Ministry of Education, Science, & Technology
Government of Kenya

ICT in Education Options Paper

31 July 2005

USAID FROM THE AMERICAN PEOPLE

dot-EDU DOTCOM ALLIANCE

EDC

AED

Table of Contents

Abbreviations and Acronyms

ADDIE	Analyse, Design, Develop, Implement, Evaluate
ADSL	Asymmetric Digital Subscriber Lines
AED	Academy for Educational Development
AIDS	Acquired Immune Deficiency Syndrome
ASALs	Arid and Semi-Arid Lands
AVU	African Virtual University
BOG	Board of Governors
CEMASTEA	Centre for Mathematics, Science and Technology in Africa
CFSK	Computers for Schools Kenya
CIDA	Canadian International Development Agency
CLC	Community Learning Centres
CLIC	Community Learning and Information Centres
CMS	Content management systems
CPE	Customer Premises Equipment
DFID	Department for International Development
ECDE	Early Childhood Development and Education
EDC	Education Development Centre
EDN	Education Development Network
EFA	Education for All
EMIS	Education Management Information System
EMS	Educational Media Services
ERS	Economic Recovery Strategy
FPE	Free Primary Education
F2F	Face to Face
GOK	Government of Kenya
GPRS	General Packet Radio Service
HIV	Human Immunodeficiency Virus
IAP	International Panel of Academies
ICSU	International Science Council
ICT	Information and Communication Technology
INSET	In-service Teacher Training
IPPD	Integrated Personnel Pay-Roll Data
IRI	Interactive Radio Instruction
ISPs	Internet Service Provider
IVEN	International Virtual Education Network
JICA	Japanese International Corporation Agency
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KBC	Kenya Broadcasting Corporation
KENET	Kenya Educational Network
KESSP	Kenya Education Sector Support Programme
KIE	Kenya Institute of Education
KIPRA	Kenya Institute for Public Policy Research and Analysis
KU	Kenyatta University
LAN	Local Area Network
LPI	Linux Professional Institute
M&E	Monitoring and Evaluation
MCT	Multipurpose Community Telecentres
MOEST	Ministry of Education, Science, and Technology
MOU	Memorandum of Understanding
NEPAD	New Partnership for Africa's Development

NFE	Non-Formal Education
NGO	Non-Governmental Organisation
NICE	Network of Initiatives in Computer Education
ODL	Open and Distance Learning
OS	Operating System
PCK	Pedagogic Content Knowledge
PDA	Personal Digital Assistant
POPs	Points of Presence
PTTC	Primary Teacher Training College
SbTD	School-based Teacher Development
SEP	School Empowerment Programme
SIDA	Swedish International Development Agency
SMASSE	Strengthening of Teaching Mathematics and Science in Secondary Education
SSA	Sub-Saharan Africa
TAC	Teacher Advisory Centre
TEFL	Teaching English as a Foreign Language
TESPOK	Telecommunications Service Providers Association of Kenya
3G	Third Generation
TIVET	Tertiary, Industrial, Vocational, and Entrepreneurial Training
TSC	Teacher Service Commission
TTC	Teacher Training College
UNESCO	United Nations Educational, Scientific and Cultural Organizations
UNICEF	United Nations Children's Educational Funds
UNISA	University of South Africa
UON	University of Nairobi
UPE	Universal Primary Education
UPS	Uninterruptible Power Supply
USAC	Universal Service Administrative Company
USAID	United States Agency for International Development
USF	Universal Service Fund
VCD	Video Compact Disk
VVOB	Flemish Association for Development Cooperation and Technical Assistance
VSAT	Very Small Aperture Terminals
WB	World Bank

Executive Summary

This Options Paper for the Ministry of Education, Science, and Technology (MOEST) discusses the ways in which information and communications technologies (ICTs) can be leveraged to support and improve the delivery of quality education for all Kenyans. As part of the USAID-funded dot-EDU project, Education Development Center (EDC) and the Academy for Educational Development (AED) led the development of this document.

The ideas presented here respond to the educational priorities outlined in Sessional Paper No. 1 of 2005 and the KESSP[1] document. They include:

- Increasing Educational Access in Urban Slums and Arid and Semi-Arid Lands (ASALs)
- Improving Quality Teaching and Learning
- Increasing and Improving Skills Development Programmes for Out-of-School Youth and for Women in the Community, esp. for Literacy
- Improving Educational Policy and Coordination
- Improving Educational Management through EMIS
- Monitoring and Evaluation the Education Sector
- Considering Costs and Benefits of Educational Interventions

Given these educational priorities, the following options are presented in this report:

- Interactive Radio Instruction (IRI) in ASALs and Urban Slums
- Quality Teaching and Learning through ICT
  - e-Content Development
  - ICTs in Teacher Training Colleges
  - Computers in Secondary Schools
  - Computers in Primary Schools Cluster Centres
  - ICT for In-Service Teacher Training
  - IRI for In-Service Teacher Training
  - Video for In-Service Teacher Training
  - Open and Distance Learning
  - ICT Infrastructure
- ICT and Skills Development
  - Community Learning Centres
  - Refurbishment Centres
  - IRI for Non-Formal Education
- ICTs and EMIS
  - Low Cost
  - Mid Cost
  - Full Cost
- Policy and ICTs in Education
  - Adoption of National ICT Policy
  - ICTs in Education Policy Coordination
  - Distance Education Policy
  - Community Learning Centre Policy
  - E-Rate

[1] MOEST 2005, *Kenya Education Sector Support Programme: 2005-2010: Delivering Quality Equitable Education and Training to All Kenyans.* Draft 9 May 2005.

- Improving Quality and Equity through Connectivity Growth
- Total Cost of Ownership Model
- Monitoring and Evaluation of ICTs in Education

Throughout the development of this report, we considered the ways in which ICTs could improve educational outcomes. By driving the process with education (rather than technology) at the forefront, we were able to consider a broad range of interventions – and creative ways for educators to use these tools to support teaching and learning. ICTs can only support teachers, not replace them.

In all, over twenty options are presented and discussed. For ease of review, each option is discussed briefly in this Executive Summary before being described in greater detail in the main body of the text.

Option: IRI in ASALs and Urban Slums

Kenya can begin testing IRI strategies in pilots that will provide high quality, minimal-cost learning opportunities for learners in ASALs and urban slums. The pilot would serve several purposes: to familiarize Educational Media Services with the skills and systems it will need to take on such a task; to demonstrate the IRI methodology to a wider audience of policy makers, planners, funders, and communities; to demonstrate the learning outcomes that IRI can achieve among the populations of urban slums and ASALs; and provide a body of radio programs that can be used in long-term implementation when taken to an expanded scale.

Option: E-Content Development

With the advent of the Internet and other technologies which are changing the way we operate locally and globally, the MOEST's goal should be to demystify and leverage these tools to provide deeper conceptual knowledge of the world around us. Technicians can be employed to fix and maintain the computers, however, teachers and educators must know how to exploit ICT for what they do best – opening learners up to the world of knowledge.

Computers themselves, however, do not come pre-packaged with relevant teaching content. Although the Internet provides a vast number of resources, most are in English and may need to be modified in order to be relevant for Kenyan students and curriculum needs. Investments in custom-made digital materials with highly relevant content for Kenyan classrooms in rural and urban contexts are important if the MOEST wants to tap into the real potential of ICTs for learning. Building capacity in Kenya to create instructional materials for an increasingly digital world is an investment that will pay dividends for improving the quality of education. This section articulates the ways in which the MOEST's Kenya Institute of Education (KIE) can begin developing and delivering educational content for delivery through a variety of digital media.

Option: ICTs in Teacher Training Colleges

Investment into upgrading computer labs and building ICT capacity at the Teacher Training Colleges (TTCs) is an intervention which can quickly yield high returns. By providing adequate access to ICTs, the TTCs can use ICTs to achieve learning objectives at various levels. At the simplest level ICTs allow for storage and display of information. However, using ICTs also fosters ***exploration*** of materials and ideas. ICTs allow learners to ***apply a concept or understanding*** to a new situation; to ***analyse ideas*** by organizing them and manipulating them; and to learn how to ***evaluate*** and ***problem solve***. At the highest level, ICTs are used to foster the ***design or construction*** of integrating projects, whereby students must explore wide range of ideas and resources, analyse and evaluate them, and synthesize them in a project. ICTs can fully utilize the multimedia environment to support this process.

The TTCs should aim to have networked desktop computers for lecturers and networked computer labs for students. This option presents integration models which will foster the thoughtful use of ICTs by teacher educators and students.

Option: Computers in Secondary Schools

There are currently 4000 public secondary schools in Kenya and the recent massive increase in primary school enrolment is putting pressure on the demand for and access to secondary schools. The MOEST remains concerned with the quality of secondary education which is characterized by poor performance in core subjects such as Mathematics and Science. There are obvious benefits for integrating computers into secondary schools as students at this age need to focus on subject-specific content, greater critical thinking skills, scientific inquiry, and maths, science and languages. Students will benefit greatly with the analytical, creative, and collaborative power of computers to map out and analyse assumptions, present ideas, and participate in projects with peers from around the country and around the world.

As noted above, foundation skills should be a stepping stone to using ICTs to enhance teaching and learning objectives. The same ICT integration concepts used in the TTC model can be adapted for secondary school teachers and students. ICT integration will take teachers and students beyond seeing ICTs as computer studies and computer literacy skills. Although these are important skill sets, they are not sufficient in leveraging the true potential of ICTs to improve creativity, innovation and collaboration – key capacities in the new knowledge economy. In both programmes, the assessment criteria should be made explicit to new users and opportunities to experiment and work with the tools towards achieving these criteria. This will ensure that their new knowledge and skills are conceptualised and more likely retained.

Option: Computers in Primary Schools Cluster Centres

Capacity should be built at cluster schools and ICT readiness assessments conducted for classrooms. One way of doing this is to introduce the concept of "learning circles" and project-based learning. Learning circles/stations are a powerful classroom management approach, especially for multi-grade classrooms, where the teacher organizes her classroom into 4-6 different stations that reinforce concepts in the curriculum through multi-modes of instruction. For example, to teach fractions in a multi-grade classroom, the teacher separates children into groups of 5-10 students, depending on the class size. The teacher uses manipulatives like dice at one station for tactile learners to reinforce concepts, has an older student teach the young students at the chalkboard for drill and practice, has a worksheet station for assessment of concepts that are in line with curriculum examinations, and then has a real-life application station. This will require development and support of content through KIE, as discussed earlier.

Option: ICT for In-Service Teacher Training

Large-scale ICT capacity building workshops for in-service teacher training should build on existing structures that deliver quality ongoing professional development for teachers. The program should be consistent with the workshops for lecturers and pre-service teachers at teacher training colleges. Instructional goals and activities should be highly conceptualised to address educational outcomes and teachers' realities. Introduction to computers should discuss the constraints and opportunities of using ICTs for education. Activities should focus on increasing efficiency in the teacher's workload and integrating ICTs to improve teaching and learning objectives. The distance learning material developed under the School Based Teacher Development (SbTD) program and any new materials developed for the School Empowerment Program could be put on CD-ROM and on a website to be available to all teachers with computer access at any time.

Option: IRI for In-Service Teacher Training

The most powerful use of radio as an in-service training device is to build training into IRI lessons. It is one thing to advise teachers on how to teach fractions, it is quite another to build teacher activities into a radio lesson that is teaching fractions to a classroom full of children. Radio can model the ways in which a teacher can introduce the concept of fractions, lead teachers through the process of explaining fractions in concrete terms, solve problems in the radio lesson, and then model different kinds of instructional

practice, and show how to evaluate and assess student mastery of the concept and practice of using fractions. The teachers' guide can then provide follow up activities after the broadcast.

Option: Video for In-Service Teacher Training

Digital camcorders now deliver superb quality for as little as US$1000, and the hardware and software for editing digital video is also falling in price and complexity of usage. Simply shooting and editing digital video is something that many people adopt quickly and easily. However, the skills needed to produce a video that expresses a training message clearly and economically are another matter. For that reason, a dual approach is suggested.

Strategy one would be to furnish district offices with digital camcorders that could be used at training events so that teachers can watch themselves and their colleagues, and reflect and comment on what they see. The primary purpose would simply be to have a visual record of a teacher's performance for discussion and review. There would probably be no attempt to edit the results, and once viewed, the sequence might be erased, although each teacher might save a digital archive of how their skills increased over time.

Strategy two would be to use digital video for the purposes of training teachers across the district, province or even the country. Sequences would be shot in classrooms by a trained teacher trainer/videographer(s) based at the national and/or provincial levels. The videographers would travel to classrooms and training sites and assemble and edit VCDs or DVDs of specific classroom practices. These could be used as a longitudinal monitoring instrument that measured changes in the national teaching capacity, and also used in training in TTCs and for in-service training purposes.

Option: Open and Distance Learning

The importance of open and distance learning (ODL) is mentioned in many parts of this document – the scale of the problems and the size of Kenya make it virtually imperative that much of the pressing educational burdens will have to be addressed using approaches that rely on technology to deliver more educational content, and to improve the quality of teaching and student performance. This section takes the opportunity to make some general observations about the process of ODL, and to point to a wide array of potential applications, not all of which we have had the opportunity to point out in the specific sections that pertain to them.

Option: ICT Infrastructure

A number of key issues must be considered for ICT equipment and other related infrastructure. Options presented here include discussions of computer leasing programmes for teachers and other education officials as well as options for developing computer labs at centralised Teacher Advisory Centres and other centrally-located support institutions in the districts. Additionally, infrastructure assessments are presented as well as hardware and software requirements.

Option: Community Learning Centres

Utilizing ICTs to reach disadvantaged groups and expand their educational opportunities demands working within the larger community and often across sectors in order to provide a sustainable solution. Community Learning Centres can be used to address the multiple goals of access, equity, quality, relevance, and efficiency, but sustainability becomes one of the greatest challenges. If CLCs are considered for provision of access to education by underserved segments of the population, then sustainability must be considered beyond a purely market-based perspective. CLCs should be considered as one valuable tool which the government can subsidise for the delivery of education to difficult-to-reach communities.

Option: Refurbishment Centres

Refurbishment centres already exist in Kenya for the delivery of adequate ICTs to schools. This section draws heavily on the ICT Scoping Paper developed by Imfundo and Digital Links International with Computers For Schools Kenya. Based on the findings of the ICT Scoping Paper (which we fully support based on our own experiences with refurbished computers in other African countries), the MOEST should strongly consider assisting CFSK to expand their refurbishment capacity as well as create other refurbishment centres around the country. These can be done in association with CFSK, SchoolNet Kenya, Microsoft, or other development partners. These centres should primarily employ volunteers, with particular emphasis on young women. The volunteer model has proved very successful in Namibia by SchoolNet Namibia, where young women are brought into the ICT field. CFSK is already employing a similar model in Kenya.

Option: IRI for Non-Formal Education

The IRI programs used for this purpose would be the same ones described above for school-based learners in ASAL regions and urban slums of Kenya with approximately 100 or 130 programs per grade level. As part of its goal to increase access and quality, the MOEST is looking into the possibility of acquiring a broadcasting channel. However, it might take some time to sort out the issues related to this, particularly the costs associated with maintaining the transmitters. It would still be possible to move forward with IRI programming even with restricted availability of airtime. Programmes for schools might be broadcast in the morning and/or afternoon for schools, and repeated in the evening for out-of-school learners. The main difference would lie in the systems set up to support and manage the IRI learning environment. Where the provision of instructional systems in ASAL regions would remain the jurisdiction of the MOEST, and would probably emphasize the school as a basis for managing instruction, these out-of-school learners are likely to be meeting in community learning centres, often managed by the private sector (communities, churches, NGOs etc).

Option: ICTs and EMIS

This section reviews the current proposal described in the KESSP document and articulates an appropriate way forward. Three funding-level options are presented. Under the Low Cost option, the key items that can be accomplished without massive infrastructure investment are undertaken. As more funds become available, the system can be expanded in concert with resources. Critical to maintain under this structure is the core implementation and design capacity team, and the important preparatory work that can still support early successes.

Options include:

- Core information creation and harmonization;
- Data collection;
- Software application;
- Data processing and analysis;
- Information sharing and dissemination;
- Policy and planning:
- EMIS infrastructure; and
- Capacity building.

Option: Adoption of National ICT Policy

To support a coordinated approach to ICTs in education, a number of policy recommendations are made in this section. These include the adoption of the draft National ICT Policy to ensure a consistent framework is utilised for ICTs in education activities; the development of an ICTs in Education Steering Committee to develop and revise quality assurance guidelines for programs; the accreditation of commercial institutions for the delivery of distance education; the development of guidelines based upon

the Community Learning Centre described in this report, particularly to reach out-of-school girls; and the implementation of an "e-rate" (education rate) to ensure that the cost of basic connectivity is affordable.

Option: Improving Quality and Equity through Connectivity Growth

Most of the available options for the effective use of ICT in support of education are much more powerful when the activity is linked in a communication network that permits Internet access for email, administrative communication, file transfer and web site browsing. This element of the system adds value at every level of the educational system: it enhances the performance of the traditional work of the Ministry through greatly accelerating internal communication, and it brings new dimensions to what can be accomplished under new objectives by bringing access to instruction and information resources to groups that otherwise would be excluded.

There are several potential approaches for leveraging the advantages that an extensive WiMax network could offer to the MOEST's goal of bringing all secondary schools online. Just what would be appropriate would depend on certain regulatory issues as well as on the availability of resources or willing donors or private sector partners to participate. For the sake of this analysis, three levels of option are discussed: a small, single tower program serving the schools within the broadcast radius, designed primarily as a demonstration model to allow the MOEST to learn from a pilot activity distributing classroom support and in-service teacher training; an operational system located in strategic rural or geographic areas; and a national network developed through a commercial partner to build out and operate a WiMax system that would serve not only the schools but also all other commercial, governmental, or residential who desired service.

Option: Total Cost of Ownership Model

The TCO model captures the different options available and applicable for the deployment of ICTs for teaching and learning in schools. The proposed model seeks to evaluate all the costs associated with the appropriate and applicable technology for each situation. Equal emphasis is placed on the initial investment as well as the continuous operational costs associated with the ownership of the technology.

To illustrate the scope and relative magnitudes of the different costs, three hypothetical ICT scenarios are presented in Appendix F. Sample one presents the TCO for placing 4 workstations for use by teachers in 100 schools. Sample 2 presents the cost of deploying radio-based programmes in 1000 schools. And sample three presents the costs of placing computer labs with 20 workstations each into 1000 schools. All figures in these simulations are hypothetical, rather than being comprehensive estimates of the costs involved. The purpose of these presentations is to illustrate the importance of considering the total cost of ownership by emphasising the importance to budgeting for ongoing maintenance and support, upgrades, and training of support personnel and teachers.

Option: Monitoring and Evaluation of ICTs in Education

Based on local experience and international research, it is clear that a comprehensive set of indicators must be developed to discretely reflect the goals articulated in the ICT in Education strategy documents. This Options Paper articulates key areas for measurement to support the development and delivery of ICT throughout the education sector. The three key areas identified are (1) Infrastructure & Access, (2) Training & Usage, and (3) Impacts. Possible research areas are also presented.

Introduction

The development of this ICTs[2] in Education Options Paper for the Ministry of Education, Science, and Technology (MOEST) in Kenya, is based upon the following Terms of Reference issued by the MOEST to USAID/Kenya:

- To review and assess current and planned programs that utilize ICT to improve education in Kenya;
- To conduct a review of international best practices that effectively utilize ICT for education that could be relevant for use in Kenya;
- To consult with key stakeholders, including the MOEST, private sector and civil society, to gauge level of interest and gather information and recommendations for developing ICT in Education programs;
- To conduct a review of Government of Kenya and MOEST polices on ICT in Education, and ICT and Management. Identify gaps in the current policy framework;
- To prepare a draft ICT in Education Options Paper for senior managers at the MOEST. This Options Paper will synthesize all of the work undertaken in tasks 1-4; and
- To consult with key stakeholders both within and outside the MOEST to get their feedback on the draft Options Paper and assist the MOEST to develop a consensus on strategic options.

The paper articulates the ICTs in Education options available that would best meet the needs of Kenyan schools and be most suitable for the local context while also addressing the Government's desire to equip all learners for their social and economic responsibilities for the development of Kenya. That is, ensuring that learners are able to contribute to the well-being of society and be adequately prepared for the world of work. This final Options Paper provides a comprehensive range of potential technologies to improve teaching, learning, and management and is intended to enable the Government of Kenya to plan appropriate ICTs in Education interventions as they move forward with the comprehensive Kenya Education Sector Support Programme (KESSP).

The United States Agency for International Development (USAID) responded to a request for support from the Kenyan Ministry of Education, Science, and Technology in helping to organise and think through the options. USAID turned to the dot-EDU Project to deliver that assistance. The Prime Awardee on dot-EDU Project is the Education Development Center (EDC), which in turn involved its partner on dot-EDU, the Academy for Educational Development (AED), in putting together a joint team of education professionals to participate. The joint team consisted of employees of the US firms and of Kenyan consultants, and reflected a very broad range of educational expertise.

The team began its work with participation in the May, 2005, Sector-Wide Assessment Program meetings in Nairobi, and spent more than a month in-country, interviewing MOEST and other stakeholders involved with the KESSP process. A draft report was circulated among the stakeholder community in mid-June to give the participants time to read and reflect on the findings of the team. After the MOEST and other stakeholder groups had had adequate time to consider and comment on the draft, a general "Stakeholders Meeting" was held in Nairobi on July 15, 2005, in which members of the team formally presented the findings and solicited comments and feedback from the stakeholders, which has been incorporated into this final version of the report. The MOEST will now consider its priorities in this arena, continue its discussions within government and among the stakeholder community, and move to integrate the programs into the KESSP process.

The options presented are organised according to Kenyan educational priorities as articulated through key educational policy directives which include, among others, Sessional Paper No. 1 of 2005 (GOK 2004) and the Kenya Education Sector Support Programme (KESSP) (MOEST 2005a). Using these key priorities for direction, the following options are discussed in detail:

[2] The terms ICTs and ICT are used interchangeably throughout this document. The authors consider ICTs as a variety of technologies which assist in creating, manipulating, and exchanging digitised information.

- Educational Access and Quality through IRI
- Quality Teaching and Learning through ICT
- ICT for Skills Development
- Policy and ICTs in Education
- Improving Quality and Equity through Connectivity Growth
- Using (and Not Using) ICT to Improve EMIS
- Monitoring and Evaluation of ICTs in Education
- Total Cost of Ownership

While this list of priorities is by no means exhaustive, our working premise was that by looking closely at the educational priorities of the Government of Kenya (GOK) we could more effectively present ways in which ICTs could be leveraged to improve teaching, learning, and management.

Throughout the development of this Options Paper, it became apparent that various interpretations and understandings of ICTs in education exist in Kenya. Many stakeholders described ICTs in education as refurbished desktop computers in a computer lab with student work narrowly defined as accessing the Internet; sending email; word-processing; and learning 'about computers'. These are indeed some of the starting points of ICTs in education, though leaving this as the primary definition and aim of ICTs in education misses the powerful opportunities presented. It became apparent during the KESSP discussions that a complex understanding of ICTs in education was limited to a few of the more recent policy and strategy documents, highlighting the need for greater discussion and coordination between educators, managers, and policy makers.

In this Options Paper, we primarily consider ICTs as those tools which allow digitised information to be created, accessed, stored, manipulated, and exchanged. This is an important distinction to make. Digital information processing and real-time communication are the technologies revolutionising the ways in which societies (and thus education systems) are organised. This reorganisation is not discussed in this report but is competently dealt with in the GOK's Sessional Paper No. 1 of 2005. ICTs are tools which can contribute to the development of MOEST's core function: developing the knowledge, skills, values, and attitudes which allow citizens to participate in Kenya's social, political, economic, and cultural activities in a valued and creative manner. While ICTs can be associated with a discrete set of skills and knowledge, we consider the main aim for the introduction of ICTs in education as a means to contributing to the delivery and assessment of the Kenyan curriculum by teachers. This is not an easy task.

ICTs in education can be considered in three key ways: ICT Integration, ICT Equipment, and ICT Foundation Skills. ICT Integration should be the main goal of any ICTs in education intervention. When we know our goals, we can then consider what type of equipment would be most appropriate for these goals. And when know what equipment will be utilised, we can determine the basic skills which teachers and students require to work with these tools towards the integration goals. Let us now turn to those goals and the ways in which ICTs in education can help achieve them.

Educational Access and Quality through IRI

The Government of Kenya is committed to the internationally recognised priorities of Universal Primary Education (UPE) and Education For All (EFA). Currently, it is estimated that there are 1.7 million children and youth of school going age in Kenya who are unable to access conventional education due to special circumstances or various socio-economic reasons. While these children can be found throughout the country, two areas in particular contain a larger percentage of these 1.7 million children: Arid and Semi-Arid Lands (ASALs) and urban slums. The population in ASALs is made up mainly of poor nomadic pastoralists in sparsely populated areas who have limited access to basic education and correspondingly high illiteracy rates. Urban slums on the other hand are characterized by overcrowded informal settlements and high poverty levels.

Though a great deal has been achieved in the area of early childhood education, access to services remains low in Kenya with 65 percent of the children aged 3-6 years currently not accessing ECDE services. In ASAL areas this situation is much worse with only 9 percent of children aged 3-6 accessing ECDE services.[3]

The nature of the problems facing children in urban slums and ASALs include:

- Lack of schools;
- Lack of space in existing schools;
- Great distance to school for students;
- Lack of trained teachers;
- Poverty; and
- School attendance constrained by students need to work.

The MOEST's priorities for the coming years include increasing access and quality throughout the education sector. The Ministry also embraces the notion of alternative teaching and learning opportunities and recognizes that appropriate use of technology can provide opportunities for student-centred teaching, reaching more learners, greater teacher-to-teacher and student-to-student communication and collaboration, and greater enthusiasm for learning amongst students.[4]

The adaptation of Interactive Radio Instruction (IRI) for educating children, especially girls, in ASALs and urban slums is an option that Kenya can employ for both formal schooling and Non-Formal Education (NFE) centres.

