.org/NGPPIVGAC1

ICT in Teacher Education in Africa Questionnaire

The following questionnaire aims at exploring the use of Information and Communications Technologies (ICT) in teacher training in Africa. The questionnaire consists of four groups of questions: (A) Demographic questions; (B) ICT Training and Course Identification; (C) ICT Skills and Access; (D) General Self-Assessment in ICT.

A: Demographic questions

* **1iam: I am a**

Please choose **only one** of the following:

- ☐ Teacher
- ☐ Teacher Candidate

---

* **2Gender: Gender:**

Please choose **only one** of the following:

- ☐ Female
- ☐ Male

---

* **3institution: Name of my school/institution**

Please write your answer here:

---

* **4location: Location of my school/institution**

Please choose **only one** of the following:

- ☐ urban
- ☐ rural

---

* **5educationalgoal: My educational goal or nearest equavalent:**

Please choose **only one** of the following:

- ☐ Diploma
- ☐ Bachelor Degree
- ☐ Masters Degree
- ☐ PhD
- ☐ Other

---

* **6teachingsubjects: Teaching subjects:**

Please choose all that apply and provide a comment:

- ☐ Major
- ☐ Minor
- ☐ Others

---

* **7languageofinstructi: Language(s) of instruction in your institute:**

Please choose **all** that apply:

- ☐ English

- [ ] French
- [ ] Portuguese
- [ ] Spanish
- [ ] Swahili

Other:

B: ICT Training and Course Identification

* **8a-participatedinICT: Have you participated in any survey on ICT use in teacher education before?**

Please choose **only one** of the following:

- [ ] Yes
- [ ] No

[Only answer this question if you answered 'Yes' to question '8a-participatedinICT ']

* **8b-reason: If yes, please name survey.**

Please write your answer here:

* **9a-trainingreceived: In the course of your studies, did you receive training on Information and Communication Technology (ICT)? Please indicate duration of course.**

	two weeks	one month	one semester	12 months	never
word processing	☐	☐	☐	☐	☐
spreadsheets	☐	☐	☐	☐	☐
presentation tools e.g. Powerpoint	☐	☐	☐	☐	☐
internet research	☐	☐	☐	☐	☐
email, chat	☐	☐	☐	☐	☐
education networks, forums	☐	☐	☐	☐	☐
statistics	☐	☐	☐	☐	☐
elearning	☐	☐	☐	☐	☐
databases	☐	☐	☐	☐	☐
programming	☐	☐	☐	☐	☐

Please choose the appropriate response for each item:

* **9blanguageofsoftware: Please name language of software that you use in learning**

Please choose **all** that apply:

- [ ] English
- [ ] French
- [ ] Portuguese
- [ ] Spanish

☐ Swahili

Other:

* **10evaluatecourses: In the following questions in this section, we would like you to evaluate two of the ICT courses which you attended more specifically, one course with which you were very content and another course with which you were less satisfied. FIRST: What do you think of the ICT course with which you were content? Name and give short description of the course:**

Please write your answer here:

* **11a-courseassessment: For this course, please indicate in the table below to what extent do you agree with the following comments (1=Strongly Disagree, 5=Strongly Agree):**

Please choose the appropriate response for each item:

The context of the coursework was empowering to me	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
The method courses are/were relevant and prepared me well for the real classroom	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Many of the ICT teacher preparation courses integrated examples and experiences I can relate to	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
The courses provide opportunities for me to improve my knowledge in teaching with ICT	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

* **11b-Ifoundcourse: I found this ICT teacher training course (1=Strongly Disagree, 5=Strongly Agree):**

Please choose the appropriate response for each item:

Relevant – I acquired knowledge and skills to prepare me for teaching using ICT	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Exciting – I was inspired to find creative ways to work with the computer	☐ 1 ☐ 2 ☐ 3 ☐ 4

	☐ 5
Validating – I was encouraged to value my background and experiences as a teacher /	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Empowering – I had meaningful interactions with instructors and peers	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Methodic – I was taught processes and procedures to follow	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

* **12notcontent: SECOND: What do you think of the ICT course with which you were not so content? Name and give short description of the course:**

Please write your answer here:

* **13notcontentcourse: For this course, please indicate in the table below (1=Strongly Disagree, 5=Strongly Agree):**

Please choose the appropriate response for each item:

The context of the coursework was empowering to me	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
The method courses are/were relevant and prepared me well for the real classroom	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Many of the ICT teacher preparation courses integrated examples and experiences I can relate to	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
The courses provide opportunities for me to improve my knowledge in teaching with ICT	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