Current Radio and Education Interventions in Kenya

Kenya has a long history of educational broadcasts dating back to pre-independence days, when school broadcasts were part of the Voice of Kenya. In 1975, the broadcasts were moved to the Kenya Institute of Education (KIE) under the Educational Media Services (EMS). The broadcasts were intended to supplement school activities by providing an additional resource for teachers and students. In the 1980s, the public media services became commercialised and, as in many countries in the region, KIE was required to pay for the broadcasts. But the Ministry of Education was unable to meet the high cost of broadcasts and, unable to negotiate a fair deal with the Kenya Broadcasting Corporation (KBC), eventually had to sever the relationship.

However, EMS continued to produce programmes in-house which were sold to schools or individuals. In 2002, KIE entered into a relationship with WorldSpace to revive the broadcasts to schools. The schools were each supposed to pay about Ksh 9,000 per year for this service. WorldSpace provided special receivers to receive their satellite signal. To date, about 11,000 receivers have been distributed to schools that are listening to the broadcasts. The target is all schools, with special emphasis on the hard to reach

[3] MOEST 2005, *Kenya Education Sector Support Programme : 2005-2010 : Delivering Quality Equitable Education and Training to All Kenyans*. 9 May 2005 Draft.
[4] Ibid.

areas. In 2003, due to the declaration of free primary education, the government felt that they could not charge schools to receive the educational broadcasts and therefore picked up the bill.

The team visited EMS and met with the Coordinator of Programming, the Head of the Radio Service, and the Chief Engineer as well as producers and studio technicians to discuss the current use of radio in education. The current radio broadcasts are intended to supplement classroom instruction. Broadcasts that supplement instruction are based on the premise that what is happening in classrooms is fundamentally sound, and that children will graduate from primary schools having mastered the basic skills on which all subsequent learning is based. The role of the radio in this type of environment is to enrich this education, usually by not more than a single, weekly broadcast for any grade or subject. This is currently the case at EMS, thus providing an excellent opportunity to improve and expand their radio broadcasting to eventually become Interactive Radio Instruction.

Interactive Radio Instruction

The underlying assumption of IRI is that schooling is completely absent or that the quality of teaching and learning is impaired in some way, usually for reasons such as a lack of instructional materials or untrained teachers or overcrowding, and that children are not mastering basic skills such as mathematics, science, and reading and writing in English. Under these circumstances, IRI programs provide an intensive half hour each day of high quality instruction of a kind that teachers by themselves simply cannot provide.

IRI programs cover the entire basic curriculum, not just selected elements of it, and are broadcast daily. Each day of the week there is a 30-minute lesson for Standard 1, another for Standard 2, and so on. Each program is carefully organized, scripted, evaluated and revised before it is used in the classroom, the sequencing of topics is carefully organized, and topics are returned to for revision and practice throughout the year. The quality and daily frequency of the broadcasts is at the heart of the success of IRI, and any compromise of these standards leads to a compromise in learning outcomes.

IRI programs emphasize meaningful student-centred learning activities, active learning strategies that elicit many responses from learners (e.g. 100 responses during a 30-minute program is common), activities such as songs that are fun and appeal to many different learning styles as well as plenty of practice, and objectives that focus on mastery of essential basic skills such as literacy and numeracy. The success of IRI can be mainly attributed to its focus on practical learner-centred activities which promote many learner responses and critical thinking. Each day the radio models active learning strategies and new classroom management ideas for the teacher/facilitator.

IRI brings a dynamic mixture of songs, games, drama, and activities that make learning fun. Where resources such as books are scarce, radio can help the teacher with what to write on the blackboard, provide an audio stimulus to replace the visual stimulus provided by books, and suggest or lead student drills and practice. Programs model the pedagogy used by the most effective teachers in real classrooms. In this way, untrained teachers receive many hours of training as they respond to the radio prompting them to manage the classroom activities in ways used by the best primary school teachers.

Evaluations of IRI projects in many countries have shown:

- IRI has high front-end costs as programs are written, developed, and tested. However, recurrent costs (typically for airtime, print materials, and teacher training) are low. When compared with conventional schools, the unit cost falls as more learners are served, even with populations of a few thousand learners. Typically costs range from USUS$1 to USUS$3 per student per year.
- Children learn from IRI. IRI programs have achieved their greatest success in teaching basic skills in the first four years of primary school. In Bolivia, South Africa, and Honduras, comparisons of test scores between schools using IRI and those not using IRI have shown a gap of about 20 points in favour of children getting IRI as well as conventional instruction.
- Girls attending IRI lessons perform as well as boys, thus minimizing gender performance gaps.

- IRI tends to close rural/urban gaps since all the learners get similar instruction in exactly the same way.

IRI is also being used successfully in a variety of contexts with a variety of audiences including preschoolers in early childhood education programmes, in school learners, out-of-school children and youth and adults. IRI is currently being used in several countries to meet challenges such as:

- Lack of sufficient qualified teachers and/or schools – Zambia, Dominican Republic, Somali populations in southern Ethiopia, Haiti
- Increasing access to education – Zambia, Tanzania, Ethiopia, Haiti and Honduras
- Improving quality – Guinea, Nigeria, Nicaragua, Venezuela, South Africa
- Lack of sufficient spaces in schools – Zambia, Haiti, Honduras
- Long distances to schools – Zambia, South Africa, Ethiopia's Region 5
- Inability to attend formal system due to special circumstances such as lack of time for school due to need to work, take care of siblings or sick relatives – Dominican Republic, Zambia
- Poverty/inability to afford fees – Zambia, Tanzania
- School preparation for young learners – Bolivia, Honduras
- Updating teacher skills and pedagogical practice – Mali, Nigeria, Guinea, Colombia, Madagascar

The constraints faced in Kenya are similar to those faced by out-of-school children in Zambia and Tanzania as well as by nomadic populations in Somalia and southern Ethiopia. IRI has been effectively utilised in these countries to serve these populations, thus ensuring equitable access to quality education for more children.

Many factors combine to constrain access and quality in schools. Typically, urban schools suffer from very large classes and shortages of instructional materials. Children find it difficult to move around or work productively in groups because of noise and lack of space, and the environment encourages a pedagogy that promotes copying from the board, choral chanting, and speaking only when questioned by the teacher.

In remote rural schools, the problems are often the reverse: smaller classes but multi-grade classes or classes without teachers, and insufficient or untrained teachers because teachers wish to be posted to urban schools. Children often work by themselves while the teacher attends to children in other grades. IRI has been used to address both these circumstances. Kenya should consider IRI as a way to improve educational quality and access among disadvantaged children in slum areas and in ASALs, initially focusing on early primary grades where foundations in literacy and numeracy are laid that are essential to later learning. These programs might include daily 5-minute segments that address HIV/AIDS. Kenya might also test strategies for using IRI for improving the quality of early childhood centres. If results are positive, these programs could then be broadcast over a dedicated broadcasting channel.

Option: IRI in ASALs and Urban Slums

Kenya can begin testing IRI strategies in pilots that will provide high quality, minimal-cost learning opportunities for learners in ASALs and urban slums. The pilot would serve several purposes: to familiarize EMS with the skills and systems it will need to take on such a task; to demonstrate the IRI methodology to a wider audience of policy makers, planners, funders, and communities; to demonstrate the learning outcomes that IRI can achieve among the populations of urban slums and ASALs; and provide a body of radio programs that can be used in long-term implementation when taken to an expanded scale.

The proposed IRI project would seek to accomplish four goals:

- To develop a cost-effective instructional program led by daily interactive radio programs that would work both in schools and out-of-school settings;
- To design a system that would include inputs from the government, target communities,

NGOs, faith based organizations and other stakeholders;

- To monitor the effectiveness of educational broadcasts in terms of increased access for learners in ASALs and urban slums and quality measured by learning gains and
- To work with KIE/EMS staff to improve systems and procedures that would lead to production of good quality programmes and to define the kind of external systems that would need to be put in place in order to institutionalise the programme and provide the necessary support in formal and informal educational settings utilizing the programmes.

Proposed Institutional Base

Due to KIE's long history or educational broadcasting and demonstrated commitment to this medium of instruction, the IRI program would be best housed at the Kenya Institute of Education (KIE).

Subjects and Duration

EMS could begin with a design for 30 minute daily programs appropriate for Standard 1 learners, drawn from the new curriculum focusing primarily on teaching literacy, language, mathematics, and life skills. Depending on the demands of the curriculum, an entire series might consist of 100-150 lessons, but most IRI pilots have provided sufficient evidence for decision makers and funders within 40 lessons. KIE could then look for additional support to develop the expanded system at the earliest opportunity.

This system would be more challenging than the current EMS broadcasts because it will need to demonstrate success in formal and non-formal settings in remote and difficult settings. If formative evaluation demonstrates that system elements (such as the instructional design, the limited use of centrally produced print materials, the management of instruction in schools and centres, or delivery systems) need further refinement, or early decisions need revisiting, one option would be to continue on a pilot basis until the system is proven effective.

Design options would ensure that while meeting the objectives in the syllabus, the lessons would introduce contexts and characters that are relevant to the learners' lives given the special circumstances surrounding the lives of learners in ASALs and slums.

Scriptwriting

As noted above, there is a big difference in a program that aims to supplement what is going on in schools and IRI. The success of an IRI intervention would require a notable shift from the current approach employed in KIE broadcasts.

The team learnt that scriptwriting at EMS is currently utilizing the panel system of scriptwriting which involves the engagement of university and college lecturers and practicing teachers as freelance writers. Teams may consist of up to 20 subject specialists/writers and meet for periods of up to two weeks at a time. These teams come in from places as far away as Mombasa and Kisumu, and the travel and accommodation costs seem to consume a substantial part of the EMS budget, so that essential processes such as formative evaluation of programs are under-funded and happen irregularly.

If EMS is interested in using IRI, it might consider switching to a system of hiring fulltime writers as well as producers. These in-house writers would likely prove more cost-effective and could be trained in the specialized instructional practices that are used by IRI as well as other technologies that the MOEST may wish to use in schools and for out-of-school learners.

If EMS chose to use in-house producers (who would also be scriptwriters), they could work in teams where each team drafts, tests and revises a script each week. Producers/writers would receive an initial training program on IRI writing skills, though further technical assistance would be essential to ensure that radio broadcasts would be effective instructional instruments. Becoming competent IRI scriptwriters generally takes two years.

Completing the training of scriptwriters; developing a program master plan and formative evaluation plan; identifying participating schools, centres, and communities; as well as other program design issues will take approximately six months.

Production

EMS has 10 producers at present and can produce up to three programs a day in each of its two studios. A team of 8-10 writers would most likely be sufficient. The biggest investment in terms of time would most likely be devoted to scriptwriting training. Different countries have chosen different approaches to staffing scriptwriters and producers: some choose to train the same individuals to become both scriptwriters and producers while others choose separate teams of writers and producers. Each method has its merits and drawbacks.

There are 2 studios at EMS that use reel-to-reel recording. The two studios are each capable of producing about three programmes per day. It would be more efficient to digitise those studios and record and edit on computers for dubbing to CD and DVD. There are 10 studio technical operators. The current EMS programmes are mainly targeting upper primary and secondary learners with weekly programs in several subjects. The impact of these broadcasts has undergone an internal evaluation which is not yet finalized. EMS has not produced any programs for Standards 1-3 since the new curriculum was instituted. As mentioned above, IRI is particularly suited and has demonstrated results at these lower levels.

To ensure efficiency and enhance production quality, the introduction of more modern equipment in the EMS studios is of paramount importance.

Formative Evaluation

As mentioned above, formative evaluation is a critical component of each IRI series. Each programme must be field tested with real children before being aired. EMS staff said they have not been able to pre-test the programmes due to financial constraints.

EMS may hire independent evaluators to look at the overall impact of the programs, but formative evaluation could be conducted by the producers themselves with some assistance from a research specialist. There may be university or college lecturers who could help producers to design observation sheets, for example, or devise valid assessments of student learning.

Support Materials

Radios would be the most important consideration. Depending on the transmission, Kenya may wish to continue with WorldSpace receivers or try Freeplay radios which come with a provision for a wind-up or solar option and are extremely durable. The Freeplay Foundation has supported education and has been donating thousands of radios to countries using IRI.

Print materials, mainly in the form of teachers' guides that accompany each lesson are also extremely important. They support the teacher in various ways particularly in reminding them of important things and helping them prepare for each lesson.

IRI programmes also often call for the innovative use of locally available resources that teachers collect in Teachers' Kits that are intended to enhance learning. Training of scriptwriters and teachers would typically include encouraging them to keep such kits.

Transmission

In 2005, EMS is eager to meet the needs of schools and learners, especially those that are not being served well or at all by conventional systems. There is interest in looking at alternatives to the WorldSpace system due to the overall cost of the system. WorldSpace broadcasting is proving quite expensive to the MOEST which must pay for the satellite time and to schools which must buy batteries for the WorldSpace radios. The radios themselves are essentially modems which receive data from the

satellite, not radios, so they do not receive conventional FM or AM signals. In this sense, WorldSpace is establishing a monopoly since the schools and EMS cannot turn to other providers once they have purchased a WorldSpace radio. EMS is looking at alternative transmission systems and the feasibility of establishing a dedicated educational broadcasting channel.

Current broadcasts run from 8:00am to 4:25pm daily for weekly subjects of 20 minutes each. A major reorganization of the broadcast schedule would be required as daily broadcasts of 30 minutes per class as the primary means of instruction would take up a great deal of airtime depending on the number of grades KIE decides to take on.

Monitoring and Evaluation

Both the MOEST and funders may have specific evaluation requirements in order to report on the progress of the activity, and indicators would need to be discussed with each group in detail. Based on data that IRI programs in other countries have gathered, indicators might include achievement tests in mathematics, literacy, and language; comparisons between learners getting IRI and those in schools without IRI; and enrolment and dropout figures in schools and centres. It is also common to design a system of supporting teachers through regular 'spot checks' for feedback, coaching, and supervision purposes.

Quality Teaching and Learning through ICT

As mentioned above, the Government of Kenya (GOK) has made substantial gains to increase enrolment rates through the Free Primary Education (FPE) initiative towards achieving Education For All (EFA) by 2015. "Whether or not expanded educational opportunities will translate into meaningful development – for an individual or for society – depends ultimately on whether people actually learn as a result of those opportunities, e.g., whether they incorporate useful knowledge, reasoning ability, skills, and values."[5] This has obvious implications for how success is measured. Although higher enrolment and efficiency are important, learning achievement and knowledge acquisition are fundamental indicators.

To complicate matters, the emerging global economy has sharpened the focus of education towards innovation; initiative; accessing, processing, and applying large amounts of information; exercising appropriate judgment; and collaborating with others to makes sense of new situations. The stakes are high as the new labour force must meet the demands of the changing world in order to participate in market-driven economies, as well understand and take on the social responsibilities to conserve and utilize precious resources, protect the environment, and mitigate public health issues such as HIV/AIDS.

ICTs have the potential to play a powerful role in enhancing the tools and environment of learning and preparing students to acquire skills, competencies, and social skills fundamental for competing in the emerging global "knowledge" economy.

Research and experience has shown that ICTs, *if well-utilized* in the classroom, have the potential to enhance the learning process in the following ways:[6]

- Motivate and engage students in learning. It has been shown that students are motivated when learning activities are authentic, challenging, multi-disciplinary and multi-sensorial.
- Bring abstract concepts to life, especially when concepts go against immediate intuition and common knowledge.
- Foster inquiry and exploration.
- Allow students to use the information acquired to solve problems, formulate new problems, and explain the world around them.
- Provide access to world-wide and local information sources.
- Provide a means to communicate, share research, and join projects across geographical borders.

The caveat is in the phrase, "*if well-utilized* ICTs have potential for enhancing learning." Several investments into computerising schools have not achieved the desired learning outcomes because the overall strategies were neither comprehensive nor realistic. International best practice highlights that ICT integration should cut across all levels of the education sector, but experience also notes that the costs of integrating ICT into the entire education system can be daunting. An innovative approach to infrastructure, staff development, technology deployment, and community involvement is necessary.

The following options, though presented separately, should be seen together as a multi-faceted, sequenced, and coordinated approach to introducing ICTs into teaching and learning at multiple levels (teacher training colleges, in-set professional development, secondary schools and primary schools). This is in line with the Kenyan context and attempts are made throughout to balance issues of cost with equity and relevance.

The following options are discussed:

- e-Content Development
- ICTs in Teacher Training Colleges
- Computers in Secondary Schools

[5] Jomtien Declaration, article 4. Derived from "ICT-in-Education Toolkit, Decision Makers Essentials," Haddad, Wadi D.,2004
[6] ICT-in-Education Toolkit, Decision Makers Essentials," Haddad, Wadi D.,2004, p.22

- Computers in Primary School Cluster Centres
- ICTs for In-Service Professional Development
- IRI for In-Service Teacher Training
- Video for In-Service Teacher Training
- Online Professional Development
- ICT Infrastructure

Option: E-Content Development

Often when policy makers begin discussing integration of ICTs into education, hardware and connectivity considerations trump content development. As a consequence learning objectives are displaced in the process. When this happens, there is a tendency to lose focus on the reasons why we are introducing technology. We must remind ourselves that the introduction of any technology is first and foremost about improving educational outcomes.

Presently, much of the discussion around ICTs in the Kenyan education system focuses on ICTs as a discrete subject area rather than as an educational tool. This is apparent in the current version of the ICT syllabus for Teacher Training Colleges and Secondary Schools. The objectives in the teacher training syllabus are to teach ICT literacy, e.g. basic word processing, spreadsheet and database applications. In secondary school, ICT is generally only taught as Computer Studies, an elective for students keenly interested in programming and computer networking. This approach leaves many students and staff uninterested and unprepared to leverage the power inherent in ICT. In fact, this approach to ICT leaves many educators outside, viewing ICTs as not applicable to their subject domain.

> Apart from these infrastructural inadequacies, there is also little educational content available in electronic medium. Content is the clear driver that would justify greater investments in computers by schools and parents of students attending those schools.
> There is also a pressing need to design ICT-based curricula rather than treating ICT as a separate education product.
> The presence of a rural-urban divide in access to ICT solutions in education is also compounded by the gender bias in favour of boys. This would require affirmative actions to redress such imbalances. Among obstacles that would need to be overcome include mindsets that perceive computers as being exclusively associated with the field of science.
> – SchoolNet Kenya

However, with the advent of the Internet and other technologies which are changing the way we operate locally and globally, this approach is very short-sighted and potentially damaging for the future of Kenya. The MOEST's goal should be to demystify technology and leverage the tools to provide deeper conceptual knowledge of the world around us. Technicians can be employed to fix and maintain the computers, however, teachers and educators must know how to exploit ICT for what they do best – opening learners up to the world of knowledge.

Computers themselves, however, do not come pre-packaged with relevant teaching content. Although the Internet provides a vast number of resources, most are in English and may need to be modified in order to be relevant for Kenyan students and curriculum needs. Investments in custom-made digital materials with highly relevant content for Kenyan classrooms in rural and urban contexts are important if the MOEST wants to tap into the real potential of ICTs for learning. For example, while ICTs can by no means replace teachers, digital materials can be developed for students to occasionally work unassisted. With the affects of HIV/AIDS starting to be felt across the education system in Kenya, self-guided materials can be utilised to support learning when teachers are absent from their classrooms. Building capacity in Kenya to create instructional materials for an increasingly digital world is an investment that will pay dividends for improving the quality of education.

Proposed Institutional Base

Kenya Institute of Education (KIE), the MOEST curriculum development and educational media services institute, is the most appropriate place to build e-content development capacity. KIE already has a long

history of developing radio instruction content and the MOEST can tap into the capacity of these curriculum developers and content providers and begin reshaping their processes and skills for digital content production.

To highlight the need to develop Kenyan educational content, let us turn briefly to the Teacher Training Colleges (TTCs). (The Colleges are discussed in detail later in this section.) Currently, all 21 Teacher Training Colleges and the 2 diploma schools that produce teachers in Kenya have computer labs with 10-15 functioning computers. These labs were either purchased by the Board of Directors or donated from different agencies. Of the TTCs visited (Highridge, Machakos and Kenya Science) none has educational materials beyond a basic software application package for word processing, spreadsheets, databases, etc. The computers are used to teach basic ICT awareness and instructors are struggling to cover the new ICT syllabus introduced by KIE in September 2004.

In fact, after initial testing of the ICT syllabus, KIE realized that they needed to provide TTCs with a supplemental teacher guide explaining how to "integrate" ICTs into teaching and learning. They are currently working with VVOB and other master teachers trained at Kenya Technical Teachers College (KTTC) to improve the ICT syllabus. (This will be discussed more in the following section.) However, it is essential to understand that the absence of educational materials installed on the computers makes it increasingly difficult for teachers to optimise the use of ICT into learning and instruction. TTCs are forced to create their own learning materials and without Internet connectivity, progress will be very slow, especially in resource-poor areas. Moreover, it is important to make the distinction between instructional materials created by students and teachers and those vetted by a national institution for quality assurance. As noted above under the IRI discussion, there is great need to develop the capacity of KIE to conduct these quality assurance functions.

The following option stresses that KIE take the initiative in creating quality educational materials to be distributed via computers, as well as radios. KIE will also be responsible for coordinating other institutions that are developing appropriate content. This is a two-pronged approach - adapting existing educational materials and distributing them to the schools, and beginning the process of having schools create their own e-content.

Adapting Existing Content

Though exploring the Internet is part of the ICT syllabus for TTCs and secondary schools, connectivity is not feasible at all schools at this time. One low-cost stop-gap measure is to produce CD-ROMs with the digital version of the national curriculum as well as educational materials downloaded from the web that address curricular areas.

In order to achieve this, KIE can designate educational researchers and master teachers to research existing educational content on websites organised by institutions for which they are applicable:

- Teacher Training Colleges and Diploma Colleges
- Secondary Schools
- Primary Schools
- Community Learning Centres

Ideally these educational resources should be input into a database that is accessible via a web browser, though not necessarily on the Internet, as in the accompanying Figure, "Organization of Web Resources". If content is developed to work within a web browser, this content can also be distributed on CD-ROM and viewed on any computer platform. Schools can view the content without Internet connectivity.

Considerations regarding database design, web interface design, and web hosting will need to be made. KIE can decide whether they want to build this capacity in-house or outsource it to an external design firm and hosting company. The advantage of ICTs is that this can be outsourced anywhere in the world if local price structures are cost-prohibitive. The baseline cost for a simple web interface is US$600.00 with hosting fees of US$20-30 a month.

Figure: Organization of Web Resources

URL/Publisher:

Content Topic and short description:

Priority Areas Addressed:
- ☐ Early Childhood Education
- ☐ Special Needs
- ☐ Girls Education
- ☐ Guidance and Counselling
- ☐ Out of School Youth
- ☐ HIV/AIDS awareness

Primary Teacher Training College Curricular Topics
- ☐ English
- ☐ Kiswahili
- ☐ Art and Crafts
- ☐ Physical Education
- ☐ Social Studies
- ☐ Creative Arts
- ☐ Music
- ☐ ICTs

Secondary School Curricular Topics
- ☐ English
- ☐ Math
- ☐ Kiswahili
- ☐ Biology
- ☐ Physics
- ☐ Geography
- ☐ History
- ☐ Religious Studies (Christian, Islam, Hindu)
- ☐ Physical Education
- ☐ Chemistry

Electives:
- ☐ Agriculture
- ☐ Business Studies
- ☐ Computer Studies
- ☐ Home Science
- ☐ Foreign Language (Arabic, French, German)
- ☐ Art and Design

Usage
- ☐ Integrated into Curriculum - Integral part of the teaching/learning process
- ☐ Enrichment – Used as a resource outside regular classroom
- ☐ Self-standing - Used for distance education, virtual schooling, online courses, etc…
- ☐ Information Management - Used for management of administration and/or learning systems

Instructional Objective
- ☐ Content item may be used for non-teaching objectives
- ☐ Presentation of a piece of information
- ☐ Demonstration of a concept, idea, phenomenon, law, or theory
- ☐ Drill & Practice to achieve student competence in the application of knowledge
- ☐ Animation and simulation to abstract reality and offer an efficient and inexpensive environment to reach generalizations or to draw implications from a law or theory
- ☐ Research for professional development and preparation of lessons
- ☐ Collaboration/communication on projects with other teachers in the school or in other schools in the country or elsewhere, or with scientists in the field.

Cost
☐ Free ☐ Sample Only
Priced at: (specify cost of copy/or license) -

Is it Externally Evaluated?
☐ Yes ☐ Not

*** Please see Appendix for Evaluation Form and a list of Existing web-based resources**

Duplication of CD-ROMs is very affordable. Investment into a stand-alone CD-ROM duplicator starts at less than US$1,000. For as little at US$5,000, a duplicator with built-in labeller allows you to duplicate 1,000 CD-ROMs at the touch of a button. After the initial investment, the MOEST can duplicate educational content for distribution at a cost of about Ksh10 per CD. This, combined with the distribution mechanisms already in place through District Education Offices and Teacher Advisory Centres, will facilitate the distribution process.

Creating New Content

Creating new materials requires more sophisticated expertise, substantive time, and significant up-front financing. Commitment at the Ministry level is essential to ensure that materials are used at schools and that the unit utilization cost is justifiable. Investment into this mode of capacity building, however, is becoming increasingly important as opportunities for e-learning have continued to rise.

Composition of Development Teams

Depending on the scope of content development, KIE should develop one core team to provide overall instructional and technical leadership supported by "satellite teams" focusing on different curricular subjects. Due to the multifaceted nature of different e-learning content, the composition and expertise of both the core and satellite teams should reflect this diversity. The team should draw upon other specialists and institutions in the implementation of their work. Instructional design methodology can be shared with the IRI script writing process (if the IRI option is developed as detailed above). Bringing in subject matter experts from outside of Nairobi, as done now with the panel team model, may be cost-prohibitive. A core team should reside at KIE with satellite teams of master teachers utilizing ICT to revise and comment on drafts via email without incurring travel and housing costs.

The Table below, "Composition of Development Teams," shows a summary of the composition of a typical development team specifying roles, specializations, qualifications, and experience. The scope of work determines the numbers of each specialty.

Training of Development Teams

The above specialists need to be oriented/trained in the process of design, development, and testing of modules. The scope of the orientation/training program depends on the level of qualifications and experience of the team members. KIE may need to look outside the institute to locate a programmer/software developer and graphic artist. A typical program may include the following:

- Initial Orientation/Training: One-two weeks
- Practicum/Development of Experimental Modules in a priority area such as Science and Math for secondary schools, Literacy for women or Life Skills/HIV/AIDS awareness for pre-service and in-set teachers: Three months
- Feedback and Evaluation Workshop: One week

The program of Initial Orientation/Training includes the following topics (including hands-on workshops):

- Overview of Instructional Design Process (ADDIE model – Analyse, Design, Develop, Implement, Evaluate – stressing the importance of Needs Analysis, Audience Analysis and Task Analysis
- Overview of Multi-media Production Process
- Team Building - Overview of steps and modalities of work
- Timetable of development and testing
- Review of samples
- Surfing for educational objects/assets

- Writing Content for digital consumption
- Wireframes and Storyboarding
- Tools and Technology review
- Presentation of examples
- Analysis of examples

The practicum should cover the following areas:

- Grounding the design in authentic teaching/learning situation – create educational scenarios
- Information architecture and interface design
- Development of script (in line with curricular areas, applicable to audience)
- Development of storyboard design
- Review and critique of interface design, navigation and educational script for first version
- Revision of design, and presentation of version 2
- Review and critique of version 2
- Testing on group of users
- Develop instructions for teachers guide

The feedback and evaluation workshop allows the design team to reflect and make adjustments to the workflow process.

Conclusion

Creating custom, Kenya-specific e-learning content is a long-term investment and will develop over time. Building capacity slowly through a concerted and coordinated effort may initially demand external support; however, searching for, organizing, adapting and distributing existing e-content can be less costly.

The MOEST must understand that computers in schools are becoming increasing demand-driven. More and more schools are acting on their own initiative to put computers in their schools. Organizations like Computers for Schools Kenya (CFSK) and SchoolNet Kenya are committed to providing ICTs across the sector. The MOEST should now take a coordinating role to ensure ICTs are achieving national educational objectives around quality, equity, relevance, and access.

Table: Composition of Development Teams			
Team Member	**Role**	**Specialization**	**Qualifications**
Content Specialist	Writes content text and scripts; injects nature of discipline and of learning into team discussion.	In subject-matter area. All specializations should be represented.	Solid background in subject area; training in instructional methodology desirable (e.g. science education, TEFL); experience in development of multimedia materials highly desirable
Master Teacher	Provides the classroom perspective for the development of modules, e.g., how to select effective teaching/learning activities, how students react to specific approaches, what difficulties teachers and students may face in presenting specific topics, etc.	In a subject-matter area. All specializations should be represented.	Solid background in subject area; distinguished teaching career; experience in development or use of multimedia materials highly desirable; open to innovations.
Instructional Design Specialist (often acts as Project Coordinator)	The architect of the team; helps translate the curricular content into specific teaching-learning activities and then into instructional options; provides crucial input into the design of the learning module.	Does not need to be an expert in a curriculum subject; specialization is in Instructional Design; in case no such specialization exists, the alternative would be a candidate with either background training in curriculum development or solid experience in instructional materials development.	Experience in instructional design, curriculum development and design of multimedia materials; creativity and innovation.
Programmer/Software Developer	Brings to the discussion the potential of different technology options and translates the instructional design of a module into a multimedia product electronically and artistically.	In one or more media applications depending on content needs; knowledge of authoring tools.	Experience in developing multimedia materials.
Graphic designer/ Media Producer	Responsible - with the programmer - for creating module ICT assets (audio, video, graphics, simulations, etc)	Competency in relevant skills such as graphics and animation design such as Photoshop, Flash, and Fireworks and other common graphic packages.	Experience in developing educational software is highly desirable.

Option: ICTs in Teacher Training Colleges

"The government is committed to the improvement of Primary Teacher Education and has continuously reviewed the program to make it more relevant to the needs of the country and in tandem with the latest international trends in teacher education."[7]

Currently there are 21 public primary teacher training colleges (PTTCs) in Kenya, almost all of which have computer labs and are making bold efforts to establish and improve PTTC ICT capacity. Due to lack of funding, however, a number of challenges have emerged:

- Access to computers for students is poor. PTTCs enrol 500 to as many as 1000 students with 65 - 80 staff members. In most cases, the number of functioning computers is around 15. If these were only available to staff, access ratios could be considered poor to good; however, primary use of the labs is to teach ICT to students and not to college staff. Therefore, ratios drop to very poor. If 15 computers are available to 600 students, each student has only 1 hour per week at a computer. This is not sufficient.
- The condition of the computers is not up to very basic standards. Many of the computers were donated by different organization and have inadequate RAM, processors, and software. PTTCs do not require the latest ICT equipment, but it must be of a very basic level. Some machines viewed had less storage space than a 64MB flash drive.
- The Teacher Service Commission (TSC) is unable to find qualified Education Technology instructors. Many of the ICT teachers are hired by the Boards of Directors for their computer knowledge but are not qualified teachers and have no background in pedagogy. Some of the ICT are seconded from other subject areas, e.g., the Arts and Crafts teachers in Machakos is acting as the ICT instructor on a volunteer basis, performing these tasks outside of his regular job description.

With these difficulties faced, a number of positive factors were also identified regarding the integration of ICT at the PTTCs:

- ICTs are demand driven from PTTC's Boards of Directors and Association of Principals, so there is very little need to sell the value of ICTs.
- Many of the PTTCs have already designated a secure space.
- Many of the PTTCs have mechanisms in place where they are charging ICT fees to students – one of the keys to sustainability models.
- Many of the PTTCs are on main tarmac roads and can therefore serve the outside community – another key to sustainability.
- PTTCs are ready to leverage usage of ICTs for education as evidenced in multiple site visits.

The PTTCs are ripe for a coordinated ICT intervention and much can be gleaned from international best practices from countries that learned certain lessons the hard way. Additionally, local, existing programs

[7] MOEST 2005, *Kenya Education Sector Support Programme: 2005-2010: Delivering Quality Equitable Education and Training to All Kenyans.* 9 May 2005 Draft.

and structures, such as VVOB's and DFID's experiences with teacher training and educational management support, can provide Kenya-specific lessons to the MOEST.

Equipment

Investment into upgrading the computer labs and building ICT capacity at the Teacher Training Colleges seem like obvious interventions with high returns. The PTTCs should aim to have networked desktop computers for lecturers at a ratio of 1 computer for each lecturer and networked computer labs for students with a ratio of 1 computer for every five students. This will not be possible in the short-term but, based on the equipment models discussed below, this can become possible[8]. Initially, PTTCs should have at least 1 computer lab with 20 computers for every 300 students.

Foundation Skills

ICT foundation or "computer literacy" skills include introduction to computers, keyboarding, file management, word processing, spreadsheets, email, and Internet use. At the current time, this is all that is covered in the PTTC syllabus and is only being taught to students; however, lecturers and school administration should also be exposed to foundation skills workshops.

Many models already exist to teach these skills and the PTTC should not try to "reinvent the wheel;" however, when choosing a model, it is important not to focus on foundation skills as the end goal, but as a basis for which to build other knowledge and skills by leveraging ICTs. If adequate access ratios are available, these skills can be learned through project-based activities. Instruction goals and activities should be highly conceptualised to address educational outcomes and the teacher's or administrator's reality. Each document produced should not be extra work but instead increase efficiency in the handling a teacher's workload, e.g. word processing for schemes of work, spreadsheets for student records, presentation software for visual aids. Please see Appendix E for an example model.

It is also important that training programs focus on making the assessment criteria explicit to students and lecturers as these new knowledge and skills are developed. New users should not be "left to their own devices" but rather provided clear guidance as to what they are able and expected to do with these new tools and then given the opportunity to experiment and work with the tools towards achieving these criteria. Discussion and reflections on innovative ways to use technology for educational objectives and priority areas such as HIV/AIDS awareness and gender sensitivity can be incorporated throughout.

Capacity Building in ICT Integration Skills and Awareness

ICT integration means applying computer and Internet technology to enhance the quality of teaching and learning objectives. It is the end goal of ICT in education interventions. In fact we see the deployment of equipment and the development of foundation skills as a means towards ICT integration.

Using ICTs to achieve learning objectives can happen at various levels. At the simplest level it allows for storage and display of information. However, using ICTs also fosters ***exploration*** of materials and ideas. If a student is consciously pursuing information on the Internet or on CD-ROMs, they gain a greater understanding of certain questions, issues, or concepts. ICTs allow learners to ***apply a concept or understanding*** to a new situation; to ***analyse ideas*** by organizing them and manipulating them; and to learn how to ***evaluate*** and ***problem solve***. At the highest level, ICTs are used to foster the ***design or construction*** of integrating projects, whereby students must explore wide range of ideas and resources, analyse and evaluate them, and synthesize them in a project. ICTs can fully utilize the multimedia environment to support this process.[9]

8 Certain considerations are needed in order to upgrade or introduce ICTs into schools. These considerations are generally the same for teacher training colleges, secondary schools, and community learning centres and are discussed below under "Option: ICT Infrastructure" to avoid repetition.

9 For further information, see http://education.ed.pacificu.edu/aacu/workshop/reconcept2B.html

Similarly, ICTs can be used to enhance teaching objectives, such as managing student learning and assessment, researching professional development opportunities and preparing lessons. ICTs can also help visually present information as well as demonstrate a concept, idea, phenomenon, law or theory. ICTs such as computer simulations and animations help explain abstract reality. Teachers can also use the Internet to collaborate on projects with other teachers in the school or in other schools in the country or elsewhere, or even with scientists in the field.

However, there needs to be awareness at the national level of how important ICTs are to enhancing teaching and learning. In mid-2005, KTTC with support from VVOB, will be coming out with a Teachers' Guidebook on how to integrate ICTs into teaching practice. KTTC has already trained a number of master teachers and any further training could be coordinated with these efforts, as they seem highly relevant to the Kenyan context and in-line with international best practices.

Option: Computers in Secondary Schools

There are currently 4000 secondary schools in Kenya (approximately 3600 public and 400 private) and the massive increase in primary school enrolment is putting pressure on the demand for and access to secondary school. The MOEST remains concerned with the quality of secondary education which is characterized by poor performance in core subjects such as Mathematics and Science. There are obvious benefits for integrating computers into secondary schools as students at this age need to focus on subject-specific content, greater critical thinking skills, scientific inquiry, and maths, science and languages. Students will benefit greatly with the analytical, creative, and collaborative power of computer technology to map out and analyse assumptions, present ideas, and participate in projects with peers from around the country and around the world.

At this time in most of Kenya's secondary schools, ICTs are not being utilized to enhance subject matter learning. This is due to the lack of adequate computer to student ratios as well as the current focus on ICTs as a subject matter rather than to enhance the curriculum.

Equipment

Secondary schools should have computer labs and 2-3 computers on wheels to integrate technology into classroom practice. This is, however, an enormous investment and currently cost-prohibitive, though not impossible. For instance, Computers for Schools Kenya (CFSK) has provided labs of 20 computers each to nearly 150 secondary schools throughout the country. CFSK has begun working with more cost-effective technologies to bring the cost down considerably. This model is discussed below under "Option: ICT Infrastructure." Additionally, many schools have utilised their own funds to purchase computers from private vendors. The MOEST should coordinate and monitor these efforts but also consider investing into further integration of computers in secondary schools through the Computers for Schools Kenya model.

An assessment of the number of schools that already have computers and that are ICT-ready, (e.g. infrastructure, connectivity availability, etc.) needs to be done to phase in ICTs to secondary schools across the country. SchoolNet Kenya and Commonwealth of Learning have begun this type of study. NEPAD is planning to pilot six e-schools in Kenya as part of a regional pilot program.

Educational Content

In order to truly affect the quality of teaching and learning at secondary schools, investment into computers should be in tandem with:

- subject-specific content development,
- sensitisation of school administrators, and
- establishment of a set of national ICT standards that encourage integration of ICT across subjects.

SchoolNet Kenya and CFSK also support this approach and both indicated that they will continue to develop their training programmes to accommodate these multiple goals.

According to the KESSP, there is also a desire to strengthen teaching of Math, Science and Technology by upgrading CEMESTEA at Karen to a fully-fledged institution for in-service training for Science, Mathematics and technical teachers. JICA-funded SMASSE, (Strengthening Math and Science in Secondary Education) may also play a role in producing math and science content into digital format. All these content development efforts should be coordinated by the MOEST and shared with secondary schools.

Foundation Skills and ICT Integration Awareness

Currently only a small percentage of secondary students are learning ICT through the "computer studies" programs. However, school administrators, teaching staff and students should all be presented with opportunities to develop file management, word processing, spreadsheet, email, and Internet use skills, as well as ICT integration awareness.

As noted above, foundation skills should be a stepping-stone to using ICTs to enhance teaching and learning objectives. The same ICT integration concepts used in the KTTC model can be adapted for secondary school teachers and students. ICT integration will take teachers and students beyond seeing ICTs as computer studies and computer literacy skills. Although these are important skill sets, they are not sufficient in leveraging the true potential of ICTs to improve creativity, innovation and collaboration – key capacities in the new knowledge economy. In both programmes, the assessment criteria should be made explicit to new users and opportunities to experiment and work with the tools towards achieving these criteria. This will ensure that their new knowledge and skills are conceptualised and more likely retained.

Additional Uses of the Computer Laboratory Model: TIVET

Sessional Paper No. 1 of 2005 describes a Technical, Industrial, Vocational, and Entrepreneurial Training (TIVET) system in need of major overhaul. The current offerings are described as inadequate and unaligned to labour market needs with little space for participation by and input from private sector stakeholders. Much work needs to be done. Any TIVET remodel will require upgraded training facilities. As these facilities are considered and developed, computer laboratories can be included for TIVET institutions. Based on institutional size, student to computer ratios of 5 to 1 should be utilised as a long-term goal. (Ratios of 20 students per computer are more likely in the short-term.)

With the introduction of ICTs in TIVET, it again becomes important to understand the difference between ICT integration and foundation skills development. All students enrolled in TIVET programmes should learn foundation skills but all students should also utilise ICTs across all training programmes, not only course streams directly related to ICT. And this should not simply be done in a linear fashion. Students should not be required to achieve full-competence in foundation skills before starting to utilise ICTs for other activities. An iterative process should be introduced whereby students learn and utilise new ICT knowledge and skills, thus exposing them to other possibilities and uses of ICTs, thus requiring them to develop and utilise new skills and knowledge. And so on. The model described above would provide the means to appropriately introduce and utilise ICTs in the TIVET sector. By ensuring the dual focus of integration and foundation skills, the sector would quickly be able to justify the availability of ICTs for TIVET students.

Option: Computers in Primary Schools Cluster Centres

Although there have been arguments to focus ICT interventions in secondary schools before advocating the usage in primary schools, it is important to note that currently only 47% of children in Kenya who complete primary school go on to secondary school. The remaining leave the system or (ideally) go on to TIVET programs. Digital exclusion is exacerbated when a large segment of the population is not exposed

to ICT. However, with a total of 18,000 primary schools, any large-scale ICT intervention quickly becomes cost prohibitive. Introducing ICTs at the primary schools, therefore, should be piloted in order to evaluate a model that can be assessed for sustainability, impact, and scalability.

An ICT intervention strategy needs to build off of the existing physical and instructional infrastructure, such as a cluster school model where capacity building and sharing of resources is already taking place. Cluster schools are essentially a group of schools in close proximity to each other, with one school acting as an information centre. The cluster model has already been developed in some areas. For instance, UNICEF has set up 80 clusters in 9 selected districts throughout the country, including remote areas in North Eastern Province. A select number of Teacher Advisory Centres which are located in each zone in every district could also be considered as information hubs.

Equipment

This option advocates that 5-10 computers with Internet connectivity, either via VSAT or WiFi/WiMax (See "Improving Quality and Equity Through Connectivity Growth"), are put into a select number (10-20) of cluster school "information centres" in rural, urban poor, and ASAL areas equitably distributed throughout Kenya with a strong emphasis on resource-scarce and underserved areas. Innovations in low power and off-grid technology solutions make this possible; however, policy and regulation issues remain to solve the high cost of connectivity.

Learning Circles

While procurement of equipment is taking place, capacity should be built at cluster schools and ICT readiness assessments conducted for classrooms. One way of doing this is to introduce the concept of "learning circles" and project-based learning. Learning circles/stations is a powerful classroom management approach, especially for multi-grade classrooms, where the teacher organizes her classroom into 4-6 different stations that reinforce concepts in the curriculum through multi-modes of instruction. For example, to teach fractions in a multi-grade classroom, the teacher separates children into groups of 5-10 students, depending on the class size. The teacher uses manipulatives like dice at one station for tactile learners to reinforce concepts, has an older student teach the young students at the chalkboard for drill and practice, has a worksheet station for assessment of concepts that are in line with curriculum examinations, and then has a real-life application station. This will require development and support of content through KIE, as discussed earlier.

If the teacher and students are accustomed to a traditional approach, this kind of transformation cannot happen overnight, but introducing ICTs provide an excellent opportunity to introduce change. When computers are introduced to the classroom, they become just one learning station and use the medium in the most appropriate manner. Visual presentation of difficult concepts, as well as graphs, maps, etc., can be used. The Enlaces project in Chile has used this model with much success.

Other Uses of the Learning Circle Model: Children with Special Needs

The model described above is proposed as an option when considering appropriate ways in which to address the introduction of ICTs into primary schools. The learning circles model is also useful for working with children with special needs. The smaller groups and direct attention for students serves to ensure that students with special needs receive the extra care required for their success.

While this model can be utilised appropriately for the students with special needs, it must be noted that the GOK estimates that over 95% of special needs students are not accommodated in the education system at all.[10] The GOK recommends that advocacy and awareness campaigns be undertaken to bring these students into the education system. But as the GOK highlights, more support must be given to

[10] Sessional Paper No. 1 of 2005, A Policy Framework for Education, Training and Research, page 13.

schools in order to make the learning environment truly inclusive for all students. The use of ICT-based learning circles is but one tool to assist teachers working with students with special needs.

Other Uses of the Learning Circle Model: Early Childhood Development and Education

Of the many constraints facing Early Childhood Development and Education (ECDE) in Kenya, the introduction of ICT-based learning circles could be utilised to address the limited teaching and learning materials and lack of facilities described in GOK Sessional Paper No. 1 of 2005. As described above, materials would need to be developed in line with ECDE curriculum guidelines and teachers trained and supported to utilise these materials appropriately and effectively.

Children involved in ECDE programmes require the type of direct attention and guided practice which the learning circle model utilises. This model, like other ECDE interventions, requires the support described in the Sessional Paper regarding in-service and pre-service teacher training, clear ECDE policy guidelines, and community participation. This model could be utilised to support other ECDE interventions.

Option: ICT for In-Service Professional Development

According to most surveys, the majority of in-service teachers – both at primary schools and secondary schools – have minimal to no ICT literacy or integration skills; however, outreach to this community of teachers is very important in an overall ICTs strategy. Currently, few organisations in Kenya are conducting ICT foundations and integration workshops for Inset teachers.

Foundation Skills and ICT Integration Awareness

The need for increased and improved in-service teacher training grows when the impacts of HIV/AIDS are taken into account. While the prevalence rate has dropped from estimates of 14% to 9% over the past few years[11], the impacts on those affected will not subside for years to come. These impacts include larger numbers of orphans and vulnerable children in schools requiring greater support from teachers; more teachers taking more leave to support family members and colleagues; and more teachers not in their classrooms due to illness and death. These impacts alone call for the development of new teacher training and support programmes. ICTs can provide much needed support to these new programmes.

Large-scale ICT capacity building workshops for Inset teacher training should build off any existing structures that deliver ongoing professional development for teachers. This may mean travelling to TTCs or secondary schools with computer facilities.

The program should be consistent with the workshops for lecturers and pre-service teachers at teacher training colleges. As stated above, foundation skills should not be the end goal and instruction goals and activities should be highly conceptualised to address educational outcomes and the teachers' reality. Introduction to computers should discuss the constraints and opportunities of using ICTs for education. Activities should focus on increasing efficiency in the teacher's workload and integrating ICTs to improve teaching and learning objectives.

Content

The distance learning material developed under the School Based Teacher Development (SbTD) program and any new materials developed for the School Empowerment Program could be put on CD-ROM and on a website to be available to all teachers with computer access at any time.

[11] Sessional Paper No. 1 of 2005, A Policy Framework for Education, Training and Research, page 24.

Option: IRI for In-Service Teacher Training

Face-to-face in-service teacher training is costly and difficult to accomplish on a regular basis without taking teachers away from the classroom. For these reasons, radio is being systematically and regularly used in Guinea, Nigeria, Zambia, and Mali as part of an integrated in-service training delivery system. Each country ingrates radio into a broader strategy that may involve printed reference materials or teachers guides, face-to-face training, peer groupings, supervision by inspectors, and expanded roles for school principals.

Radio is incorporated into the systems at many different levels. At a central and district level, IRI is integrated into in-service training. At zonal or school cluster level, IRI assists individual teachers in classrooms and/or in their homes. Radio is used to initiate and explain new technical or administrative strategies and to model specific pedagogical approaches. In some instances, radio plays a central role in implementing broad reforms such as an emphasis on student-based active learning strategies, a re-organization of the curriculum, or the use of the mother tongue for teaching initial literacy.

Typically, the radio has added value in several ways:

- Modelling pedagogic strategies, such as asking and answering different kinds of questions, so that they are demonstrated rather than merely described;
- Weekly or even daily contact with every teacher in the nation in a way that would not be affordable or even feasible through face-to-face methods;
- Communication among peers so that teachers can become their own trainers; and
- Swift and even immediate responses to new circumstances can be fed back to teachers.

The most powerful use of radio as an in-service training device is to build training into IRI lessons. It is one thing to advise teachers on how to teach fractions, it is quite another to build teacher activities into a radio lesson that is teaching fractions to a classroom full of children. Radio can model the ways in which a teacher can introduce the concept of fractions, lead teachers through the process of explaining fractions in concrete terms, solve problems in the radio lesson, and then model different kinds of instructional practice, and show how to evaluate and assess student mastery of the concept and practice of using fractions. The teachers' guide can then provide follow up activities after the broadcast.

Option: Video for In-Service Teacher Training

Video is another useful technology for demonstrating pedagogy. In Egypt, the New Schools Program worked to improve the quality of classroom instruction in rural schools in conservative Upper Egypt. Training focused not only on teachers but also on principals, lead teachers and district level supervisors and inspectors, but many principals and supervisors had little or no mental image of the kinds of teaching the project was promoting. They had not used student-centred methods in their classrooms when they were teachers, and they had never been taught using those methods. While they were in favour of active learning and could "talk the talk", they had trouble supporting teachers to actually change their teaching practice and in fact, some of their supervisory classroom visits ended up reinforcing older "chalk and talk" methods of teaching as opposed to encouraging the use of active learning techniques.

To address this issue, a video was created for the training of supervisors and principals (which was then also used to train teachers themselves). The video and accompanying training manual consisted of three 20 minute classroom segments. The first was a regular Egyptian teacher using the traditional lecture, "chalk and talk" method; the second segment was the same teacher using what the project termed "transitional" methods–e.g. the use of some active learning techniques but not at the level of mastery; the third segment showed a teacher in a regular Egyptian classroom giving an innovative math lesson using well developed techniques of active learning. With the accompanying training manual, supervisors and principals watched each segment and then answered question on the segment in groups.

While most principals and supervisors could clearly distinguish between the traditional and the transitional teaching, their greatest learning occurred as they compared the transitional teaching to the

segment that demonstrated real mastery of the techniques of active, student-centred instruction. The last segment of the video modelled for them, in a real Egyptian classroom, the target techniques, giving them a solid mental image of what good active learning looks like in a classroom setting. The video, along with participatory, hands-on face to face training, helped supervisors and principals to better support teachers in their schools and districts (in some ways by no longer acting as unwitting obstacles), as those teachers moved from traditional teaching to truly student-centred instruction.

Two models

Digital camcorders now deliver superb quality for as little as US$1000, and the hardware and software for editing digital video is also falling in price and complexity of usage. Simply shooting and editing digital video is something that many families adopt quickly and easily. However, the skills to produce a video that expresses a training message clearly and economically are another matter. For that reason, a dual approach is suggested.

Strategy one would be to furnish district offices with digital camcorders that could be used at training events so that teachers can watch themselves and their colleagues, and reflect and comment on what they see. The primary purpose would simply be to have a visual record of a teacher's performance for discussion and review. There would probably be no attempt to edit the results, and once viewed, the sequence might be erased, although each teacher might save a digital archive of how their skills increased over time.

Strategy two would be to use digital video for the purposes of training teachers across the district, province or even the country. Sequences would be shot in classrooms by a trained teacher trainer/videographer(s) based at the national and/or provincial levels. The videographers would travel to classrooms and training sites and assemble and edit VCDs[12] or DVDs of specific classroom practices. These could be used as a longitudinal monitoring instrument that measured changes in the national teaching capacity, and also used in training in TTCs and for in-service training purposes.

The point about digital camcorders in service of this kind of application is that they can be low-cost devices relative to the way in which video and film technologies have traditionally been used. Digital editing equipment consists of little more than appropriately equipped computers; they do not need special studios and sound and lighting facilities; and their operation does not need to be cloaked in the same kind of mystery that media technologists have traditionally invoked. On the other hand, to be of real value, their use does require a) selective use; and b) a sharp, creative intelligence on the part of the videographer in order to design a series of concise, economically conceived sequences that demonstrate the desired training objectives.

Option: Open and Distance Learning

Other countries in Africa have delivered online professional development activities to TTC lecturers, primary school outreach teachers, curriculum development education officers, and professional development education officers. Open and distance learning (ODL) has been given a recent push as ICTs have provided opportunities to expand and improve delivery mechanisms. Universities in Kenya are developing their own ODL courses which utilise electronic systems. Other countries are also offering courses to Kenyan professionals. Both of these options are presently coming under close scrutiny in Kenya. For instance, at time of writing, the World Bank is organising a workshop to discuss these issues with policy makers in great detail.

[12] **VCDs** (Video Compact Disc): A VCD is a CD that can contain moving pictures, sound, and photo album/slide show type content. VCDs can also be authored to display interactive menus; a user may choose between different songs, video clips or modules or play all of the content sequentially. A VCD has the capacity to hold up to 74/80 minutes of full-motion video along with quality stereo sound. A VCD can be played on almost all standalone DVD Players and on all computers with a DVD-ROM or CD-ROM drive. VCD costs 1/10 of a DVD.