* **14foundcoursenotcont: I found this ICT teacher training course (1=Strongly Disagree, 5=Strongly Agree):**

Please choose the appropriate response for each item:

Relevant – I acquired knowledge and skills to prepare me for teaching using ICT	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Exciting – I was inspired to find creative ways to work with the computer	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Validating – I was encouraged to value my background and experiences as a teacher /	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Empowering – I had meaningful interactions with instructors and peers	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Methodic – I was taught processes and procedures to follow	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

15pedagogictheory: Of the ICT courses you have attended, can you relate any course to relevant educational theories? Please name course and theory:

Please write your answer here:

C: ICT Skills and Access

* **16skilllevel: Indicate your level of skills in the use of the following computer applications:**

	excellent	very good	good	fair	no capability
word processing	☐	☐	☐	☐	☐
spreadsheets	☐	☐	☐	☐	☐
presentation tools e.g. Powerpoint	☐	☐	☐	☐	☐
internet research	☐	☐	☐	☐	☐
email, chat	☐	☐	☐	☐	☐
education networks, forums	☐	☐	☐	☐	☐
elearning	☐	☐	☐	☐	☐
statistics	☐	☐	☐	☐	☐
databases	☐	☐	☐	☐	☐
programming	☐	☐	☐	☐	☐

Please choose the appropriate response for each item:

* **17ICTsubjects: In which subjects do you use ICTs?**

Please choose **all** that apply:

- ☐ Computer class
- ☐ Mathematics
- ☐ Science
- ☐ Social Sciences
- ☐ Languages
- ☐ Art

Other: _____

* **18locationcomputer: Where do you use computers in your institution?**

Please choose **all** that apply:

- ☐ classroom
- ☐ computer laboratory
- ☐ library

Other: _____

* **19otherlocation: Where else can you access and use ICT tools and facilities outside your institute?**

Please choose **all** that apply:

- ☐ ICT training courses
- ☐ Cyber/internet cafe
- ☐ at home

Other: _____

* **20useinassignement: Do you use ICTs in doing your assignments?**

Please choose **only one** of the following:

- ☐ Yes
- ☐ No

* **21howoften: How often do you use the following ICT resources for learning / teaching:**

	every day	once a week	once a month	rarely	never
word processing	☐	☐	☐	☐	☐
spreadsheets	☐	☐	☐	☐	☐
presentation tools e.g. Powerpoint	☐	☐	☐	☐	☐
internet research	☐	☐	☐	☐	☐
email, chat	☐	☐	☐	☐	☐
education networks, forums	☐	☐	☐	☐	☐

Please choose the appropriate response for each item:

statistics	☐	☐	☐	☐	☐
elearning	☐	☐	☐	☐	☐
databases	☐	☐	☐	☐	☐
programming	☐	☐	☐	☐	☐

D: General Self-Assessment in ICT

* **22generalselfassess: How would you describe the way you handle ICT resources? Please indicate in the table below (1=Strongly Disagree, 5=Strongly Agree):**

Please choose the appropriate response for each item:

Through ICTs I can interact with teachers / student teachers from different colleges, faculties, countries	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I'd like to know more about computers	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Computers scare me	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I only know the basics of computers	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I use ICT effectively but don't know how to teach pupils to use it	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Using ICT, I manage information more effectively	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Using ICT helps me with my learning	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I find it easy to select appropriate ICT resources for my teaching	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I find using ICT time consuming	☐ 1	☐ 2	☐ 3	☐ 4	

		☐ 5
	Systems are slow; I'd be quicker using a book	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

* **23skillinterest: Are you interested in developing your skills and knowledge in ICT?**

Please choose **only one** of the following:

☐ yes
☐ maybe
☐ no

* **24why: Please briefly explain why Yes, Maybe or No**

Please write your answer here:

* **25difficulties: My major difficulties in developing ICT skills are (1=Strongly Disagree, 5=Strongly Agree):**

Please choose the appropriate response for each item:

time	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
training	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
IT support	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
confidence	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
relevance	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
hardware availability	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
software availability	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

26website: Suggest one website resource that you find useful for learning

Please write your answer here:

* **27email: Do you have an email address?**

Please choose **only one** of the following:

☐ Yes
☐ No

[Only answer this question if you answered 'Yes' to question '27email ']

28email: If you don't mind, please write it down.

Please write your answer here:

Submit Your Survey.

Thank you for completing this survey. Please fax your completed survey to: 00492214705030.