The MOEST can consider ODL using ICTs in a number of ways. Education professionals can enrol in relevant distance learning courses based on local and international experience. The courses could cover ICT integration, pedagogy, curricular content, pedagogical content knowledge for different subjects, assessment, and educational management. A number of courses are available through UNISA (South Africa), Open University (United Kingdom), and Harvard University (United States), among others. Courses should also be developed in association with AVU and Kenyan universities. It may be possible to develop strategic partnerships to develop and deliver these courses thus achieving the dual goals of capacity building for development and delivery of professional development activities in an electronic format. These courses should not be delivered completely online or electronically given the difficulties new users face with the medium. A blended approach which includes electronic and face-to-face (F2F) support to course participants will be needed to ensure success.

One additional concern will be how to ensure commitment to the course by education professionals. Many education professionals will work hard and successfully complete their courses. But, if the MOEST or a development partner pays for the courses, incentives must be built into the model for those that may not be as committed to these professional development activities. This may include requiring participants to pay up-front for the courses and be reimbursed upon successful completion. Other incentives may include the distribution of refurbished computers to successful course participants.

The importance of open and distance learning (ODL) has been mentioned in many parts of this document – the scale of the problems and the size of Kenya make it virtually imperative that much of the pressing educational burdens will have to be addressed using approaches that rely on technology to deliver more educational content, and to improve the quality of teaching and student performance. This section takes the opportunity to make some general observations about the process of ODL, and to point to a wide array of potential applications, not all of which we have had the opportunity to point out in the specific sections that pertain to them.

We are really talking about "mediated" education

An important point to make is to clarify that the casual use of the phrase "open and distance learning" throughout this document incorporates a wide diversity of actual approaches, many of which do not happen at a distance. Historically, we have talked about learning organized from some distant source as distance learning because we focused on the distance between the instructor and the student. Now, however, distance learning is much more varied. In some instances, it is actually accomplished over a distance, with an instructor interacting in real time through electronic channels with the student. However, with the advent of inexpensive multi-media computers, it is often the case that the instructional materials are delivered to the student and used locally on a computer, without any sort of electronic link back to the instructor. An entire world of tools is now available to us to achieve this new kind of instruction, and the differences mean that it is more affordable and more equitable than older conceptualisations of "distance" learning. It is generally more accurate to call the new model "mediated" learning.

Connectivity is often not necessary

The use of media support for sound and video enhancement, and for packaging lots of additional information resources with the basic instruction, means that much of the necessary teaching can be done without any connectivity. This is good news for developing country environments where connectivity is expensive, unreliable, or completely unavailable. While direct interaction with the instructor almost always adds value to instructional materials, it is possible to deliver very effective materials that can be used either in "stand-alone" mode, or with only intermittent contact with the instructor.

This will be an important distinction in thinking about mediated instruction in the Kenyan context, because the availability of decent connectivity today is fairly low, and the current costs are held high by the low volume and non-competitive environment.

Mediated learning can shift the costs away from the government

Mediated learning offers a host of new opportunities to accomplish learning among populations or in contexts that we previously never thought were possible, because the costs associated with older concepts of distance learning were completely prohibitive. There are quite a few reasons why the mediated learning is less expensive to deliver than face-to-face, even if it depends on computers for delivery.

For one thing, many computers and access to connectivity are "appearing" in the environment without the government having to pay for them, as a result of consumer demand and other organizations' investments. Many employed people can find a way to use a computer at work; businesses are bringing them in for other purposes, but they serve just as well as teaching machines, even if they were bought to track payroll. Most government facilities are beginning on the path of having computers that could be used.

A second factor is that as computers and connectivity penetrate into the everyday routine of society, it is usually the case that the student can find one to use, without the government having to bear the cost of providing it. While this shifts a large portion of the cost of distance learning to the user, and away from the government, questions of equity take centre stage to ensure that existing patterns of access to quality education are expanded to all students.

Kenya does not have to seize all the opportunities at once

In the list of opportunities that is presented later in this section, one notes immediately that there is a plethora of ways in which mediated instruction can be applied. That does not mean that all of them should be tackled at once. What it does mean is that Kenya must be strategic about how it approaches this cluster of solutions. Some of the applications are obvious, given the government's emphasis on increasing equity, access, and quality.

However, in choosing to prioritise some applications over others, it is valuable to remember to plan ahead for the ones that are being deferred. If the curriculum is going to be rationalized in a non-priority area, one should still take into account that eventually it is probably going to be delivered in part as mediated instruction, at least in some contexts. During whatever curriculum or instructional materials development might be done in the interim, the professionals involved need to be mindful of making sure that the investment will also serve when the mediated instruction is developed. In many cases, this means capturing "talking head" content, if that is the present mode, in a way that can be edited later for short clips to be incorporated in more carefully designed instruction. It means gathering over time a video clip library not of talking heads but of actual demonstrations of the points being made in the curriculum, in order to enrich the final product. It means accumulating resource materials, teacher support materials, good exercises, etc., in advance, so that the investment in the creation of mediated materials will have a rich content base to build on.

It also means that MOEST should be developing as they go a human resource pool of trained and experienced developers of mediated instructional content, so that as activities go to scale, there is a resource base to draw on during the expansion. This probably implies the creation of one or more academic programs to create the trained pool, and a conscious effort to "professionalise" this career track in the minds of young educators.

Build using available tools

In many cases, there is an implicit assumption that starting an ICT-centric activity requires that one build a special network or a special software platform early in the process. In most cases, this turns out to be counter-productive. There are several aspects to the dilemma:

Governments sometimes assume that they need a proprietary network to transmit their data, and end up spending a great deal of money designing and building one. This often results in a network that is inappropriate for the task, once one has collected enough experience to understand what the real constraints and objectives are.

- The concern is often motivated by a concern about security, which is generally obsolete. In

the modern context, virtually any level of security can be attained on a public network. Ironically, very little of the government traffic needs to be kept secure in any case.

- This is true in the extreme in the case of distance learning, where easy public access to the content is vital. Proprietary networks have the unfortunate characteristic of making it more difficult for would-be students (whether they be young or old) to get access to the instruction. A public Internet Protocol network provides the best access.
- Proprietary networks are much more expensive, but that's only half the problem. The government can end up paying a high price to have its traffic, and only its traffic travel on exclusive lines. The result is that the lines are sized for a smaller amount of traffic, which is more costly than larger shared lines, AND they are less efficiently utilized, which means that they must be sized larger to handle the peak flow, but seldom use most of the capacity, resulting in further economic inefficiency for the government. The ideal solution is for the government to be a customer of a larger, public network, and have its traffic share in the economies of scale.
- There is another, less obvious, downside to proprietary networks, which is that they work against the government's goal of achieving universal public access to the Internet. A private network for the government essentially subtracts the government's traffic volume, and hence revenue, from the equation that a private sector network provider looks at when deciding whether it is economical to serve a given area. This results in many rural areas being uneconomical markets and not getting service, when they would be profitable markets to serve if the government's traffic were carried on the private sector network.

A similar kind of issue arises in the arena of choosing an e-learning software platform for delivering "distance" or "mediated" instruction. There is often a haste to settle on, or even develop *de novo* a platform to manage course administration, student completion, grading, and the like.

- Kenya's foray into distance education is quite multi-faceted, and it is unlikely that the same platform will be appropriate to all the different instances of the interventions and student populations. This is a time to be experimenting and learning what is needed, before making a commitment that may prove to be off the mark.
- In a separate part of this document, a number of open source e-learning platforms are discussed. These represent a good intermediate approach, with low costs of adoption and an inexpensive path to customisation. When enough experience has been accumulated, it will be much clearer what features are important in what contexts, and a better-informed decision can be made.

Examples of important options for implementing open and distance learning

The table below presents a broad survey of ways in which the MOEST might consider applying mediated instruction to different learning outcomes. The list is intended to spark the imagination, rather than to be exhaustive. The details of many of the applications mentioned have been discussed in other sections of the report, so they are not repeated here. The ones that represent ideas not discussed elsewhere have many differences, and we do not want to overwhelm the reader by attempting to elaborate them all. There are many more useful applications than MOEST could hope to include in its strategic plan. The intent here is to spur the discussion of options to range into a very broad consideration of useful applications.

ARENA	OBJECTIVE
Degree-Oriented Instruction to Students	
Primary School Level	• Increase equity by permitting groups of families without access to a conventional school to organize primary level instruction for their young children (e.g., nomadic groups in the North East). • Increase access from home, workplace, or community learning centre for those older students who did not have a chance to go to primary school, and have not been able to take advantage of the new availability of primary education to work for a primary certificate at their own pace, without jeopardizing their employment, and without having to attend a conventional school with much younger students. • Use Interactive Radio Instruction (IRI) to deliver engaging, pedagogically sound instruction to all schools, in order to standardize instruction, improve learning, demonstrate modern teaching techniques to teachers, etc..
Out of School Youth	• Increase equity of access for students who have left school early but would like a chance to complete their primary certificate, using the same opportunity to introduce content specific to a school-to-work transition.
Adults	• Improve access to primary certificate level by instituting an "equivalent" primary certificate for adults who complete a specially adapted curriculum through open or distance learning.
Teacher Training	
In-Service	• Make a quick and significant impact on teacher behaviour and knowledge by implementing a major distance instruction program for in-service training of primary and secondary school teachers. Such instruction can be completed, if necessary, on computers that lack Internet connections, by distributing CD-ROMs or DVDs to even a single computer in each school, in the teacher assistance centres, in community learning centres, or by utilizing MOEST-paid vouchers to let the teachers use equipment at any local cyber café.
Pre-Service	• Strengthen the quality of instruction at pre-service teacher training facilities, particularly primary teacher training, to achieve better mastery of content to be taught and better command of pedagogical approaches, using connected or unconnected computers to supplement the existing instruction.
Non-Degree-Oriented Instruction	
Employability Training	• Solve a major problem of the disarticulation of school curriculum vis-à-vis the skills immediately needed by employers by implementing a distance education program to reach graduates and school leavers, and offering them additional instruction in the technical and social skills most sought by employers.
Literacy	• Increase equity by addressing the adult literacy problem by utilizing the multi-media capabilities of computers to create interactive instruction that can be used by people who cannot read and are not computer literate, administered through community learning centres, during the evenings at schools, or through local cyber cafés.

Computer Skills	• Accelerate the achievement of universal computer literacy among the working population and youth by utilising a multi-media distance learning curriculum on skills required to master an operating system and the major types of applications programs, to be offered in primary and secondary schools, if they lack local instructors with knowledge to teach such content, and freely on the web so that individuals can learn it at work or in commercial cyber cafés. High-quality, free resources are readily available.
In-Service Professional Training	
School Administrators	• Address the problem of limited opportunity for in-service professionals other than teachers to receive mid-career training though distance education courses addressing management issues, finance and budgeting, and working with communities as decentralization progresses.
Non-Education Government Employees	• While not directly within the MOEST mandate, MOEST is probably the best equipped ministry to assist with creation of distance education for the training of employees of other ministries and local government. These employees are typically too scattered and too needed in their roles to be able to come together for in-service training opportunities, and distance education is the ideal way to provide such desperately needed training. However, such interactive training without a sound basis in pedagogy would not be as useful as it otherwise could be; MOEST will be the ministry with the overwhelming amount of expertise in making effective materials, and it would be appropriate for them to help other ministries create such instruction.
Private Sector Employees	• Address the broader issues impeding Kenya's development through a significant MOEST involvement in creating the human infrastructure for delivering high quality distance education in all sectors. The needs for training of school administrators and other government employees are a mere microcosm of the needs experienced in the private sector. MOEST should use its own involvement in implementing distance education solutions as a stimulus to create training programs for such instructional professionals, and ensuring that there is a large pool of well-trained, qualified personnel for the private sector to draw on when they also invest in distance education.

Option: ICT Infrastructure

Equipment

Much of a school's initial investment for computers often will come from government agencies, international donors, or local businesses. After this first investment, schools generally are expected to maintain and expand their computer system by generating needed funds from their own sources and by modifying the school's budget. Funds are needed to maintain the computers, buy supplies and additional equipment and software to meet expanding demand, pay for monthly Internet access fees, replace failed or outdated equipment, and possibly cover the salary of technical support specialists or instructors. Some schools use their computers to raise needed funds through a mix of revenue-generating activities after normal school hours, including computer training courses open to the public, computer time rental programs, desktop publishing businesses, and a variety of high-end computer services offered to local businesses and government agencies.

Providing teachers and other education professionals with access to technology is one key component to developing the necessary human capital which the education sector requires for the wide adoption of technology. Throughout the development of this Options Paper, it has been apparent that, while a priority for education planners, the GOK is not able to provide every teacher and education professional with a computer at this time. If the GOK would like to increase access for educators, other more economically viable models must be considered.

Computer Leasing

One option would be to develop a computer (laptop and desktop) leasing program. Laptops would allow support educators (e.g. TAC tutors) to utilise digital media (DVD, CD-ROM, etc.) to share best practices with their colleagues. This proposal suggests a leasing solution for the provision of technology to teachers, principals, district education officers, TAC tutors, Zonal Inspectors, and other education officers as appropriate. The leases could be provided via a local ICT in education NGO such as CFSK. To lower monthly lease costs, the Ministry or a development partner would be asked to provide a once-off lease origination fee. The monthly leasing costs would then be paid by the education professional who receives the laptop (or desktop) computer. Monthly payments would be made through an automatic payroll deduction or stop order payment. Given international experiences, this type of procedure should be mandatory. These payments would contribute to a rolling fund, thus ensuring sustainability through continuously available capital for the provision of more technology for more education professionals. At the end of the three-year lease, the professional would be given the option to buy out the lease by paying the *future value* of the remaining 25% purchase cost of the hardware and software. The other option would be to return the laptop and originate a lease on a new laptop.

Computer Labs at Resource Centres

Another way of providing access to ICTs for teachers and education officers would be to develop local computer centres through District Resource Centre and/or TACs. Online/electronic courses, foundation skills development, and training on Math, Science, and Language content knowledge as well as Pedagogic Content Knowledge (PCK) activities can be delivered to support teachers through these centres. The lab model should closely resemble the Community Learning Centre (CLC) model. Like CLCs, these computer labs should available to community members during school hours and available to teachers after school hours. Private sector partners can be invited to assist in the management of the centres and to deliver recognised ICT in education support activities at no (or reduced) cost to teachers. In exchange, private sector partners are given access to the computer labs to deliver ICT training to community members for profit, thus addressing the key issue of sustainability.

Assessment of Infrastructure

PTTCs and schools require secure, burglar-proof rooms to house the computers. For instance, CFSK requires all schools to undergo pre-installation assessments before equipment can be installed. Schools unable to establish secure spaces do not receive equipment. This ensures that equipment installations are demand driven. The drawback is that this model does not ensure equitable distribution of resources since poor schools will have greater difficulty raising the additional funds necessary to secure a room for computers.

Hardware and Software Requirements

The following Table shows hardware and software requirements are for the computer lab model:

Table: Computer Lab Requirements	
Hardware requirements	**Software Requirements**
20 - 40 computer work stations with following peripherals: monitors, keyboards, speakers, DVD/R, CD/R, & CPUs	Operating System – Linux-based OS and Windows OS should both be strongly considered. TCO should determine selection.
Printer	Productivity Tools - word processing, spreadsheets, presentations, database (Open Office or Microsoft Office Suite)
Copier	Bundled web development, graphics, and animation software (Dreamweaver MX)
Scanner	Web Browsers (comes with OS)
Overhead Projector	Media Player (comes with OS)
Digital video camcorder	Anti-virus
Digital cameras	Keyboarding Software
Webcams	*Educational/Curriculum Materials
Microphones for audio recording	Inspiration or Mind Mapping Software
*Special Needs peripherals	*Special Needs software (text to speech)

Thin-Clients and Fat-Clients

LANs can be established using thin-client or fat-client (stand-alone) machines.[13] Discuss pros and cons here. Many computer labs in Africa experience virus problems when utilising Microsoft operating systems. (See http://www.bridges.org/software_comparison/report.html.) CFSK and SchoolNet Namibia have both successfully introduced thin-client computer labs in difficult environments. Both organisations have utilised open source operating system on their thin-client machines in an attempt to reduce cost. CFSK also utilises fat client workstations running Windows 98 and has signed an agreement with Microsoft to install this software at no cost.

The thin-client model should be further explored and expanded to bring down cost, increase security, improve virus protection, and ensure Microsoft's interest in Kenya's education sector. For example, by championing open source software, SchoolNet Namibia has done more than any other organisation to ensure Microsoft's strong interest in the Namibian education sector. This has resulted in additional ICT in education interventions including Microsoft's development of IT academies, lesson plan competitions, and computer refurbishment centres, among others.

[13] A **Thin client** is a computer (client) in client-server architecture networks which has little or no application logic, so it has to depend primarily on the central server for processing activities. A **Fat client** is a computer which processes applications itself and can operate on its own or as part of a network.

ICT and Skills Development

The challenges for extending the benefits of information technology are great. Even with collective access, the recurring costs of satellite connectivity are still too high to reach some areas. Trained technicians may be hard to find. Electric power may be unavailable or unreliable. Wireless solutions hold promise, but standardization is still needed to drive costs down. Once connectivity arrives it must be turned into tools that bring real value and improvement to peoples' lives.

Option: Community Learning Centres

Utilizing ICTs to reach disadvantaged groups and expand their educational opportunities demands working within the larger community and often across sectors in order to provide a sustainable solution. Early impact assessments of Community Learning Centres[14] indicate steep challenges in management, content generation, and sustainability. ICT community access points have been shown to be more relevant to the community when communities participate in the planning and implementation of the centres.

Community Learning Centres can be used to address the multiple goals of access, equity, quality, relevance, and efficiency, but sustainability becomes one of the greatest challenges. If CLCs are considered as one invention the MOEST can employ to provide access to education by underserved segments of the population, then sustainability must be considered beyond a purely market-based perspective. This is an important distinction to make early on in the discussion of this option. CLCs are often not sustainable when seen as a private sector intervention. CLCs should be considered as one valuable tool which the government can subsidise for the delivery of education.

Community Learning Centres are at the intersection of these issues. As centres come to reflect the communities they serve, more models for sustainability will emerge. Effective business planning for centres that takes the wider market, universal access, and social development into account may become what determines the rate and relevance of the expansion of Internet connectivity. The results of many community learning centre interventions around the world indicate great obstacles for the success of these projects.

Total Cost of Ownership

CLCs (and all computer labs) cost more than the price of 10 computers. Any CLC costing exercise must include all key aspects detailed in the TCO model discussed in this report under the section "Total Cost of Ownership." These concerns include professional development, maintenance, support, connectivity, hardware, software, building retrofit, installations, and replacement cost among others. It soon becomes apparent that the cost of hardware and software is only a fraction of the overall CLC outlay. As Mardle highlights, "The only way the Pentium can function in a Least Developed Country is to import a slice of its native economy with it. That requires sealable windows and doors, air conditioning..."[15]

Proposed Locations

If labs are to be installed, existing structures can be utilised for the development of Community Learning Centres (CLCs). These include, but are not limited to, TACs, District Resource Centres, cluster centres, community centres (e.g. YWCA), and teacher training colleges. The location should be based upon access by the primary target audience. Given the MOEST's priority to build new classrooms, it will likely be easier to retrofit existing buildings for use as CLCs than building new centres.

---

[14] These include Community Learning Centres, Community Learning and Information Centres, Multipurpose Community Telecentres, Telecentres, Community Access Points, etc. For the purposes on this discussion, the term Community Learning Centre is employed to describe points of access to information and communication technologies.

[15] http://topics.developmentgateway.org/ict/sdm/previewDocument.do~activeDocumentId=440944

Private Sector Partnership

The Ministry of Education in Namibia has recently begun developing strategic partnerships with Computer Education Community Society Namibia. CECS is a South Africa-based ICTs in education NGO. Funded by the Open Society Initiative for Southern Africa, the project works with local organisations in Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, and Zambia. The objectives of the programme include delivering accredited IT Literacy programmes in OSISA countries; establishing local centres, which are democratically managed and operated; delivering train-the-trainer courses for local country centres; convening IT Literacy curricular workshops in the countries; and helping to market local training centres and develop innovative linkages within the broader community in which they operate.[16]

In this model, the MOEST would provide the space and computers to an organisation to deliver ICT training activities to teachers, students, and community members. The MOEST could negotiate that the organisation would offer free training to all teachers and principals and, in exchange, the training organisation would be able to offer training to community members during schools hours as well as after hours as arranged. The training organisation would also be able to assist in the management of the centres and maintenance of the equipment. Since the training organisation would need the equipment to function properly in order to make any income from community members, it would be to their advantage to ensure the equipment is kept running properly.

Equipment

For a lab model, see section above "Option: ICT Infrastructure" under "Quality Teaching and Learning through ICT".

Option: Refurbishment Centres

Recently, much has been written on the use of refurbished computers in Africa and in Kenya in particular. The discussion is taken in full from the ICT Scoping Paper[17] developed by Digital Links International for the MOEST and the Imfundo Project. The discussion is then taken a step further to advocate for the development and expansion of refurbishment centres in Kenya.

From ICT Scoping Paper

> *It is important to underline that Digital Links International has a strong organizational interest in promoting the use of refurbished computers. Having said this, the following points are drawn from the Africa-wide experience of SchoolNet Africa, and present both the potential advantages and problems that need to be considered when it comes to using refurbished computers to support schools. This section summarizes relevant points captured in SchoolNet Africa's report from its International Workshop on the Campaign for One Million Computers for African Schools, held in Johannesburg in October 2004. Based on SchoolNet's Position Statement on the Use of Refurbished Computers in Education, the following extracts are presented:*
>
> *There is a potentially large supply of computers that are discarded or regarded as obsolete in western countries, and refurbished second-hand computers can be obtained for a significantly lower cost than new computers. While the exact scale of the use of refurbished computers is unknown, recent research by SchoolNet Africa suggests that over 20,000 computers have been imported by/for African Schools. The use of refurbished computers is therefore a significant trend, but equally not yet one that is making a significant impact on meeting the demand for computers in African schools.*

[16] http://www.iconnect-online.org/News/IConnectNews.import1868

[17] MOEST 2004, "ICT Scoping Paper" through Imfundo's support to MOEST. Paper developed by Digital Links International with Computers For Schools Kenya.

On the supply side, indications are that the number of discarded computers potentially available for reuse is in the millions. However, the effective reuse of computers is not simply a question of matching supply and demand. As the position statement points out:

- *There may be many hidden costs in accepting and using second-hand computers. The true cost is therefore often not known upfront.*
- *Deploying second-hand computers may impose a significant implementation and support burden on school networks and schools.*
- *The worst-case scenario is one of considerable expense and effort for equipment which may not work reliably or meet the needs of its users.*

In Kenya, as elsewhere in Africa, the experience with refurbished computers initially was very mixed. Donations tended to be of low capacity machines of various brands, sent out with little if any technical or other support. This approach was seldom useful and led to scepticism about the use of second-hand computer equipment generally, and in some cases to accusations that western countries were using Africa to dump hazardous electronic waste. In the case study for Narok, a pile of second-hand Mackintosh computers were seen lying unused in a corner, illustrating the problem.

However, learning has taken place and there is much more awareness among NGOs and the MOEST, as well as among donor organizations, about these issues. The following, taken again from the SchoolNet paper, are among the important considerations:

- *Not all donated equipment can be used or refurbished to an acceptable quality. There may also be compatibility problems with older hardware and newer peripherals.*
- *Batches of donated equipment may include many different hardware types. Heterogeneous collections of equipment can cause compatibility problems and substantially increase deployment and support costs.*
- *Refurbished computers may have higher maintenance and support costs, owing to the age of the equipment and higher failure rates.*
- *Depending on how refurbished computers are used (stand-alone or networked, fat- or thin-client), there may be restrictions as to what software can be run on them.*
- *Environmental considerations must be taken into account when disposing of unwanted second-hand computers, or refurbished computers at the end of their useful life. Computer components contain toxic materials that should be disposed of responsibly.*

All of the points above are considered in programmes such as that of Computers For Schools Kenya, which contributed strongly to the position statement.

The following are among further key considerations for decision makers in terms of the extent to which, and the manner in which, refurbished computers are used.

- *Fitness for Purpose: The ability of refurbished computers to meet the computing needs of the school or end-users should be assessed. In some cases it is possible to increase the usefulness of refurbished computers by using them on a network, and in other cases it may be possible to meet schools' overall computing needs by a mixture of refurbished and new computers.*
- *Total Cost of Ownership: This refers to the overall costs of using a particular technology solution over its expected lifetime, and the issues to be taken into account include costs of:*
  - *Initial purchase*
  - *Installation*
  - *Training*
  - *Maintenance and Support*
  - *Disposal*

- *Integrated Strategy: Deployment of refurbished computers is more likely to be successful when there is an integrated strategy which addresses all stages of the pipeline, viz:*
  - *Donation and/or procurement of second-hand PCs*
  - *Refurbishment of second-hand PCs*
  - *Distribution and installation of refurbished PCs*
  - *Maintenance and use of refurbished PCs*
  - *Disposal at end-of-life of refurbished PCs*
- *Absorption Capacity: The volumes of refurbished computers that can be accommodated in a project are determined by the capacity of each stage of the pipeline. As there is a large demand for computers from schools, and a potentially large supply of second-hand computers, the capacity of refurbishment centres and availability of technical support are likely to be constraints.*

Potentially, given the limited resources available, the use of refurbished computers may present an opportunity for schools to acquire good quality computers at a fraction of the cost of new machines. However, it is strongly recommended that those involved in making decisions around school computerization read the position statement referred to throughout the discussion above, and give consideration to the many important issues raised.

CFSK is currently running a refurbishment centre for the delivery of adequate technology to schools. They are utilising both fat client and thin-client models and refurbishing computers as appropriate to these model. Based on the findings of the ICT Scoping Paper (which we fully support based on our own experiences with refurbished computers in other African countries), the MOEST should strongly consider assisting CFSK to expand their refurbishment capacity as well as create other refurbishment centres around the country. These can be done in association with CFSK, SchoolNet Kenya, Microsoft, or other development partners.

These centres should primarily employ volunteers, with particular emphasis on young women. The volunteer model has proved very successful in Namibia by SchoolNet Namibia, where young women are brought into the ICT field. CFSK is already employing a similar model in Kenya.

Option: IRI for Non-Formal Education

Challenges facing Non-Formal Education (NFE) include the lack of a clear policy framework to guide and regulate the sub-sector, shortage of qualified and competent teachers, inadequate and quite often substandard teaching/learning materials and physical facilities, negative societal attitudes towards NFE, inadequate accurate data and lack of assessment and monitoring and evaluation mechanisms and capacity. Planned reforms include the provision of quality inputs in NFE programmes by providing professional support in curriculum development, teachers training, monitoring and evaluation and resources sharing between formal and non-formal systems.

However, given the challenges and commitments government has made to the formal system, it will take some time to meet all these goals. We propose adaptation of IRI using the existing curriculum – this would ensure all children are getting the same education, make assessment easier and cut down on the extra cost of development of a special NFE curriculum and teaching and learning materials.

NFE is defined as "flexible complementary delivery channels of quality basic education to children in especially difficult circumstances, in particular those in need of special care and protection, or children who live or work in circumstances which make it impossible for them to access education through existing conventional formal school arrangements in terms of time, space, and entry requirements".[18]

Learners not served in the formal school system could be included in non-formal schools and non-formal education centres. Currently, such programmes are largely in the hands of a wide range of non-

[18] http://www.education.go.ke/

governmental, community organisations, faith-based organizations, entrepreneurs and philanthropists and are registered under various government departments. The KESSP document describes the MOEST's capacity to coordinate and support these schools and centres as "inadequate". Consequently, the quality of education varies from very good to poor. Still, the Ministry's goal is to increase teacher support to NFE with 300,000 children attending per year. [19]

The provision of basic education, including literacy and numeracy skills, to learners outside of the formal school system often suffers from poor quality and high drop-out rates because of limited resources and instruction that lacks direction and clear objectives. If these learning centres can receive a daily infusion of high quality instruction that leads to a desired outcome in fixed period of time, they can become valuable educational resources. The result can be a productive partnership between government and private sector partners, including communities, churches and NGOs.

This kind of partnership has been demonstrated most clearly in Zambia, where the Ministry of Education developed interactive radio programs as an alternative basic education delivery system. The agreement with the communities, churches and NGOs which run learning centres has been that the Zambian MOE will deliver the means to learn while the private sector provides the support to communities for the management of learning. The Zambian MOE makes the radio programs, pays for airtime and for drafting and printing a teachers' guide, and for training volunteer teachers, and each day the radio provides a daily half hour of high quality instruction for each grade, 1 through 5. Communities provide a place for learners to meet each day, provide a board, enrol learners and deliver the services of a volunteer instructor. The daily interactive radio programs deliver the entire basic education curriculum in mathematics, language, science and social studies, with a daily 5-minute segment on life skills. Criterion referenced tests at the Grades 1 and 4 levels have shown that learners perform about as well as children attending regular government primary schools.

Because the instruction is at the same time each day but is for only a limited period of time, 30-60 minutes per grade, the system suits orphans who must make a living as well as try to get an education, or children who are required to work by their families. In Zambia, older siblings often bring the infants that they are minding, and adults who have missed out on an education set up IRI learning groups so that they get a second chance at becoming literate and numerate. In Tanzania, the system of IRI learning centres has become a popular option for children who are exposed to the worst forms of child labour but who want to learn basic skills. In southern Ethiopia, nomadic Somalis who have no brick and mortar schools to attend learn from the radio in itinerant learning groups, and those in refugee camps are using a similar system.

The IRI programs used for this purpose would be the same ones described above for school-based learners in ASAL regions and urban slums of Kenya with approximately 100 or 130 programs per grade level. As part of its goal to increase access and quality, the MOEST is looking into the possibility of acquiring a broadcasting channel. However, it might take some time to sort out the issues related to this, particularly the costs associated with maintaining the transmitters. It would still be possible to move forward with IRI programming even with restricted availability of airtime, but it would probably require that each grade level's daily broadcast integrated mathematics, language and literacy, science and social studies, rather than seeking to create a program for a single subject. For the same reason, it would probably not be possible to develop different programs for out-of-school learners, although such learners might prefer listening to IRI broadcasts at different times of the day from those in formal schools. So programmes for schools might be broadcast in the morning and/or afternoon for schools, and repeated in the evening for out-of-school learners.

However, the main difference would lie in the systems set up to support and manage the IRI learning environment. Where the provision of instructional systems in ASAL regions would remain the jurisdiction of the MOEST, and would probably emphasize the school as a basis for managing instruction, these out-of-school learners are likely to be meeting in community learning centres, often managed by the private sector (communities, churches, NGOs etc).

[19] KESSP document

If used in Kenya, this system could augment the quality of basic education that is already being delivered through urban NFE centres or remote rural schools where the quality of instruction is under pressure from inadequate teaching, large numbers of learners or a lack of instructional resources. In addition, the existing system of NGOs, faith based organizations and others of supporting NFE would provide a valuable base to support, monitor and evaluate the teaching and learning.

IRI generally provides 20 or 30 minutes of intensive, focused learning – hence, the time on task adds much value since NFE learners typically do not have much time compared to conventional systems where teachers and learners have a lot of time and may spend considerable time on non-instructional tasks. Moreover, alternative basic education strategies adapted by various NGOs and organizations such as Oxfam in parts of ASAL such as the mobile learning centres have shown that such strategies can provide a valuable alternative when children are not able to access conventional schools.

ICTs and EMIS

The specific elements of an effective, multipart EMIS in Kenya are well described in two preparatory documents: "Needs Assessment Report for the Establishment of EMIS"[20] and "Design and Specification for the Establishment of EMIS"[21]. Of critical importance is the insight that currently disparate uncoordinated data collection efforts could be dramatically reduced and harmonized. However, Kenya and specifically the MOEST have had a history dating back to the late 1990s of multiple suggestions regarding EMIS. Only a few of these have been effectively implemented, specifically the work led by the TSC, and later the Annual School Census. In all cases, much of the information gathered as a result of these efforts (many of which duplicate existing efforts) is available only to the sponsoring agency and most specifically is not shared with Districts (who have a substantial processing burden) and schools (who have a substantial burden in terms of completing multiple requests for the very same information). In fact, as with many countries with similar contexts to Kenya, schools have an increasing, though generally undersupported, paper burden from which they can see little if any direct benefit.

Regrettably, as presently configured, the current Needs Analysis and Design and Specification (with the important exception of a Core Data Collection Instrument) do not address this information gap. The key to any effective EMIS is that in a very real, concrete, and operational sense the information derived from a burdensome collection process is available readily and in a timely manner to those who need it. In a rapidly decentralising environment, it is even more critical that every district and other operational unit below the national level be committed to the information outcomes from any new system. Just as important are the schools themselves, and their own governance groups such as PTAs, or local civic committees, all of whom must believe that their efforts result in information from which they can benefit. At the second level, in a rapidly decentralizing environment, the districts too must feel fully empowered and capable of making effective use of such information.

As a quick aside, in an increasing number of countries in Southern and Eastern Africa, districts have become an important part of EMIS sustainability as they see how EMIS' features and capacities assist their local governance units, and how they themselves can understand the most important elements of their operation. Hence, the most critical part of a new EMIS is understanding what information and in what form key stakeholders require information – both presently and in the immediate future. At the moment, lacking from the assessment and design, in a direct way, is the actual output of information required by key units connected with the educational system. Many elements of this are implied by the careful elaboration of the instruments now used, but the actual reporting required by current units is not illuminated to the same extent. This exercise, focused on who needs what, when, and at what level of detail should precede or at least run in clear parallel with any extensive design effort. As one small example, most countries in the world continue to collect a UNESCO standardized age-grade matrix. This is at the core of most major educational analysis – no instrument at present in Kenya provides this information. The Core Instrument exercise should perhaps be re-titled as the "Core Information Exercise."

Secondly, extremely large and complex EMIS exercises have a tendency to fail after several years because of their complexity and the difficulty of seeing concrete progress after years of preparation. This problem cannot be underestimated as politics, unrepresented stakeholders, inevitable production/delivery delays, and competitive or procurement issues affect the timeline.

Elements of Success

Almost all major, successful EMIS efforts need:

[20] MOEST 2005, "Needs Assessment Report of the Establishment of EMIS: March 24, 2005 Draft" through the World Bank's support to MOEST. Paper developed by Techsphere Ltd.
[21] MOEST 2005, "Design and Specifications for the Establishment of EMIS: April 4, 2005 Draft" through the World Bank's support to MOEST. Paper developed by Techsphere Ltd.

- Demand driven requirements for EMIS outputs – i.e., EMIS must be seen to support **an important if not critical** need for information – either in support of money, teacher allocations, or explanatory material required to support educational policies and at the level where it is most useful. A reasonable way to look at information requirements and needs is as Operational, Managerial, and Strategic;
- **Early successes**, which have a demonstrable effect on the lives or operations of all participants, especially at school level. Systems or approaches that are working well now, even if somewhat inefficiently, provide insights into the key components of sustainability;
- **Options and alternatives early** in the process in order to keep on a timetable–which means **extensive and capable project management**;
- Very likely, **30% more time** required for implementation than planned largely because the absorptive capacity of the host sites–in this case the districts and selected agencies. Hence, 5 years is most likely to mean 7 years;
- **Capacity building is a "catalytic" factor** in transforming data into information. Capacity building must be at least 25% of the cost of most automation efforts since all EMIS is a combination of: people, process, and technology. Right now, much of the articulated thinking is on technology–not the people and process;
- **Multiple sources of access that do not necessarily involve technology**–or use technology to cost-effectively produce needed information. Printed output remains the most favoured form of information exchange and print remains expensive. New techniques to create better, more focused paper-based output are necessary;
- **Clear approach to finding and retaining skilled staff**–either internally or through a reliable outsourcing mechanism in keeping with the complexity of the installed technology;
- **Reliable, continuous funding to support the capital investment of EMIS**–for almost all instances, at least 10-14% of any equipment and software investment must be provided each year for maintenance, and at least 5-10% of current operating budgets must be spent each year for consumable supplies like ink, special paper, CDs, and communications charges. Most districts will require adequate storage and control approaches to ensure effective use of this material. These charges are so often the least respected and hardest to obtain. Computer based systems are notoriously reliant on recurrent support–lacking support, they collapse quickly. Please see the "life cycle" cost analysis presented later in this work. It is a critical component of sustainability for a system of this magnitude; and
- Finally, an EMIS project, probably as much as any other intervention, requires the elements of implementation success, namely:
  - Leadership–a lead person with a clear, communicated, and concrete vision of project outcomes, supported by a small group of politically and administratively influential persons;
  - A good support structure composed of sufficient, top quality staff with strong skills and excellent work ethic who command the respect of their colleagues and counterparts;
  - Funding which is available as needed and can be dispersed on schedule. EMIS projects require much more precise timing, and have an increased level of technical complexity than almost any other educational intervention.

Different Funding Levels for the Implementation of EMIS

Given the articulated funding gap in the original KESSP outline, it may be relevant to look at several "roll-out" alternatives based on available funds. The options suggested are based on a few simple principals described in part above:

- Make sure that key educational information is widely available on a timely basis–at a minimum before the end of each year;
- Make sure that information is in the hands of those who can use it, quickly;
- Simplify and harmonize to reduce the data demands on the most important part of the school system–the schools;

- Pilot all information efforts for simplicity and clarity with the key audiences first–make sure you know what they think they need to do an effective job;
- Mine the data that is already available–emphasizing analysis and use of existing information rather than simply increasing the collection of information that might be now, poorly used.

Option: Low Cost

Under a Low Cost Option, the key items that can be accomplished without massive infrastructure investment are undertaken. As more funds become available, the system can be expanded in concert with resources. Critical to maintain under this structure is the core implementation and design capacity team, and the important preparatory work that can still support early successes. The financial consequences of this option are indicated in Table 1 below.

This option would include:

- Core Information Creation: The main change here is a focus on the core information required by each of the stakeholders, and the pilot creation of baseline data using existing resources. Additionally, the harmonization of this activity is undertaken much as planned in the original project design. Critically included in this portion is:
- Support for common school numbering–all schools must have unique EMIS numbers, and all stakeholders, TSC, KIE, etc. have access to a common numbering scheme, MOEST maintains a comparative database including all numbers related to the same schools;
- Private school involvement is supported, encouraged, and enforced;
- Registration details include at a minimum: a)founder, b)ownership, c)operating group, and d) funding source
- The support to Data Collection in the amount of KS 50.0 Million is retained to ensure timely collection in both 2005 and 2006.
- Software Application: Scaled down and absent full network configuration. Most EMIS systems can work without continuous connectivity–in fact, most "store and forward" configurations are quite adequate for most uses.
- Data Processing and Analysis: Remains as proposed.
- Information Sharing and Dissemination: Remains as proposed and increased slightly to accommodate extra costs of semi-harmonized operation.
- Policy and Planning: Remains as proposed.
- EMIS Infrastructure: Focus on Head Office, and only 7 Pilot Districts
- Capacity Building: Increased slightly to make use of results of products from "Core Information Creation", above.

We have added an estimate for an 8th component, namely project management. Even on a low-cost basis, we believe the proper implementation of this effort will require specialized expertise that needs to be added periodically to the MOEST and organized very carefully as a team approach–independent of existing civil service regulations and requirements.

The Low Cost Option provides sufficient funds to begin to change the current mixture of duplicated systems, and demonstrates early the true products of an effective EMIS. Major focus is placed on using existing working structures and investing in the early elements of a much more advanced system. Investments in Security, Firewalls, and proper staffing remain–since these can become tremendous sources of failure in even the simplest systems. More use is made of leveraged changes from other ministries and donated software. This option will require funds for a management team, which would be a mixture of local and international expertise.

Option: Mid Cost

The Mid-Cost Option increases the extent of decentralization to half of the districts–about 38–using a unit approach. Further, the network infrastructure discussed in the Systems Design Approach is further expanded. We are concerned that operating costs for continuous access that is not based on extremely low-cost Internet presence for various districts will not be supportable in the long term.

Option: Full Cost

We believe that the basic costing already presented in the Needs Assessment and largely repeated in the KESSP document provides a reasonable estimate of costs. However, we are concerned about the operating costs that will be incurred for the proposed equipment and particularly the district software and supplies. Historically, the districts and in fact schools have had the most difficulty in obtaining disposable funds for these purposes–and this endangers the sustainability of the EMIS activity. Additionally, we have estimated that Project Management costs could increase to about KS 120.0 million for a five-year period. The following Table, "EMIS Investment Options", summarizes this information expressed as Millions of Kenyan Shillings:

Table: EMIS Investment Options

EMIS Component	Low Cost Option	Mid-Cost Option	Full-Cost Option
I. Core Information	70.0	95.0	140.0
II. Software Applications	55.0	90.0	113.0
III. Data Processing/Analysis	70.0	90.0	104.0
IV. Information Sharing & Dissemination	40.0	30.0	30.0
V. Policy & Planning	6.0	6.0	6.0
VI. EMIS Infrastructure	27.0	52.0	72.0
VII. Capacity Building	20.0	30.0	40.0
Sub-Total	288.0	393.0	505.0
VIII. Project Management	90.0	90.0	120.0
TOTAL with Management	378.0	483.0	625.0

Policy and ICTs in Education

The development of education in Kenya has been marked by dramatic changes and challenges in recent years which have had various impacts on the sector. Such changes have necessarily involved shifts in policy paradigms, most of which mirror specific the socio-political priorities of the government.[22] With these shifts, new concerns arise and policy changes necessarily take place.

A major NARC election pledge was the provision of free primary education for all Kenyan children: a promise which the Government has worked hard to keep. In January 2003, the NARC government opened the doors of all primary schools to every child in Kenya and made primary school attendance mandatory for all children of primary school age. To highlight the government's commitment to Universal Primary Education, parents were informed that they would be prosecuted if their children were found at home. The move has received overwhelming support from Kenyans while creating great challenges to provide access to physical facilities to accommodate all children; to improve the quality of teaching, especially in resource poor areas such as urban slums; and to enrich the learning environment in all schools. These challenge become even more critical as GOK plans for secondary school expansions, which are now imperative to ensure that all children who qualify for secondary school in 2010 will be accommodated.

While GOK is keen to utilise ICTs and other resources to assist in availing learning to all Kenyans, some key policy issues must be considered and addressed appropriately. These key policies are discussed briefly below and then different ICTs in education policy options are presented.

In March 2004, GOK funded the design and development of the e-Government Strategy to provide a common framework and direction across the public sector. The policy is intended to enhance collaboration within and among GOK institutions as well as between the business community, GOK, and the citizens of Kenya in regards to the development and implementation of ICTs.[23] This policy indicates that standards will be developed for hardware, software, and training requirements, among others. These standards should be sure to consider the use of refurbished computers in schools and provided additional guidance as appropriate.

The 9 May 2005 draft KESSP (MOEST 2005a: 105) indicates that:

> *The Government appreciates and recognizes that, an ICT literate workforce is the foundation on which Kenya can acquire the status of a knowledge economy. Against this background, the Government will make education the natural platform for equipping the nation with ICT skills in order to create a dynamic and sustainable economic growth.*
>
> *The Government has therefore formulated a National Information and Communication Technology Policy. The draft policy framework on ICT is currently being debated by stakeholders and will soon be tabled in Parliament for adoption and eventually lead to an Act of Parliament on ICT. Recently, the Government developed a strategic plan for ICT (e-government) thus paving the way for widespread use of ICT in Government offices. In addition, a number of international organizations have developed, or started developing partnerships with MOES&T to facilitate the use of ICT in Government offices and educational institutions. This policy will also assist in ensuring that Kenya fully benefits from these partnerships, and that there is efficient coordination resulting in Kenyan led solutions, emerging from global partnerships.*
>
> *Education and training sector has a major role to play in the implementation of the proposed ICT policy. First, the sector itself is a major user of ICT, not only in education, training and research but also in the management of the sector. Secondly, the success in the use of ICT in all sectors will require sufficient and competent human resources that are developed and*

[22] Kenya's Strategic Policies for the 21st Century, page 199
[23] E-Government Strategy, Page 1

equipped in the education and training sector. Thirdly, successful introduction and use of ICT in education and training institutions will play a critical role in disseminating skills to wider society and thus create positive impacts in the economy. To facilitate faster dissemination of ICT skills in the country, the MOES&T will work with other stakeholders in establishing ICT capacities across the country.

This is no easy task that the GOK has set out for the education and training sector. This can only be achieved through training of government officials as addressed in the e-Government Strategy.[24] Additionally, GOK Policy No. 6 seeks to put in place a national strategy on ICT that can provide guidance to the sector on infrastructure and capacity building. The policy states that "Work with stakeholders to develop strategy on ICT that addresses its use in all educational institutions and neighbourhoods, incorporating access, content training of teachers and supply of ICT to the institutions." And GOK Policy No. 7 states that the GOK should "Promote both public and private sector investments in ICT within the education and training sector."

Option: Adoption of National ICT Policy

The GOK should complete and adopt the draft National ICT Policy to ensure a consistent framework is utilised for ICTs in education activities.

Option: ICTs in Education Policy Coordination

Many stakeholders are implementing ICTs in education programs across Kenya, providing the ideal time for a demand-driven coordination intervention by the MOEST. The MOEST should develop an ICTs in Education Steering Committee to develop and revise quality assurance guidelines for programs. The purpose of the Steering Committee should not to be approve/reject proposed interventions but rather to provide a key point of coordination for all stakeholders. The proposed Learning Systems Unit[25] could be located in the Policy and Planning Department and provide coordination. The Steering Committee should consist of MOEST, private sector, and development partners.

Option: Distance Education Policy

Currently, there is no distance education policy in Kenya and majority of institutions that are providing distance learning services are operating under inconsistent institutional guidance in the absence of guidelines to be enshrined in the National ICT Policy, which remains in draft format. The government should promote the accreditation of commercial institutions for the delivery of distance education, especially in electronic format. Discussions with various stakeholders providing distance learning through various ICT mediums highlighted the need to enact clear policies that support and encourage ICTs as an additional learning medium to promote more access to quality education, particularly for those locked out of mainstream education.

The GOK should also review the current policies which require institutions of higher learning to be have certain sizes of land. These are obviously no longer appropriate given the modalities of e-learning available through computers, Internet, radio, television, and video.

Finally, the GOK should recognise institutions that administer higher education programs for overseas institutions. Kenya is currently losing thousands of students to countries like Uganda, Tanzania, the United States, South Africa, and the UK.

[24] e-Government Strategy, page 21
[25] KESSP, PAGE 106

Option: Community Learning Centre Policy

To increase women's participation in key ICT decision making forums in the education sector and ensure that women have equal access to education through community learning centres, the MOEST should develop guidelines based upon the CLC model. This is particularly important if GOK is to reach out-of-school girls. The goal should be to increase the number of women in NFE and ACE and more specifically to increase the number of women working in the ICT sector, especially at senior management levels and in regulatory bodies. Concessions could be provided to commercial institutions reaching women for NFE and ACE. Additionally, women should be supported to establish and manage community learning centres. This could occur through private sector and governmental credit facilities. The Shauri Moyo Community Learning Centre is an excellent example of increasing women's access to ICTs and can serve as a model for these policy interventions.

A recent assessment on the impact of cyber cafés in Kenya indicated their important role in enhancing Internet access at the community level. Customers throughout the country highlighted accessibility of cyber cafés as a key issue[26]. Promoting community learning centres that can meet the needs of OVC and youth affected by HIV/AIDS as well as policies that accredit community learning centres to promote a learning culture for urban youth through ICTs would contribute very directly to the ERS plans. Promoting a culture of learning through ICTs in the urban slums that are home for 60% of the Kenya population is likely to avert the looming crisis of security emanating from the urban slums due to idleness as a result of lack of jobs and exclusion from mainstream learning facilities.

The private sector should also be encouraged to support development of cyber cafés in the urban slums as part of their social responsibility which can be used to promote distance learning and skills development for the urban slum youth and entire urban slum communities to bridge the digital divide and prepare the out of school youth in urban slums for the overly competitive job market. This will create the necessary create critical mass among the urban slum youth that is ICT literate.

Option: e-rate

The GOK and MOEST should implement an "e-rate" (education rate) to ensure that the cost of basic connectivity is affordable. This mechanism should not provide free access, but should measure necessity and subsidize accordingly. The e-rate in South Africa is connected with the Universal Service Agency obligations. A program in Brazil not only subsidizes connectivity, but also allows for funding for teacher professional development. The United States has an e-rate that helps connect schools to the Internet, with the largest subsidy going to rural and urban poor schools.

The e-rate in the United States calls for telecommunications providers to contribute to a fund that is the administered in much the same way that the Universal Service Fund is administered. Subsidies are provided for schools and libraries – with the rural and urban poor getting more support for connectivity; in some cases e-rate funds cover 90 percent of the costs.

Some stakeholders in Kenya feel that an e-rate in this country might be most efficiently managed if it is part of the Universal Service Fund – or if it receives resources from the Universal Service Fund. The Universal Service Fund is proposed in the draft National ICT Policy.

An e-rate in Kenya should start by providing a subsidy for rural and urban poor secondary schools, as well as for TACs in rural areas (the latter would allow in-service teachers to come for professional development). In the ASAL region resource centres associated with schools clusters might be considered for e-rate subsidies.

The e-rate can be an important mechanism for providing sustainability. Private-sector providers that make a contribution to the fund will benefit by developing new potential customers and a more high-skilled workforce. (See http://www.benton.org/e-rate)

[26] Impact of Internet in Kenya through Cyber Cafés Report to USAID, September 2003

Conclusion

It is not enough to create policy. As one stakeholder put it, "we are great at writing papers and developing policy but not always at implementing." Through our discussions with stakeholders and review of key policy documents, it is apparent that there is no shortage of guidelines and principals for ICTs in education. As noted above, what is needed now is a coordinating body to closely review and monitor the delivery of services against these guidelines. Creating and amending policy is important; developing and supporting sector-wide bodies to monitor and evaluate these policies is essential.

Improving Quality and Equity through Connectivity Growth

The most widespread impediment to successful implementation of ICT for development in Kenya is the lack of access to connectivity to the Internet. This is common in developing countries, where lack of regulatory structures, government will, capital, and infrastructure all stand in the way of affordable access. In the short history of Internet, there have been few ways to solve these problems.

New technologies that have matured only in the last two years offer reason to expect that broadband connectivity can be provided nationwide in most countries for affordable prices. This section assesses the current situation in Kenya for providing connectivity, especially in rural areas, examines the role that the new wireless broadband delivery systems might play. It then recommends a number of options for engaging the Government of Kenya (GOK) and its development partners in exploring their use in bringing equity to social and economic development through nationwide access to affordable connectivity and the services it can support.

The Current Connectivity Situation in Kenya

Most of the available options for the effective use of ICT in support of education are much more powerful when the activity is linked in a communication network that permits Internet access for email, administrative communication, file transfer and web site browsing. This element of the system adds value at every level of the educational system: it enhances the performance of the traditional work of the Ministry through greatly accelerating internal communication, and it brings new dimensions to what can be accomplished under new objectives by bringing access to instruction and information resources to groups that otherwise would be excluded.

However, Kenya suffers at the moment from a very limited environment for achieving connectivity. Most of those limitations are typical of countries in the stage of development in which Kenya now finds itself, including:

- A difficult era of transition into a liberalized and competitive telecommunications market, with a forceful incumbent that is defending market share, rather than innovating and growing overall access to diverse services by a much larger market of users;
- Limited penetration of the physical telecommunications infrastructure into rural and low income areas;
- Growing but still nascent pools of technically qualified individuals and commercial support organizations in the ICT sector;
- Stasis in the supply-demand equation that usually promotes rapid growth of both availability of and utilization of ICT for development – supply of information technology and connectivity is so low that there is little apparent demand for the services, while the lack of supply prevents the development of demand and of locally appropriate services, which would in turn drive an increase in supply;
- Lack of access to affordable international gateway connections;
- A regulatory process that is still adopting or creating policy and has few means to enforce it;
- An evolving but still limited leadership role by the government to accelerate economic growth and social development by moving decisively into using ICTs.

The challenge for the Ministry of Education, Science and Technology is to find a path through this thicket that takes advantage of existing technology and connectivity, while at the same time planning for, and contributing to, the emergence of more modern capabilities. The process being undertaken by the MOEST in sector-wide planning that includes consideration of effective ways that ICT can be used to support Kenya's educational goals is an important step toward creating a new ICT environment in the country that will benefit those who receive more access to improved education while at the same time creating the ICT context in which all manner of development can flourish.

Technological and Regulatory Constraints in the Existing Environment

At the moment, the policy and commercial environment in Kenya does not support affordable connectivity for the entire country, especially for the disadvantaged groups that are the focus of the GOK and donor community concentration on equity. The available methods for connecting are few, expensive, and biased against rural and poor markets. Among the options that are being used at present, there are technical or commercial reasons that mitigate against the likelihood of successful delivery of an affordable, national service. For example:

- The telecommunications incumbent offers a national dial up service charged as an information service, but the pricing is high, the transmission rate is low, and the quality of the lines is poor. In those rural areas most likely to have no other alternatives, the quality of the lines is worst. While this is an important service for intermittent access and for equity, its pricing is unrealistic and the technical limitations on the transmission rate mean that it cannot be significantly improved.
- The historical alternative to dial up service through the telephone network is the purchase of dedicated lines that can be conditioned for higher bandwidth data service. This is useful to a point, but in a context where the penetration of the telephone service is not high, is not modern, and is not meeting current demand, the incumbent operators generally price these lines quite high. In Kenya, the prices are high even by these standards, and the delivered quality of service also seems to be low. The regulatory situation and the tenuous environment for infrastructure investment in Kenya make it highly improbable that dedicated lines will emerge as an affordable alternative for distributing better access to Internet.
- Distribution of local Points of Presence (POPs) for the commercial Internet Service Providers (ISPs) is poor, due in part to the pricing of dedicated lines by the telcom incumbent. With local POPs, customers can use local dial up modem calls to connect to their ISP, and avoid the worst of the impact of poor transmission over the traditional telephony network. This is leading to some experimentation with wireless connections by ISPs to their remote POPs, including some BreezeCom and Canopy networks and other broadband wireless connections. This is a positive development that merits further support, although the eventual connection to the POP through the local loop of the telephony system puts a very low limit on the bandwidth that can be obtained by any individual user.
- Local redistribution of broadband signal through wireless “hot spots” such as might be obtained by WiFi implementation have promise, but are limited in service radius to areas very near the broadband connection.
- In the largest cities, the telecom incumbent is rolling out Asymmetric Digital Subscriber Lines (ADSL), which is a service that can achieve reasonable bandwidth. However, even if the service is eventually reasonably priced, it is limited in how far from the telephone company’s central office it can be deployed (generally not more than about five miles), so it offers little hope for rural service, even if eventual deployment spreads to all central offices.
- The use of Very Small Aperture Terminals (VSATs) for satellite communication can bring service to rural areas, but the cost is usually quite high even in competitive environments because the space segment costs are very high. At present the incumbent telecom offers Hughes DirectWay service, which could bring useful bandwidth levels to schools located anywhere in the country, albeit at high cost. There are some technical alternatives for aggregating traffic and sharing channels that can bring these costs down to reasonable levels, but these solutions would require local wireless redistribution systems that would probably not be allowed without regulatory waivers.
- Cellular telephone systems around the world are moving in the direction of providing enhanced data services. In the GSM environment that is used here in Kenya, the two most immediate choices for cellular operators are General Packet Radio Service (GPRS) and Third Generation (3G) data service. These services are increasingly found in industrialized countries, but are not yet finding large markets. This is in part because the service has been quite expensive as a result of technology costs for mobile service and especially license fees paid by providers for the rights to use the additional frequencies, and in part because, these specific technologies are somewhat threatened with being overtaken by newer developments. All of this leads most cellular providers to be reluctant to invest in the additional equipment

required to deliver the service. If Kenyan cellular providers were to install GPRS equipment to deliver data service optimised for service to fixed locations, they might be able to provide affordable data links in rural areas, but there is not currently any visible inclination to do so.

Wireless Broadband

As useful as the existing technologies can be, none of them solve the problem that affects all of non-urban Kenya – you can't get a broadband connection to the Internet outside of a few of the largest cities, and you can't get an affordable one anywhere. Absent that connection, most of the benefits of the information revolution are closed off to you.

New wireless technologies and regulatory change can alter this situation dramatically. The new wireless technologies use specialized radios to carry digital traffic at high speeds. The two most relevant types of new wireless technologies are WiFi and WiMax, which are designed to cover quite small and quite large areas, respectively. WiFi, which in most uses covers a maximum of about a 300 meter radius, is useful for sharing Internet connections within a community or with a cluster of buildings. This means that if any location in a small community has access to a fast Internet connection, other members of the community can connect through it without having to invest in dedicated lines or expensive (and slow) dial-up connections. This offers tremendous opportunity for intra-community communication and for access to web-sites and services like distance education by community members.

WiMax is designed for much larger areas of service. A typical WiMax installation will provide a broadband connection to users up to 15 miles away, so a single antenna with WiMax data radios might serve users within an area of up to 700 square miles. The service radius of radios in rural areas (where there are fewer potential customers and less radio interference) can be pushed up to about 50 miles, so the potential service area can be extremely large for a relatively small investment. Just a few such towers can cover a substantial area with Internet service, at a price much lower than any previous technology. All of this is accomplished wirelessly, without a need for expensive terrestrial infrastructure or the predatory pricing of incumbent operators.

Each location that subscribes to the service requires a customer premises radio of its own, which today might cost a few hundred dollars installed, so it is useful to think of using WiFi in conjunction with WiMax to redistribute access locally. Both WiFi and WiMax are relatively new technologies, with WiFi following the 802.11 a, b, or g standards, and WiMax following the finalized 802.16a standard for fixed wireless service. Both Intel and Fujitsu are now shipping inexpensive, integrated chips that serve as the core of customer premises equipment.

The developed world is most interested in using WiMax for mobile broadband, because its need for service to fixed locations is already met by other existing infrastructure. The WiMax equipment is expected to get final approval from IEEE of its standard for mobile communication (802.16e) in the second half of '05. However, in developing countries there is a desperate need for affordable service to fixed locations, which makes the current "802.16aRev.d" (the so-called "pre-standard") WiMax equipment that is already on the market a very attractive solution. WiMax manufacturers typically design the current equipment so that it can be brought into compliance with future standards by software upgrades.

Other broadband wireless protocols exist, though the industry momentum is strongly favouring WiMax because of its technical strength and the fact that it is a non-proprietary protocol, which implies that there will be many manufacturers producing compatible equipment. The competitive and high-volume market this creates keeps prices low and hence makes the protocol more attractive to all users.

The incumbent telecom operator is currently experimenting with a non-WiMax, CDMA-based protocol for wireless broadband distribution, but has not announced any plans to offer the service commercially.

Option: WiMax for Educational Quality and Equity

There are several potential approaches for leveraging the advantages that an extensive WiMax network could offer to the MOEST's goal of bringing all secondary schools online. Just what would be appropriate would depend on certain regulatory issues as well as on the availability of resources or willing donors or private sector partners to participate. For the sake of this analysis, three levels of option will be discussed:

- **Demonstration**: A small, single tower program serving the schools within the broadcast radius, designed primarily to demonstrate the technology and allow the MOEST to learn from a pilot activity distributing classroom support and in-service teacher training.
- **Priority Areas Program**: This would establish an operational system located in the rural or geographic areas that are the priorities of MOEST and its development partners. These are areas that are currently not well served by affordable sources of connectivity. This would entail the creation of a wireless network covering a large enough area to deliver a meaningful amount of service, and would require the installation of perhaps ten to twenty or more towers serving all the schools in their signal coverage area. Depending on available resources, this could cover a large portion of the rural schools.
- **National Commitment to Commercial WiMax Service**: This level would involve engaging a commercial partner to build out and operate a nationwide WiMax network that would serve not only the schools but also all other commercial, governmental, or residential who desired service. The strategy would be to use the predictable demand of the education system (and perhaps other governmental customers) as an incentive to get a commercial carrier to build out a full rural coverage system up front, thus accomplishing a national service in the most equitable way.

Each of these models is discussed in more detail below. It is worth noting that the first two options are both designed to serve only the needs of the MOEST or the GOK, while the third is designed to have the MOEST as one customer among many others. The implication of this is that the economic efficiency of the models is quite different – in the case of the MOEST/GOK-only models, the full cost of the system would have to be borne by the government or its partners, while in the case of the commercial system, the commercial operator's other clients would share the costs. The GOK use of the commercial system might even be discount-priced or subsidized by the Universal Service Fund, which would result in still lower recurrent costs for the Government use.

Demonstration Model

This level of intervention would be the easiest to accomplish, and might be an important intermediate step in demonstrating the technical and cost advantages of the new technologies to the education and regulatory authorities in Kenya. It might also allow a useful experimental environment for developing and testing educational materials under programs starting up to service other educational objectives on a larger scale, such as distance learning for in-service training, or development of interactive, multi-media materials keyed to the formal curriculum.

The basic approach would be to mount a single WiMax installation on a high tower or hill in a rural area. Depending on the geophysical characteristics of the surrounding area, coverage area for minimal broadband service could be as wide as a 50 mile (80 kilometre) radius, although in practice the radius would typically be somewhat closer to 30 miles (50 kilometres) to assure a high strength signal to all participating schools. Thus the demonstration area would be on the order of 2500 to 7500 square miles, which, depending on the population density in the chosen area, would probably include from 25 to 100 secondary schools.

Each school could be equipped with WiMax customer premises equipment (CPE), which would exchange digital information to and from the tower, which would be connected to the country's Internet Gateway. Thus each school could be provided with a high-speed, two-way connection to the Internet. The connection would be used to deliver on-line instruction, email, web access for information seeking, and for participation in the EMIS system. The assumptions made about the schools are only that they already

have (or are getting from the MOEST's Millennium Development Goal commitment) some kind of computer equipment and the ability to power it. The additional power requirements to operate the WiMax CPE are not significant if they already have enough power to operate their computers.

Operationally, a group like the Kenya Educational Network (KENET) has the technical and organizational capacity to carry out the project. They have the mandate to serve as the ISP for the nation's educational system, but might need an experimental license from the regulatory body to operate the demonstration equipment. The capital investment for the central and CPE WiMax equipment would be in the range of US$50K to US$100K to serve 50 schools from a single tower, but might be partially covered if private sector involvement were sought. Installation, operations, and the substantive project work would have to be budgeted based on specific site information.

Priority Areas Focus

Under this option, the MOEST could take the decision to implement a broader connectivity program for those areas that have been designated as priority in connection with their equity focus. In this case, a substantial operational rural wireless broadband network would be established, to ensure that those schools least likely to be served in the early evolution of commercial services would receive connectivity now.

The areas to be covered would presumably be selected on the basis of disadvantaged status, such as rural areas with poor infrastructure, or geographic areas such as the North East of Kenya. These are large areas with low population density, so one would expect to find a relatively smaller number of secondary schools per unit of area. This feature cuts both ways – these schools are the least efficient to serve, because they are few and far between, but on the other hand, they may be ideal candidates for WiMax connectivity precisely because they are hard to serve any other way.

The WiMax advantage of relatively low-cost to reach a large geographic area makes it possible to serve the schools economically, however, at some low level of school density, it probably becomes more economic to serve the isolated schools through VSAT terminals, despite the higher recurrent costs of the satellite system The WiMax architecture delivers service to any client in the area of the coverage radius for only a small marginal cost for CPE equipment, while the VSAT approach delivers service to the exact location of the VSAT terminal, with any adjacent customer incurring not only the higher CPE equipment cost but also the higher cost of additional bandwidth on the satellite. Thus satellite service is optimal when you have very isolated points of service, and WiMax service is optimal when you can have multiple customers sharing the cost of the central service. . This is a complex trade-off that is reached earlier in a system built to serve just one group of clients – the schools and other government functions – than in a system designed to sell services to any interested client in the service area.

A focus on priority areas could be as large as the programmatic requirements demanded. A system of, say, 20 towers might cover approximately 50,000 square miles and serve 1000 schools at a capital cost very roughly estimated at between US$1 million and US$2 million. The installation, operating costs, and program costs would have to be budgeted according to the specifics of the field circumstances and the nature of the program itself. In this scenario, the capital and operational costs would be carried by the government or its partners, since there would not be any other customers to help pay for the system.

The present regulatory environment is somewhat murky on what kind of organization would be allowed to operate such a network. In terms of technical capacity, the operations are about what a large and experienced ISP might handle, and there are several such organizations in Kenya. However, ISPs are not currently allowed to own their own physical networks. In this case, it might be best to consider having a group like the Telecommunications Service Providers Association of Kenya (TESPOK), a professional organization of ISPs and telecom providers, apply for a waiver to have their membership jointly operate the system on behalf of the MOEST or GOK.

Commercial WiMax Service

The third option for achieving much more affordable and widespread connectivity for the schools is to find a way to get a commercial provider to agree to build out a national or large scale broadband wireless system. This should be done under terms that the government influences, so that full rural coverage is achieved at the time the system is set up, and affordable service for the government and private customers is assured by agreement and by the threat of or the reality of competition. The government's objective would be not only to provide good broadband service to the schools, but also to cause the acceleration of access to connectivity in the entire country through the way they arrange the deal with the commercial provider.

This is much more feasible than it might sound because of concurrent developments in the telecommunications field, with the arrival of "Voice over Internet Protocol", or VoIP, which provides huge reductions in the cost of long distance calling. Historically, long distance was carried in analogue form over a single copper wire pair, a service that required a separate wire pair for each conversation.

This made long distance calls very expensive, as the phone companies had to invest in a separate set of wires for the entire distance the call was carried. As telephone companies have begun to go digital, portions of the distance that the call is carried are done by converting the "voice" into digital form, and sending the digital signal, mixed with the digital signals of other calls happening at the same time, over a common channel (frequently a fiber optic cable). Mingling the digital signals of many calls at once has resulted in huge savings in the actual cost of completing long distance calls. Unfortunately many telcoms have not shared much of that savings with their customers, preferring instead to take high profits or cross subsidise other portions of their service.

Fortunately for the consumer, technologies have evolved to let the consumer's phone or computer digitise the voice, and send the digital signal over the much larger "pipes" of the public Internet system, letting the signal share a very efficient channel with huge quantities of other traffic, and resulting in still larger savings than sending the digitised call over the private pipes of the phone company. The signal can arrive directly at another consumer's computer, or can be routed into the expensive network of the other party's phone company only for the "last mile" from the central office to the residence.

These VoIP phone calls are able to be billed at a mere fraction of the cost of traditional phone calls. For example, where an international call from Nairobi to the United States might be billed at approximately USUS$ 2.00/minute, a commercially available VoIP carrier (Skype) charges about US$ 0.026/minute for the same call from a computer to a regular telephone in the U.S. The computer-to-Internet connection needs to be reasonably fast for the call to perform well, but otherwise the call precisely like a traditional phone call.

It is the potential of this VoIP market that makes commercial enterprises very interested in establishing broadband connections to lots of customers – they are looking to get very significant revenues from VoIP. MOEST and the GOK can turn this situation to their advantage by using their interest in broadband service to schools to leverage a deal with a commercial provider. They might, for interest, offer to guarantee the business of schools (and perhaps other government offices in rural areas) to a commercial provider, in return for a commitment from the provider to build out a rural network that will serve all the schools. The entrepreneur would get a valuable reduction in their business risk by having a guaranteed market, and the government would have accomplished the infrastructure investment for rural services without having to pay for it.

Precisely such a strategy has been supported by USAID in Macedonia, where a public tender was offered for private ISPs to bid on the contract for the connectivity subscriptions of all the nation's schools over the next several years, in return for a promise to build a full rural network in the first year. The contract was signed in spring of '05, and the contractor had already built out the first part of the network and connected half the schools in the country within the first three months. They were able to move so quickly because deployment of WiMax networks only requires that the central radios be installed on towers, which are often existing cell phone towers. The CPE simply needs to be installed on the wall of the school, and an Ethernet cable is plugged into the router for the school's computer network.

Other clauses of the contract require the commercial partner to market the service to other customers in the rural areas, with USAID helping to identify and promote development oriented applications of Internet that would also take advantage of the new network. In addition, by introducing computer training in all the schools, the arrangement is, in effect, creating a whole population of potential future customers for this or other ISPs. These factors work in favour of sustainability. To ensure that the prices of Internet subscriptions drop quickly to the low levels prevalent in Western Europe, the contract also contains clauses reducing the price levels over the period of the contract, in order to help set a low market price.

A similar strategy might be employed in Kenya, using the immediate market demand for school connectivity as a negotiating lever for inducing a provider to build out the rural network. Obviously, the regulatory climate and economic levels between the two countries are quite different, but the same principle prevails: that the needs of the government for service in rural areas can be met by aggregating that demand to induce a commercial firm to build and offer that service, and coincidentally to deliver the dual benefits of equity in the distribution of affordable services, and faster economic and social development through improved communication infrastructure.

This option, more than the other two, requires a detailed discussion of the Ministry's and the Government's strategy, as well as a consideration of status of the regulatory agency, the current infrastructure investment, and the climate for entrepreneurial innovation. It is unlikely that an approach that was exactly like the one taken by the Government of Macedonia would prove to be appropriate in Kenya. The scale of the country and its economic and social complexity must be taken into account. The purpose of describing this option is to spur some creative thinking about how the aggregated demand of the GOK and its development partners can be harnessed to produce not only the immediate development objective they seek, but also a much larger contribution to the country's growth.

The overall size of Kenya, and particularly the extent of the land that is sparsely populated and impoverished, would be a particular challenge. It would almost certainly be necessary to roll out a plan in phases to accommodate the time and money needed to serve such large numbers of people and such large areas. Nonetheless, broadband wireless is likely to be the most appropriate technical solution for reaching those populations; the architecture of traditional wired telephone systems requires enormous investments in hardware and time to string wires across such large distances, and to so few customers.

Kenya faces an additional constraint for Internet access, which is the lack of appropriate infrastructure for connecting to the world wide backbone of the Internet. The current connection via satellite is quite expensive, and will remain expensive even if competition is increased. Terrestrial carriage of the data outside of the country is also expensive. Not until Kenya is able to purchase high bandwidth capacity on fiber optic cable will the process be efficient enough to achieve much reduction in this component of the price of Internet connectivity here. The most likely point at which that situation will change is the arrival of the East African Submarine Fiber Optic Cable in 2007. However, that does not invalidate the strategy; it merely means that there will be another source of price reduction in the future.

The Importance of Achieving Affordable Connectivity

The preceding remarks outline a number of options for exploring a specific technology that can greatly reduce the cost of, and speed up the accomplishment of, sustainable, affordable connectivity in Kenya. The full value of the rapid adoption of computing by the population will not be achieved until they can all share in the benefits linkage to the communication network that links the world, and in the knowledge that is freely available there.

Almost all the things that MOEST would like to do with ICTs in education would benefit from broader connectivity, and some cannot be done without it. Addressing the cross-cutting issue of actually getting that connectivity into place can serve the full range of GOK objectives, and make the impact of MOEST's other efforts all the greater.

Total Cost of Ownership

Plans for the provision of ICT technology should take into account a whole range of requirements at the different levels such as:

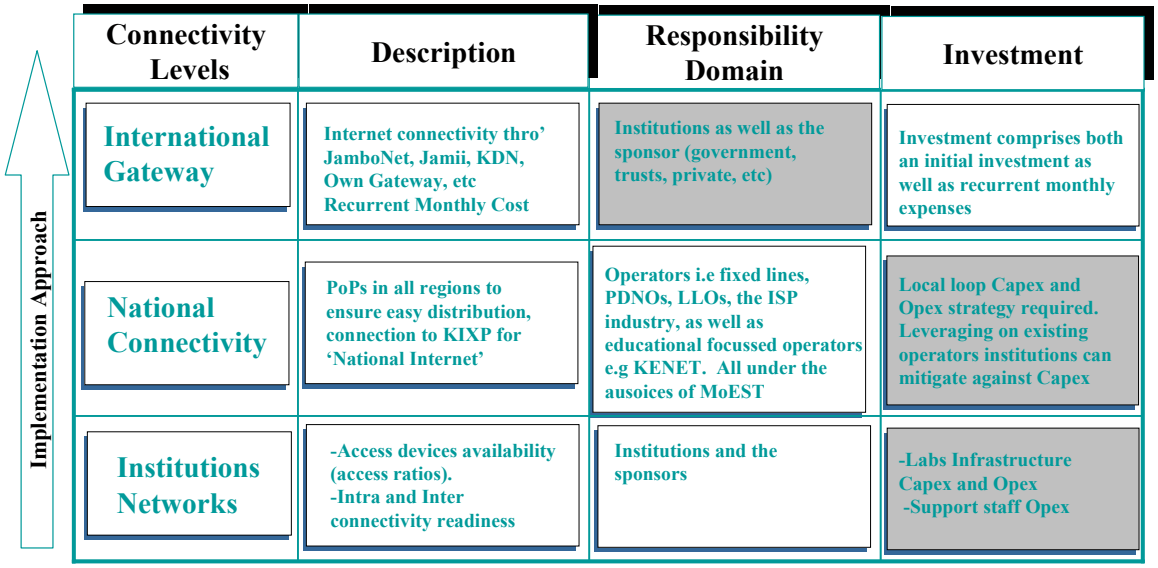
- Institution/school level issues such as availability of access to technology devices, institutional level intra-connectivity (LANs), infrastructure maintenance and cost of ownership, and continued upgrading.
- Availability and suitability of content, content cost of ownership, and content updating requirements.
- The national infrastructure attributes such as spread of power grid and alternatives available, availability and affordability of connectivity options, support and service levels.

Access E-Readiness

This can be approached by considering two levels: Access and Content e-readiness

Access e-readiness (Figure 1) must be considered at 3 levels: International, National, and Institutional, where readiness at each level is addressed comprehensively starting at the Institution/school through to the national level and the international gateway level.

Figure 1



Institution/school level

At this level consideration needs to be made of:

- The access ratio (students per computer –in the lab for instance of which the ministry has proposed to place 20 computers per school).
- Labs' readiness in terms of:
  - Power
  - Security
  - LAN connectivity
  - Maintenance (continued).

National connectivity

For external connectivity of the institution, available options and their affordability include:

- **Dial-up connection**: local dial up connections provided by both the incumbent operator and ISPs are limited mainly to urban centres. Most schools do not have access to telephone services which are a pre-requisite for dialup connectivity. The majority of the schools would have to make trunk calls for connectivity. *The incumbent operator is in the process of introducing a local call based dialup service across the country (dubbed the 944 dial plus).
- **Leased lines (clear channel circuits):** these range from 64kbps to 2Mbps (E1) circuits mainly from the fixed line operator. Availability is distributed in over 40 towns across the country (though connections ports have always been in short supply). The pricing of the circuits is still high across board, as can be seen in the Table, "Leased Line Monthly Costs" below.

Leased Line Monthly Costs	
Circuit Capacity	**Cost US$**
Digital lines up to 64 Kbps	180.00
Digital lines128 Kbps	264.00
Digital lines 256 Kbps	364.00

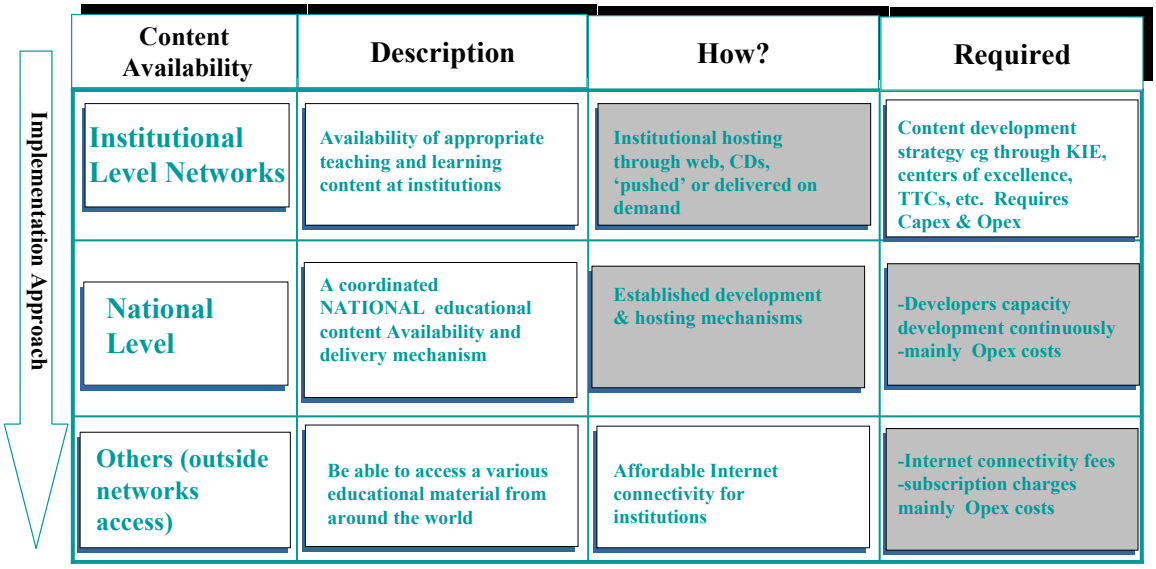
- **Wireless connectivity services**: though this sector is fully liberalized, the 4 active operators (TKL, BLUE, KDN, and Open Systems) are concentrated in the two major towns Nairobi and Mombasa. (Pricing is at the same level set by the fixed operator for leased circuits under monopoly regime.)
- **ADSL connectivity options**: this service is available in Nairobi and Mombasa only. Expansion and the entry of a second operator is also planned within the two cities. Pricing is fairly affordable and comparable to dialup rates at Ksh 13,000pm.
- **Wireless redistribution of Internet (hotspots)**: this is currently taking place within the main cities. Its spread is still very limited and pricing is way too expensive.
- **VSAT based connectivity:** currently there are 3 licensed VSAT operators (KENSAT, GILAT, and AFSAT). These services are ideal for the underserved areas and where possible backhaul to the traffic aggregation nodes is ideal. Pricing varies among the operators but is still high.

International Gateway

Currently 5 operators are licensed for commercial Internet backbone services (TKL, JTL, KDN, Harun, and UUNET). At the moment, the latter four are new entrants and effect of liberalization both in quality of services and pricing has yet to be felt. In the education sector, The Kenya Education Sector (KENET) has a license from the regulator, restricted to the sector which has been exploited for the tertiary (universities) institutions.

Content E-Readiness

The second level of readiness must address **Content e-readiness** (see Figure below); this addresses the availability of suitable (relevant) content at the various levels for use by the learners and teachers.



Institutional level

The institutional level entails mechanisms of providing content at the schools level through a CMS, CDs or content pushing. The trust is to ensure that content developed either centrally or otherwise is availed at the use point. Through skills and capacity development, educators and learners can also contribute to the development and harnessing of content at institutional level. Costs to be considered here include:

- Content management systems (CMS), or CD servers
- License costs for both the CMS platforms as well as the content
- Content management, review and upgrade costs

National level

At the national level, it is imperative that content for learning and teaching be harnessed at the national level. This calls for a coordinated approach in the collection, hosting and availing of the different content at a national level. This could also serve as the main content source for those schools which may not have the capacity to do so on their own. Costs include development, hosting, licenses, and management.

International Linkages

At the international level, for completeness, it may be necessary to put in place a comprehensive strategy for accessing content internationally in a well managed manner. This can entail collective acquisition (taking advantage of bulk licenses), mirroring, exchanges, etc.

Option: Total Cost of Ownership Model

In considering the infrastructure connectivity options, it is imperative that a Total Cost of Ownership (TCO) be developed to provide for the anticipated investment requirements. This stipulates clearly the initial infrastructure costs, utilities cost, consumables costs, staff development and running costs, etc (see Table showing example tabulation structure for the cost centres for a 5 year plan, below).

Table 1: Illustrative Tabulation Structure for Five Year TCO Analysis

In USD			5-years TCO	Year 1	Year 2	Year 3	Year 4	Year 5
		Discount rate						
Capital exp								
Deployment of ICT								
	Access devices (incl. server)							
	Display devices							
	To-school connectivity							
	In-school connectivity							
	Software and apps - Lic fee							
	Peripherals							
	Electricity devices							
	Infrastructure							
		Furniture						
		Room construction Air-cond & curtains/blinds Elec sys						
	Security - renv & alarm sys							
Content								
	Off-the -shelf materials							
	Development/Customization							
Tech support - Warranty								
Total Capex								
Operating exp								
Deployment of ICT								
	Access devices consumables							
	Display devices consumables							
	To-school connection fee							
	Periphal devices consumables							
	Electricity fee							
	Security - security employees							
Tech supp and maint								
	Maintenance fee							
	Technical support							
	Insurance							
User training								
	Initial training							
	Ongoing training							
	Student ICT training							
Total Opex								
Grand total								

The TCO model captures the following investments costs in detail:

Hardware Costs

The hardware costs are comprised of:

- Access devices (options) such as
  - New desktop PCs
  - Refurbished PCs
  - Thin client systems
  - Servers
  - PDAs
  - TVs
  - Radios
  - DVD/VCD/VHS players
- Display devices
  - Projectors

    - Interactive white boards
    - TV monitors
- Peripherals
    - Printers
    - Scanners
    - Digital/Video cameras
    - Photocopier

The installation costs and the associated consumables for these items are also captured for the periods in consideration.

Software Costs

The software costs are comprised of:

- Operating System
    - Windows based
    - Linux based
- Productivity applications
    - MS office suite
    - Open office suite
- Education specific content
    - Class subject content (on PC/Video/Radio)
    - Teacher training material (on PC/Video/Radio)
    - Student or teacher support resources software on PC
    - Student or teacher support resources on Video/radio
    - Basic ICT training software on PC

Installation, licenses and support costs for the software is also considered.

Connectivity Costs

Costs for connectivity include:

- In-school connectivity
    - LAN wiring for classrooms/Lab
    - WiFi access points
- To-school connectivity
    - Dial-up connectivity
    - Always-on connectivity
    - VSAT connectivity
    - Radio/TV broadcast

Installation, support, maintenance as well as monthly usage charges are considered.

Service Costs

The costs of servicing the operation include:

- Maintenance
    - Warranty for H/W & S/W
    - Ongoing maintenance for H/W & S/W
- Technical support
    - External support contracts

- Internal support personnel costs
- Cost of training internal support personnel

- User training
  - Initial users training expenses
  - Recurrent training of staff
  - New teachers for ICT (salaries)
  - Helpdesk support costs

Infrastructure –Utilities Costs

The investment and operations costs for infrastructure and utilities are varied, and include:

- Electricity
  - Consumption rates
  - Generators acquisition and running
  - Solar panels & batteries
  - UPSs
- Physical Infrastructure
  - Labs
  - Furniture
  - Air conditioner
  - Security (for computer rooms)
  - Insurance

National Level Costs

Additional costs are incurred at the national level:

- Specific content/applications
  - Development/customisation of class subject content (PC/TV/Video)
  - Hosting and distribution of content
- Infrastructure
  - Improvement of telecom infrastructure
  - Improvement of electricity availability
  - Subsidy of affordable infrastructure

The TCO model captures the different technology options available and applicable for the deployment of ICT for teaching and learning in schools. The proposed model seeks to evaluate all the costs associated with the appropriate and applicable technology for each situation. Equal emphasis is placed on the initial investment as well as the continuous operational costs associated with the ownership of the technology.

To illustrate the scope and relative magnitudes of the different costs, three hypothetical ICT scenarios are presented in Appendix F. Sample one presents the TCO for placing 4 workstations for use by teachers in 100 schools. Sample 2 presents the cost of deploying radio-based programmes in 1000 schools. And sample three presents the costs of placing computer labs with 20 workstations each into 1000 schools. All figures in these simulations are only illustrative, since the scope of a comprehensive calculation was well beyond what could be accomplished in the time available. The purpose of these presentations is not to provide valid data about the specific hypothetical options, but to illustrate the importance of considering the total cost of ownership by emphasising the importance to budgeting for ongoing maintenance and support, upgrades, and training of support personnel and teachers.

Monitoring and Evaluation of ICTs in Education

Based on local experience and international research, it is clear that a comprehensive set of indicators must be developed to discretely reflect the goals articulated in the ICT in Education strategy documents. This Options Paper articulates key areas for measurement to support the development and delivery of ICT throughout the education sector. The three key areas identified are (1) Infrastructure & Access, (2) Training & Usage, and (3) Impacts. Possible research areas are also presented in Section 4.

It should be made very clear that many countries are attempting to include qualitative and quantitative indicators, with varying degrees of success. "Quantitative data can be collected from indicators that will provide an overall view of infrastructure support and ICT presentation in schools. However, it is equally important to examine indicators that will show how ICTs have been used not only as a basic operational tool, but also as a communications tool, which promotes the development of creativity, interactivity, collaborative learning, critical thinking, and problem-solving" (UNESCO 2003: 8). This is the most difficult task but one which should not be avoided if the MOEST and development partners are to provide valuable, consistent data in regards to the integration of ICT in education in Kenya.

Towards this end, the areas for measurement presented below are intended to provide guidance for the later development of indicators and data collection. We envision data for the first two areas, (1) Infrastructure & Access and (2) Training & Usage, can be collected nationally. Data for the (3) Impacts section will likely be collected through highly focused case studies.

If data is collected for the areas below, the MOEST will be able to determine what ICTs are available in the education sector; where these are; from where these came; who uses these resources, and for what these are used. The MOEST will also be able to establish the number of schools achieving policy development levels. Note that all data should be disaggregated for gender and community characteristics.

The following sections detail the kinds of variables appropriate to monitor for the different kinds of outcomes of interest. These are not intended to be comprehensive, but rather illustrative.

Option: Infrastructure & Access

- Number and types of ICT by region per institution[27] and when received:
  - Hardware (including peripherals and other media)
  - Software (Platforms, Programmes, and e-Content)
  - Connectivity
- Source of each ICT (e.g. donor, GOK, purchased by school, etc.)
- Downtime of ICT in regions per institution
  - Hardware (including peripherals and other media)
  - Software (Platforms, Programmes, and e-Content)
  - Connectivity
- Access to ICT by institution, learner, student, teacher, and officer
- Number and types of technical support by region per institution which are already in the education system (Does not include private service providers)
- Total "ICT Opportunities" in curriculum by subject and grade level
- Number of ICT and Education projects and activities by region per institution

Option: Training & Usage

- Training

[27] Institutions include all education-related organisations and establishments. These include, but are not limited to, schools, MOEST offices and resource centres, colleges and universities, education support services, etcetera.

- Technical Support Training
  - Types of technical support certification (e.g. LPI, A+, EDN, etc) by institution, learner, student, teacher, and officer
  - ICT Literacy
  - Types of ICT Literacy Certification by institution, learner, student, teacher, and officer
- Pedagogic (Integration of ICT)
  - Types of ICT Integration Training and/or Certification by institution, student, teacher, and officer
- Usage by institution, learner, student, teacher, and officer
  - Hardware (including peripherals and other media)
  - Software (Platforms, Programmes, and e-Content)
  - Internet (e.g. hits/site)
  - Primary use of ICT (e.g. research, admin, etc.)
- ICT use by subject, grade, and/or institution
- Content development by institution, learner, student, teacher, and officer
- Computer Studies and Computer Literacy delivery by school per learner

Option: Impacts

- Skill and Knowledge improvements by learner, student, teacher, and officer
  - Technical expertise
  - ICT Literacy
  - Pedagogic (Integration) Use of ICT
  - Subject-area and ICT
- Attitude and Value changes by learner, student, teacher, and officer
  - Learner attendance
  - Attrition rates
  - Subject-area and ICT

Option: Research areas for further investigation

- School leaver studies
- Questions for schools w, out computers
- What encourages use of ICT?
- Impacts on overcrowding
- Total donor funding vs. total GOK funding
- HIV/AIDS
- Gender
- Teacher empowerment
- Classroom management

Appendix A: Summary of ICTs in Education Activities and Interest in Kenya

The team met with various stakeholders involved and/or interested in ICTs in education activities in Kenya. While a variety of activities are currently underway, many stakeholders were not aware of the different interventions of other organisations. This served to highlight the need for the development of an ICTs in Education Steering Committee to provide a point of coordination and information sharing for all stakeholders.

Additionally, some projects have developed rather large plans for interventions but have been unable to begin these strategies for a variety of reasons. For instance, SchoolNet Kenya has an outstanding vision for ICTs in education in East Africa which aims to train all teachers in the region. While it is an ambitious vision, few interventions have occurred under this plan. Funding is often cited as the main obstacle to plans of this scale though it is also simply that sheer magnitude which overwhelms programme implementers. This results in few successes towards the overall goal which in turn makes it difficult to mobilise funding. This lack of funding then makes it difficult to implement activities and so on. Thus, while these large-scale plans are imperative, these should not hinder small-scale progress towards the larger goals. As one stakeholder quite appropriately enthused, "to eat an elephant, you have to cut it into small pieces".

The summary below is organised into four sections: GOK, Civil Society, Donor Partners, and Private Sector. In many cases, these lines are blurred due to wide participation in projects and activities. The sections are merely a guide to present our findings on the current and planned ICTs in education activities as well as for gauging stakeholder interest. While these findings are drawn on throughout the Options Paper, they are presented here in full for the sake of completeness.

Government of Kenya

The Government's vision for education is Quality Education and Training for Development with the overall goal of achieving Education for All (EFA) by 2015.[28] GOK is committed to promoting and popularising ICTs as well as science and technology education by 2008. The main interest of GOK regarding ICTs in education is to facilitate the use of education institutions as hubs of ICT dissemination in rural areas.[29]

Meetings with key GOK officials and a review of key GOK documents indicates high levels of interest and commitment to fully integrating ICT in education has demonstrated a lot of interest in utilising ICTs in education which is well captured through the following statements on the KESSP document and Sessional Paper No. 1 of 2005 on A Policy Framework for Education, Training and Research:

> *The education and training sector has a major role to play in the implementation of the proposed ICT policy. First, the sector itself is a major user of ICT, not only in education, training and research but also in the management of the sector. Secondly, the success in the use of ICT in all sectors will require sufficient and competent human resources that are developed and equipped in the education and training sector. Thirdly, successful introduction and use of ICT in education and training institutions will play a critical role in disseminating skills to wider society and thus create positive impacts in the economy. To facilitate faster dissemination of ICT skills in the country, the MOEST will work with other stakeholders in establishing ICT capacities across the country.*
>
> *In the e-Government strategy and National ICT policy, considerable attention is given to education, particularly schools as agents with the greatest potential to address digital divide,*

[28] Sessional Paper No. 1 of 2005, A Policy Framework for Education, Training and Research, page 23.
[29] KESSP 2005-2010, page 104.

expansion of learning opportunities and e-Government. The proposed investment programme is intended to put in place the policy and strategy for ICT in education, development of e-learning delivery systems, building of necessary capacity, development of required ICT infrastructure, and institutional management systems.[30]

Towards these goals, the GOK has introduced the following activities:

KIE School Broadcasting Program

The Kenya Institute of Education has been providing Interactive Radio Broadcasting for primary schools since 1968 to address the limited number of teachers available to meeting teaching needs in the 18,000 primary schools that are located throughout the country. In the past, school broadcasting was provided through the Government owned Kenya Broadcasting Corporation (KBC) that has now been privatised. This has forced KIE to look for an alternative broadcasting channel that has led to a partnership with WorldSpace Radio.

In response to the Free Primary Education, GOK has provided WorldSpace receivers to 11,000 primary schools across the country at a cost of KSh 10,000 per receiver. The WorldSpace receivers can access the WorldSpace broadcast from anywhere in Kenya. The GOK is also US$10 per month per primary school for subscription fees to WorldSpace. This amounts to over US$1,320,000 per year in subscription fees. KIE still is required to develop the educational content for broadcasting.

KIE has three broadcasting channels to support the school radio program as well as a digital receiver for downloading educational material from the Internet that can be put on CD and sent to schools. Due to the high costs associated with the WorldSpace receivers and monthly subscriptions for schools, KIE is looking at establishing an FM education channel to provide radio learning 24 hours a day which is critical for ASALs. The WorldSpace transmitters and monthly subscription are quite expensive and will not be sustainable for many schools without GOK funding. Currently, the program is meeting the needs of primary schools though not for out-of-school youth who could benefit greatly from increased access to the KIE broadcasts. KIE also has Mobile Broadcasting Vans that are normally hired out to private schools and other learning institutions at a cost.

The KIE Broadcasting program provides an excellent opportunity for increasing access for learners in marginalized communities particularly ASALs and urban slums, using relevant and approved curriculum. KIE's intended education channel that would be available for 24 hours provides an opportunity for increasing access to education throughout the country.

EMIS

The broad objectives of the MOEST in the implementation of EMIS is to expand opportunities and facilities for education to improve enrolment and attendance at all levels, particularly early childhood, primary, secondary, and tertiary institutions.[31]

The system is intended to cover the management of education data, provision of databases in schools, coordination of data collection from districts and building capacity to manage education data, and seeks to automate administration of the entire education sector. This includes, among others, education departments, SAGAs, KIE, TSC, Kenya National Examination Council, KISE, KESI, and National Science.

The objective of EMIS is to harmonise and integrate information systems to support timely collection, processing, dissemination, and use of education data for management to identify necessary interventions to achieve relevant and quality education. The envisaged electronic-based infrastructure is intended to support the Ministry and the various education agencies to address challenges related to planning and management of education.

[30] MOEST 2005, *Kenya Education Sector Support Programme: 2005-2010: Delivering Quality Equitable Education and Training to All Kenyans*. 9 May 2005 Draft, page 104.
[31] EMIS Project Inception Report, page 7

In 2000, a needs assessment was completed to determine the challenges of providing education data. Using the questionnaire methodology for data collection, the assessment covered five districts in Western, Central, Eastern, Coast, and Nairobi and a workshop was held in February to validate the process. The assessment made sector wide recommendations and the Teachers Service Commission (TSC) promoted awareness on IT and established a unit to automate and gather data. TSC designed a program to attain 100% IT literacy by 2002.

Much of the ICT discussions during the KESSP process lumped EMIS and ICT together. All stakeholders agreed that this was not the most appropriate way to handle these topics, resulting in great confusion as to where the lines between ICTs and EMIS were drawn. These lines are discussed in great detail under "Using (and Not Using) ICT to Improve EMIS".

Kenya Institute for Public Policy Research and Analysis

KIPRA's Mission is to provide quality public policy advice to the Government of Kenya by conducting objective research and analysis as well as capacity building to contribute to the achievement of national development goals. KIPRA's main interest in ICTs for education is to ensure that GOK enacts policies that transform Kenya to a knowledge based country where e-government, e-education, e-health and e-agriculture are fully operational. To lay the foundation of a knowledge-based country, KIPRA is promoting the establishment of ICT building blocks that include, infrastructure, infostructure, human resource development, and funding. KIPRA has shown great interest in assisting the MOEST develop their ICTs and education monitoring and evaluation strategies.

NEPAD e-schools

This program forms part of NEPAD's larger project and is intended to support the design and development of computer labs in six schools in Kenya as part of a sixteen country initiative that seeks to enhance ICT capacity at secondary schools in Africa. The assistance includes provision of hardware, software, Internet connectivity, content development, and monitoring and evaluation. The e-schools program will be implemented in six schools across the country.

Enhancing ICT capacity in participating schools will certainly enhance quality of learning for the students of some of the disadvantaged districts that are hit by a shortage of books and school equipment particularly in the ASAL regions of Wajir, Isiolo and Garissa Districts. This project should be closely watched and driven by the MOEST since it will provide valuable lessons for working in resource poor areas and geographically diverse settings. Given the need to ensure sustainability of school computer labs upon cessation of donor support, MOEST should utilise this activity to develop robust ICTs in education models.

Civil Society

Arguably, the most exciting and successful ICTs in education interventions in Kenya have emerged from civil society organisations, most of which have received support from other donor partners. KENET has delivered connectivity to over 50 higher education institutions (with twice as many on their waiting list). SchoolNet Kenya has drawn up regional ICTs in education strategies for training thousands of teachers. Computers for Schools/Kenya has installed computers in nearly 150 schools and provided sensitisation and foundation skills training for principals and teachers. CFSK has also developed a refurbishment centre, collaborated with KIE for content development, and trained street children and women in computer skills. Based on these ideas and experiences, Kenya is poised for some very exciting interventions which draw on the local expertise available.

KENET

KENET was established to provide sustainable communication and networking technology to educational institutions in Kenya and to facilitate the use of Internet technology in teaching and research as well as to share information resources with the general populace at affordable cost. KENET supports 51 education

institutions that cater to over 60,000 students. National Research Institutions, Middle level Colleges, Polytechnics, and Institutes of Technology are also members of KENET.

KENET is locally managed with full Kenyan ownership and has succeeded in bringing all the public and private universities and some tertiary institutions together to articulate the connectivity needs of the education sector. The institution is one of the local best practices that has moved to recognition and acceptance by the education sector as a key vehicle of delivering connectivity to the education sector. KENET has undergone all the processes of design, development, implementation and scaling up of services and is currently meeting the ICT needs of over 51 institutions.

The KENET infrastructure supports double the number of institutions it was established to support, thus placing considerable strain on the infrastructure. This infrastructure must be strengthened if this model is to be scaled up to meet the needs of the entire education sector. Additionally, KENET does not have the necessary organizational capacity to meet the connectivity and human capacity needs of the entire education sector and would need to fully increase its organization capacity to address the needs of the education sector. Since KENET does not have the necessary funding from any donor or GOK to meet its infrastructure and human capacity needs, opportunities for appropriate funding models should be considered (as are currently under way at KENET).

African Virtual University (AVU)

The AVU is a satellite-based teaching network established through the World Bank. It targets post-secondary students and corporate employees throughout Sub-Saharan Africa (SSA). The AVU currently works with 22 partner institutions in 16 countries. AVU offers non-credit, remedial, and specialized certification programs with content provided from major universities in Africa, North America, and Europe as well as private corporations and organizations. As of the year 2000, the AVU also began providing degree-granting programs in computer engineering, computer science, and electrical engineering. AVU serves the dual mission of maximizing profitability and promoting sustainable economic and social development in Sub-Saharan Africa.

Launched in 1997, the AVU enables students in 6 African countries to take courses and seminars taught by professors from universities around the world. The professors deliver their lectures in front of television cameras in their own classrooms, and the video is routed via fiber optics, ISDN lines, or satellite to an uplink in Washington, DC, which then beams it via satellite to points in Africa. Students are able to talk with the instructors in real time using standard phone lines. A student in Kenya, say, can pose a question to an instructor in New Jersey while students in Ghana, Tanzania, Uganda Ethiopia and Zimbabwe listen in.

AVU is the first attempt to use on a large scale, the power of information technologies to meet the growing demand both for well trained African scientists, technicians, engineers, business managers, etc., and for access to quality higher education. It is also an opportunity to help stem the common perception in international development that the division into rich and poor parallels a division into the knowing and ignorant. The World Bank says the project's main objective is to tap new information technologies to overcome the many financial and physical barriers that prevent students at African universities from gaining access to quality higher education. For, most African universities have become increasingly irrelevant in the rapidly changing world. For example, they often graduate a disproportionate number of students in the humanities rather than the sciences and engineering. Hence, making use of computer networks linking Africa to the West, participating universities in USA and Ireland will provide (pre)packaged academic programmes, particularly in science, engineering and business. This is expected to be particularly relevant in the emerging economies of African countries whose work forces lack vital technical skills. In the light of the ever-growing demand for higher education opportunities in many African countries, the AVU project will alleviate, however slightly, the very high competition for university places. Government and private sector organizations in need of continuous professional training for their employees are also expected to benefit in the long-run. This type of 'teleteaching' offers two decisive advantages: the independence of time and of location. The possibility of learning without

being absent from the job and less travel expenses are arguments speaking in favour of 'telelearning' and making it attractive for advanced professional training and international training measures.

Many stakeholders indicated that AVU is in an "upswing". The history of AVU appears to have been characterised by an exciting initial start-up phase and then a difficult period as external funding slowed. From all accounts, the organisation is now getting their bearings and slowly winning the approval of the sector. A case study of AVU will be delivered during the "Education Reform Capacity Building Programme for Senior Policy Makers" workshop during the week of 19-26 June 2005. It will not be possible to incorporate this information into the final draft of this report but it should be read alongside these Options.

Computers for Schools Kenya (CSFK)

The Vision of CFSK is to establish an information-rich Kenyan society which actively contributes to sustainable national development. The Mission of CFSK is to empower young Kenyans for life in a knowledge-based society by facilitating the development of ICT infrastructure and capacity.

CFSK aims to achieve these goals by facilitating the continuous development and maintenance of ICT infrastructure in learning institutions and community access centres; building the capacity of both CFSK and our partner institutions to achieve our vision and mission; establishing strategic linkages with government agencies, corporate bodies and civil society organisations; and actively participating in national policy formulation and implementation in the ICT Sector.

The main activities undertaken by CFSK include:

1. Sourcing quality affordable pre-owned personal computers;
2. Deploying those PCs in qualifying institutions;
3. Continuously maintaining and supporting the PCs deployed;
4. Development of relevant curricula and resource materials;
5. Training of trainers and educational administrators;
6. Evaluation and certification;
7. National capacity building through volunteer and internship programmes;
8. Pioneering relevant new technologies;
9. Internet connectivity and access;
10. Management of electronic waste; and
11. Policy and advocacy work.

CFSK provides holistic solutions for fully integrating ICTs in secondary schools but lack of funding is the constraining CFSK future plans.

YMCA Community Learning Centre

In 2004, Computers for Schools Kenya provided 20 computers to YMCA Community Learning Centre in Shauri Moyo and trained 2 trainers in networking and maintenance and support. CFSK networked and connected the centre. The Centre is unique in that it provides ICT training for the community trainees and has provided training to over 250 street children through support from GOK and UNICEF. Some of their graduates have been employed.

The Centre is seeking funding to provide training to 200 AIDS Orphans and youth affected by HIV/AIDS using their facilities that have the capacity to accommodate over 1,000 youth. YMCA CLC has played the role of addressing digital divide for the poor community around its facilities by providing ICT training at very affordable rates. The major constraint facing the Centre is lack of funding.

SchoolNet Kenya

As noted earlier, SchoolNet Kenya's vision is dramatic. The strategy is based on research conducted in association with the Commonwealth of Learning and SchoolNet Africa. In fact, as we closely read through the wealth of SchoolNet Kenya workshop reports, it became apparent that most of the options presented in this paper closely align to the strategy developed by SchoolNet Kenya and their partners. For this vision to begin to take hold, the organisation should start leading the implementation of activities towards these goals. These can start small with the intention of building a critical mass of experience and support towards the larger strategy.

Network of Initiatives in Computer Education (NICE)

NICE is an Education Trust in Kenya with the quest to reach all schools in Kenya, particularly rural schools with basic computer literacy and with a vision of an ICT- competent 21st century generation benefiting from an increased opportunity and innovations in Information Technology. NICE includes a variety of NGOs, private sector partners, and GOK institutions from the education sector. Members include Computers for Schools Kenya, Kenya Community Media Network, African Regional Centre for Computing, Kenya Private Sector Alliance – ICT Board, Heinland Institute, Tracom College Nakuru, Rift Valley Institute of Science & Technology, Rural Schools Computer Project, CRAIG Enterprise Development Institute, and KENET.

Donor Partners

Donor partner interest for ICTs in education focuses on improving the quality of learning as well as educational efficiency and relevance by building the capacity of teachers and MOEST officials to integrate ICTs into teaching. This is demonstrated by VVOB's several activities focusing on building the capacity of teachers to deliver quality learning. Similarly, DFID's programs focus on improving the quality of learning for teachers through ICTs. This is demonstrated through the School Empowerment Program and E-Learning pilot projects. In regards to schools management and ICTs, the World Bank has worked to build the capacity of the MOEST to effectively manage the education sector through EMIS. Additionally, USAID's support focuses on building the internal communication capacity of MOEST and other Ministries through ExecNet and KENET. USAID's interest in KENET facilitates wide use of Internet technology in teaching, research, and sharing of other information resources to the general populace at affordable cost. These activities are described in greater detail below.

School Empowerment Programme

The School Empowerment Programme (SEP) is a national programme designed to provide a blended learning experience for all teachers in Kenyan primary schools. The programme is a whole school initiative which adopts an integrated approach to whole school development. It seeks to mobilise and involve the school community – including both internal and external members – in the successful implementation of GOK Free Primary Education policy.

The rationale for the design of SEP is, in part, essentially grounded in the earlier SPRED Textbook and School-based Teacher Development (SbTD) initiatives. The overall aim of the DFID-supported SEP is to improve pupils' performance and retention in primary schools and help teachers better manage the challenges presented by the GOK Free Primary Education policy. The SEP is a school based multi-media training course using print, audio and video to support professional development.

BBC World Interactive Learning

BBC WIL (through Imfundo/DFID support) has engaged in capacity building with the School Improvement Programme (SEP) MOEST writers. Under this BBC capacity building project for MOEST, DFID supports in-service teacher training for basic education through use of text, videos, audiotapes, and e-learning. The e-learning component of this program provides ICT integration skills, basic ICT literacy, and a web portal for teachers and Ministry officials.

KTTC ICT Integration and Resource Centre

The VVOB project at the Kenya Technical Teachers College aims to integrate ICT in learning by training staff and students of the Higher Diploma course in computer skills, integration methodology, and HIV/AIDS training. Internet is utilised daily for information access and development of learning and teaching materials, as well as for in-service training. VVOB has designed and established a resource Centre at KTTC to increase ICT access for teachers.

The initial target group was defined as holders of a *Diploma in Technical (Teacher) Education* (about 5000 graduates) who are (or aspire to be) in senior officials in the administration or management of technical training (estimated to be about 1000 graduates)." It is important to note that, after one year, it was felt that the curriculum would be beneficial for a wider target group. This lead to a curriculum review which included adopting a modular approach. The new curriculum *Higher Diploma in Education Management* was approved by the Kenya Institute for Education in May 2004. These are practical projects which offer MOEST an opportunity to fully integrate ICT in learning at tertiary institutions.

Kenya Polytechnic ICT and GIS Programs

Technical training is instrumental in the plans of the Kenya Government to transform the country into "an industrialized nation" by 2020. The Kenya Polytechnic in Nairobi is the oldest (1963) and the biggest (11 departments, 4000 students on day courses, 4000 students on evening and holiday courses, and 315 full time lecturers) of the four GOK Polytechnics. The objective of Poly ICT Programme is to assist Kenya Polytechnic to meet its needs regarding acquisition and use of ICT structures in learning, management, and development. VVOB assists the Kenya Polytechnic through the PolyICT and PolyGIS programmes.

Plans include the development a central ICT Centre delivering standardised ICT services to all departments; the development of broadband network infrastructure to provide central ICT services and e-learning throughout the institution; training of all personnel of the ICT Centre for their specific tasks (hardware, software, network infrastructure, and/or management); development of institutional ICT strategies, policies, and procedures for hardware, software, procurement, security, and staff training; development of a management information system and ICT Master Plan for the institution; ACE curricula are reviewed and ICT components are incorporated in all relevant curricula; and a basic inter-departmental Mechatronics Laboratory is established and appropriate training is organized for all staff involved.

The overall objective of PolyGIS is to meet the needs of the industry for skilled technicians in the field of Geographic Information Systems by offering courses of high quality with respect to data acquisition and data management. PolyGIS trains teaching staff on data acquisition and data management, integration of data acquisition and data input in GIS-trainings, and developing courses-to-measure for clients. Both the PolyICT and PolyGIS projects are equipping teachers with the necessary technology skills to prepare tertiary students to meet the industry needs.

Private Sector

Private sector support has shown that it can be strong if well motivated by civil society and GOK. For instance, KIE was able to get thousands of WorldSpace radios funded by Kenya Airways as well as other companies. CFSK and SchoolNet Kenya have worked with Microsoft to secure free software licensing fees and to deliver training activities respectively. And a number of schools around the country have received computers from local businesses over the past 5 years. It becomes apparent that there is a clear role for the private sector to play in the ICTs and education sector in Kenya but that the private sector will not, nor should they be expected to, lead the process. During many discussions, businesses made it clear that they wish to participate but are unsure how the GOK and MOEST would like them to engage. This again provides strong support to a MOEST-led coordinating committee with representation from all sectors, public, civil, and private alike.

ICT Trust Fund

The ICT Trust Fund mobilizes funds from various private sector companies in Kenya and has trustees from top private sector companies including Barclays Bank of Kenya Limited, Safaricom, Kenya Breweries, Access Kenya and others. These companies represent some of the most powerful business interests in the country. Social responsibility funds form the basis of the ICT Trust Fund and the current vision is to facilitate provision of hardware and software, content development, and wireless access to secondary schools in Kenya. While this is happening on a small scale in some areas, the ICT Trust Fund provides a very important opportunity for a coordinated large-scale intervention from these corporations. It appears that they are eager to work with the GOK but that everyone is unclear how best to make this happen.

Microsoft

Microsoft, as a member of the ICT Trust Fund, indicated that the private sector's interest in ICT in education is in facilitating technology access for marginalized communities. They feel that this can be accomplished through the provision of hardware and software to schools as well as through the creation of sustainable community learning centres for out of school youth and marginalized communities to access learning. Microsoft has also established their Partners in Learning programme in Kenya. This programme provides the opportunity for the GOK to develop a national intervention for ICTs in education delivery and support. A MOEST-led ICTs in education steering committee could ensure that any partnership benefits the MOEST as well as Microsoft's interest. Microsoft has made it clear in their GOK MOU that they are eager to provide transparent support. This opportunity should be quickly seized.

Summary

Many institutions in Kenya are already utilising ICTs in education to address access, equity, and quality of education through the implementation of various projects. With greater coordination, these projects can provide valuable lessons to meet GOK's goal of Education for All. GOK has already identified ICT as a critical tool for creating greater enthusiasm for learning amongst students and offering access to a wider range of courses. GOK is keen to use education institutions as hubs of ICT dissemination in rural areas.

A final National ICT Policy and an ICT Policy for Education can provide guidance for the implementation of ICT activities. The lack of these documents is a notable constraint for these policies can facilitate the development of a coordinating body within the MOEST to provide guidance as well as monitoring and evaluation to ICTs in education activities.

Appendix B: Local and International Best Practices

The following section serves two purposes; primarily to inform the ICTs in Education options presented in this report, but also to clearly articulate and support the thinking behind the careful formulation of appropriate ICTs in Education interventions. The options are based on the international best practices, or perhaps more appropriately lessons learned and collective wisdom of years of investigating the potentials of ICTs for education. No one country or international institution has all the answers regarding ICTs and their effectiveness, but decision makers, planners and practitioners can be aware of the wealth of worldwide knowledge, research, experience, and thinking on the subject. This awareness should not lead to transplantation of ideas and experiences but should rather enlighten, guide, and inspire locally conceived and implemented decisions and plans.

Common ICT-in-Education Myths

Myth 1: ICTs represent one monolithic entity. When speaking of the potential of ICTs, this should not be discussed in the singular. Technologies differ in their properties, scope, and potential and different technologies can be used for different purposes.

Myth 2: Providing ICTs to schools transforms the learning process, and merely connecting to the Internet changes the learner's world. Technology is only a tool: no technology can fix a bad educational philosophy or compensate for bad practice. In fact, if we are going in the wrong direction, technology will get us there faster.

Myth 3: Just buy the necessary hardware and software, secure a connection to the Internet, and ICTs can be a substitute for schools and teachers. ICTs have the potential to enhance, complement, and even transform the way we structure, create, disseminate, and share teaching and learning materials; however, pictures and text on a screen or voices on a radio are not an adequate replacement for the existing teaching environment. In order for education to work, people need a place and a pedagogical structure to engage with content, obtain knowledge, and gain deeper conceptual understandings of the world around them.

(Derived from ICT-in Education Toolkit, Decision Maker's Essentials, Wadi Haddad, 2004)

The most important lesson that experience has consistently taught us is that it's not about the technology, but about educational outcomes. Although this may be clear, the process of integrating technology into the educational process is not straightforward. It is an intricate, multifaceted process that involves a series of deliberate decisions, plans, and measures.

Within this understanding, it is fortunate that this report comes within the context of a wider educational reform agenda where the Kenya Ministry of Education Science and Technology has rigorously analysed the national educational objectives and goals articulating them in the Kenya Education Sector Support Program and Sessional Paper No.1.

Given the defined national educational goals and objectives and Kenya's realities and prospects, we have researched the ICT applications that most appropriately address these needs to more adequately inform the investment in the necessary human, physical, and instructional infrastructures.

Below is a compilation of international "best practices" in ICT-in-Education organized by Kenya's Educational Priority areas. This is by no means a comprehensive list of all ICTs in education activities, but a carefully selected set of examples that show a significant impact in addressing educational outcomes.

Enhancing Access to Educational Opportunities

Equity is a primary theme throughout the MOEST's educational objectives, particularly providing equal educational opportunities for women, populations living in the ASALs and in the urban slums. Optimists may posit that technology can level the playing field; however, this has not been proven. In fact the introduction of ICTs into the education system can often exacerbate an existing divide between the haves and the have-nots due to the high cost of sustaining the technology. International experience now

advocates a holistic strategy in introducing ICTs into the educational system that takes special consideration of how to reach marginalized groups.

Interactive Radio Instruction

The underlying assumption of IRI is that schooling is completely absent or that the quality of teaching and learning is impaired in some way, usually for reasons such as a lack of instructional materials or untrained teachers or overcrowding, and that children are not mastering basic skills such as mathematics, science, and reading and writing in English. Under these circumstances, IRI programs provide an intensive half hour each day of high quality instruction of a kind that teachers by themselves simply cannot provide.

IRI programs cover the entire basic curriculum, not just selected elements of it, and are broadcast daily. Each day of the week there is a 30-minute lesson for Standard 1, another for Standard 2, and so on. Each program is carefully organized, scripted, evaluated and revised before it is used in the classroom, the sequencing of topics is carefully organized, and topics are returned to for revision and practice throughout the year. The quality and daily frequency of the broadcasts is at the heart of the success of IRI, and any compromise of these standards leads to a compromise in learning outcomes.

IRI programs emphasize meaningful student-centred learning activities, active learning strategies that elicit many responses from learners (e.g. 100 responses during a 30-minute program is common), activities such as songs that are fun and appeal to many different learning styles as well as plenty of practice, and objectives that focus on mastery of essential basic skills such as literacy and numeracy. The success of IRI can be mainly attributed to its focus on practical learner-centred activities which promote many learner responses and critical thinking. Each day the radio models active learning strategies and new classroom management ideas for the teacher/facilitator.

IRI brings a dynamic mixture of songs, games, drama, and activities that make learning fun. Where resources such as books are scarce, radio can help the teacher with what to write on the blackboard, provide an audio stimulus to replace the visual stimulus provided by books, and suggest or lead student drills and practice. Programs model the pedagogy used by the most effective teachers in real classrooms. In this way, untrained teachers receive many hours of training as they respond to the radio prompting them to manage the classroom activities in ways used by the best primary school teachers.

Evaluations of IRI project in many countries have shown:

- IRI has high front-end costs as programs are written, developed and tested. However, recurrent costs (typically for airtime, print materials and teacher training) are low. Even with populations of a few thousand learners when compared with conventional schools, and the unit cost falls as more learners are served. Typically costs range from US$1 to US$3 per student per year.
- Children learn from IRI. IRI programs have achieved their greatest success in teaching basic skills in the first four years of primary school. In Bolivia, South Africa, and Honduras, comparisons of test scores between schools using IRI and those not using IRI have shown a gap of about 20 points in favour of children getting IRI as well as conventional instruction.
- Girls attending IRI lessons perform as well as boys, thus minimizing gender performance gaps.
- IRI tends to close rural/urban gaps since all the learners get similar instruction in exactly the same way.

IRI is also being used successfully in a variety of contexts with a variety of audiences including preschoolers in early childhood education programmes, in school learners, out-of-school children and youth and adults. IRI is currently being used in several countries to meet challenges such as:

- Lack of sufficient qualified teachers and/or schools – Zambia, Dominican Republic, Somali populations in southern Ethiopia, Haiti
- Increasing access to education – Zambia, Tanzania, Ethiopia, Haiti and Honduras
- Improving quality – Guinea, Nigeria, Nicaragua, Venezuela, South Africa

- Lack of sufficient spaces in schools – Zambia, Haiti, Honduras
- Long distances to schools – Zambia, South Africa, Ethiopia's Region 5
- Inability to attend formal system due to special circumstances such as lack of time for school due to need to work, take care of siblings or sick relatives – Dominican Republic, Zambia
- Poverty/inability to afford fees – Zambia, Tanzania
- School preparation for young learners – Bolivia, Honduras
- Updating teacher skills and pedagogical practice – Mali, Nigeria, Guinea, Colombia, Madagascar

The constraints faced in Kenya are similar to those faced by out-of-school children in Zambia and Tanzania as well as by nomadic populations in Somalia and southern Ethiopia. IRI has been effectively utilised in these countries to serve these populations, thus ensuring equitable access to quality education for more children.

UNESCO has set up a Sub-Saharan Africa higher education Open and Distance learning knowledge base with the Commonwealth of Learning. The knowledge base includes selected readings, reports of good practice, and other information tools, targeted to help public and private organizations, and individuals using distance education as a means of human development in the education sector, beginning with higher education.

This site is implemented as a partnership venture between the UNESCO Harare Cluster office, the World Bank, and the Global Distance Education Network (GDENet.)

Cisco Gender Initiative

The Gender Initiative is a project established by the Cisco Learning Institute and Cisco Systems, Inc. to address the gender digital divide, and develop ways to increase women's access to IT training and career opportunities. Recognizing the need to leverage opportunities for women in the field of IT, CLI has collaborated with the Academy for Educational Development (AED), the Institute for Women in Trades, Technology, and Science, Trust for Americas, and Youth International to conduct research on gender recruitment, participation, and retention strategies by studying the Cisco Networking Academy Program. The aim of the project is to provide a "research laboratory" for gender and ICT.

The Cisco Learning Institute and its partners are developing tools to increase female retention and recruitment in the classroom and are also developing best practice profiles. The results of the Gender Initiative have been presented at national and international conferences and through press releases and industry publications, report research conducted with AED. The project is active in Jordan, Philippines, India, West Bank & Gaza, and other areas.

For more information, go to: http://www.gender.ciscolearning.org.

African Virtual University (AVU)

(This section is taken from "Appendix A: Summaries of ICTs in Education Activities and Interest in Kenya" of this report.) The AVU is a satellite-based teaching network established through the World Bank. It targets post-secondary students and corporate employees throughout Sub-Saharan Africa (SSA). The AVU currently works with 22 partner institutions in 16 countries. AVU offers non-credit, remedial, and specialized certification programs with content provided from major universities in Africa, North America, and Europe as well as private corporations and organizations. As of the year 2000, the AVU also began providing degree-granting programs in computer engineering, computer science, and electrical engineering. AVU serves the dual mission of maximizing profitability and promoting sustainable economic and social development in Sub-Saharan Africa.

Launched in 1997, the AVU enables students in 6 African countries to take courses and seminars taught by professors from universities around the world. The professors deliver their lectures in front of television cameras in their own classrooms, and the video is routed via fiber optics, ISDN lines, or satellite to an uplink in Washington, DC, which then beams it via satellite to points in Africa. Students are able to talk with the instructors in real time using standard phone lines. A student in Kenya, say, can

pose a question to an instructor in New Jersey while students in Ghana, Tanzania, Uganda Ethiopia and Zimbabwe listen in.

AVU is the first attempt to use the power of information technologies on a large scale to meet the growing demand both for well trained African scientists, technicians, engineers, business managers, etc., and for access to quality higher education. It is also an opportunity to help stem the common perception in international development that the division into rich and poor parallels a division into the knowing and ignorant. The World Bank says the project's main objective is to tap new information technologies to overcome the many financial and physical barriers that prevent students at African universities from gaining access to quality higher education. For, most African universities have become increasingly irrelevant in the rapidly changing world. For example, they often graduate a disproportionate number of students in the humanities rather than the sciences and engineering. Hence, making use of computer networks linking Africa to the West, participating universities in USA and Ireland will provide (pre)packaged academic programmes, particularly in science, engineering and business.

This is expected to be particularly relevant in the emerging economies of African countries whose work forces lack vital technical skills. In the light of the ever-growing demand for higher education opportunities in many African countries, the AVU project will alleviate, however slightly, the very high competition for university places. Government and private sector organizations in need of continuous professional training for their employees are also expected to benefit in the long-run. This type of 'teleteaching' offers two decisive advantages: the independence of time and of location. The possibility of learning without being absent from the job and less travel expenses are arguments speaking in favour of 'telelearning' and making it attractive for advanced professional training and international training measures.

Enhancing Quality of Learning

To enhance the quality of learning through the use of ICTs, the most logical assumption is to improve capacity of teachers and use ICTs to support and facilitate instruction and classroom management. It is important to note that providing access to computers and the Internet is not sufficient in itself to improve the quality of learning and technology cannot replace teachers. Both IRI and computer facilitated/enhanced instruction should be in line with national curriculum standards and the focus should be on learning outcomes and not technology.

As countries achieve higher levels of basic education, there will be more demand for secondary, technical and tertiary education. Providing such education across the country through efficient and affordable means is seen as the next challenge after the challenge of "Education for All." Investing in the creation of more schools is important however, investing concurrently in ICTs at the secondary school level is seen as an important step to prepare these students for the new knowledge economy which demands a labour force which is innovative, creative and entrepreneurial. At the secondary school level, students must begin to think independently, construct their ideas, concepts and understanding of the world around through active exploration, experimentation and discussion. The following examples of using ICTs for these purposed are highlighted below.

IVAN - International Virtual Education Network

Science and mathematics are supposed to provide conceptual and technological tools that allow people to describe and explain how the world works with power and precision, and to achieve a richer understanding and appreciation of the world they experience. Unfortunately though, school conditions, in most cases, have reduced the wonderful, dynamic and multidimensional world of science into flat texts, scripted demonstrations and occasional cookbook experiments. Similarly, the world of mathematical constructs, concepts and relationships has been transformed into drill and practice of computations and abstract problems.

To address this problem, The Inter American Development Bank financed in 1999, the International Virtual Education Network (IVEN) for the Enhancement of Science and Mathematics Learning, a pilot

collaborative cross-country project in Latin America. The project was designed by Knowledge Enterprise, Inc., which also acted as the International Coordinating Secretariat through early 2002. The participating countries are Brazil, Peru and Venezuela. Argentina and Colombia participated for a short time. The project is now in its implementation stage.

The backbone of the pilot project is the development of multimedia modules for the whole science and math program for the last two years of secondary schools. However, it is comprehensive, involving: the setting of learning standards, translation of standards into teaching/learning activities, production of multimedia curricular materials, staff training, distribution, testing and refinement of curricula, educational materials and pedagogical approaches, learning achievement assessment and program evaluation. IVEN is composed of three phases: preparation and capacity building; development; application in schools, and scaling up. For details, see:

http://wired-vig.wired.com/news/culture/0,1284,42660,00.html?tw=wn_story_related

The Teaching Science Portal

"Teaching Science" was created to link education decision makers and scientists to projects and resources that support quality science education, to collect and share information on International Science Council (ICSU) and International Panel of Academies (IAP) educational and training activities, and to provide examples of "best practices" in science education and training. It includes information on: projects dedicated to science education based on "Hands-on" methods; Educational and training activities of ICSU and IAP members; science education systems in various countries; and Meeting reports and research articles about science education at the primary level.

Project Based Learning

iEARN is a global network of teachers and students who are using the Internet and email to implement collaborative projects that exemplify active and creative teaching and learning. iEARN participants and educators seek to prepare today's youth for a constantly changing and evolving multicultural world as new technologies emerge and economies become more interdependent. In the last decade, iEARN has connected schools from all over the world in more than 90 countries and is currently working with approximately 350,000 students with representation from 29 different languages. The projects are based on interactive discussions and sharing of work, as students and teachers debate, perform research and exchange opinions. The project topics and themes range from global arts and music to international foods and cultural patterns, world religions, local histories, indigenous peoples, youth service, and more. The idea behind iEARN is to get students to compare and contrast their lives with those of their peers in other lands. Through this process, better communication and cross-cultural understanding, as well as learning, result. By going directly to the source in dealing with the problems they face – to the real people of another country – problems will be solved and relationships forged. With the help of ICTs, learning and communicating takes on a new meaning and dimension.

Enhancing Quality of Teaching

Teachers are the key translators of the curriculum into learning activities and the key mediators between knowledge and learners. A sound education system, therefore, relies heavily on the skills and efficacy of the teacher. Many ICT interventions around the world therefore focus on teacher training.

Examples include the use of IRI in Liberia and Mali, the VVOB-supported Learning Centres in Kenya, the work of dot-EDU at the teacher training colleges in Namibia and Uganda, the development of teacher practice videos for pre-service teacher training in Namibia and the DRC.

VVOB Learning Centres at TTCs in Kenya

In Kenya, VVOB is working with the KTTC in Nairobi to develop appropriate, high quality, training course in Education Management at Higher Diploma level. The project is supporting KTTC to achieve the envisaged quality. The project has an important ICT component. KTTC staff and students of the

Higher Diploma course are trained in computer skills and Internet is used daily for information access and development of learning and teaching materials, as well as for in-service training (distance learning). The overall focus is on ICT integration in the teaching environment.

Interestingly, this activity has gone through the difficult process of moving from ICT skills to ICT integration. Working in relative isolation, the VVOB team realised that they needed to more complex understanding of how to address the use of ICTs at TTCs. As has been noted throughout this report, this is no easy task. The work at KTTC now involves more application of ICTs to learning situations. While this is a relatively small project, it has major implications for Kenya and serves to highlight the need for information sharing among those working in the ICTs in education sector.

dot-EDU Namibia and Uganda

Under dot-EDU (a USAID-funded mechanism delivered by the Education Development Centre with the Academy for Educational Development), teacher trainers have undergone online professional development courses. The course was delivered through the Harvard Graduate School of Education's WIDE World. WIDE World is an online professional development program at the Harvard Graduate School of Education. WIDE World's online courses have a strong focus on the concepts of teaching for understanding, differentiated instruction, multiple intelligences, technology integration and Math.

Participants from Namibia and Uganda completed courses online with support from dot-EDU through face-to-face workshops and virtually through email. Consistent access to technology proved to be a major obstacle for course participants. Power outages and connectivity interruptions created the majority of obstacles. Even so, lecturers who participated in project activities in Namibia showed a significantly higher frequency (54%) of using ICTs with student teachers when compared with those lecturers who had not worked with the project (19%). While the course presented great difficulties, those who completed it in both countries found it effective for considering how to integrate technology as well as for improving teaching methodology and subject-content knowledge over all.

Community Learning Centres

When launching the Community Learning and Information Centres (CLICs) in Mali, USAID looked for locations and local partners that would help integrate the CLICs into multiple sectors. Today there are CLICs operating in municipal government offices, branch offices of a national teachers training college, health offices, nongovernmental organizations, agricultural businesses, and community radio stations. The choice of locations stems from the non-profit model of the CLICs. The centres offer fee-for-use services to recover costs and reinvest in new equipment or software, add new programs, and develop new sector-specific content. In contrast, for-profit centres would favour locations in high-traffic areas such as markets, town centres, or bus stations.

In Uganda's rural communities like most parts of Africa, there is general lack of basic ICT infrastructure. By the end of 1998, Multipurpose Community Telecentres (MCT) pilot projects had been launched with the support of IDRC/ITU/UNESCO at three different sites in Uganda. The broad mission of the MCTs was to study the efficacy of use of ICTs to promote rural community development.

Connectivity for MCTs deep in rural areas had by 2000 proved a serious challenge to overcome through ordinary technologies.

In Zimbabwe, the World Links program was at the same time experimenting with another approach -- School-based Telecentres -- with a twin objective of introducing ICTs in the process and delivery of educational content and also providing communities with access to communication facilities and ICT training in the after-school hours, evenings, weekends and holidays. Based on this experience, World Links commissioned the development of a new week-long training program on the Establishment of School-Based Telecentres which it first pilot-tested in February 2001.

A national School Based Telecentre project in Uganda was formally started in September 2001 with a revised week-long training program. This training, delivered to headmaster representatives from fourteen

secondary schools and one national teachers' training college, was partly built on the Zimbabwe experience but also crafted to accommodate a different national setting, local MCT experiences, and an innovative technological pilot opportunity – a national satellite network to deliver high speed Internet to schools in peri-urban and rural areas.

The network, established by World Links through support from the Bill and Melinda Gates Foundation, involves fifteen SBTs. Of these, eleven use Very Small Aperture Terminal (VSAT) satellite technology to link to the Internet with at least eight computers on a Local Area Network (LAN). These sites are geographically well distributed around the country in the districts of Jinja, Iganga, Mbale, Soroti, Lira, Arua, Moroto, Hoima, Kabale, Masaka and Luwero. The four other school sites will be connected via spread spectrum technology off the VSAT hub from the school in Jinja.

The bandwidth (256 Kbps "download"/32 Kbps "upload") on the VSAT is shared among the participating sites and the cost is accordingly shared among the schools with a payment of US $200 per month. (World Links is contributing the other US$200 per month per site for a two-year period). The schools raise funds from charging students tuition fees each term and other community user fees. On average, each student pays US $18 per year. A typical secondary school has between 800 and 1000 students around the year.

Facilitating Skills Formation for out-of-school youth in urban slums

ICTs are an obvious fit for technical and vocational training and MOEST is looking at ways to improve their TIVET programs using technology. This section provides examples of how to use ICTs to train disadvantaged groups, such as out of school youth in urban slums.

Program for the Future: Out of School Youth Learn ICT Skills for Employment

The Programa Para o Futuro (Program for the Future) project is a pilot information technology (IT) employability training project for poor and disadvantaged youth in Recife, Brazil. As a pilot project, AED was asked to create a new integrated curriculum and instructional methodology directed toward the complex needs of disadvantaged youth and which would be responsive to market demands. Fifty disadvantaged youth (half boys and half girls) were selected through a competitive process from some of the poorest communities of Recife, Brazil to participate in the pilot project. One of the most important goals of this pilot project has been to test and successfully implement innovative approaches to prepare very poor disadvantaged youth, 16 to 21 years of age, for entry level jobs with private sector companies, government agencies and NGOs that require strong information technology skills. Since much more than basic technical skills are required to enable disadvantaged youth to compete successfully for jobs with their more advantaged middle-class peers, AED developed a job readiness program that simulates the workplace and integrated this into the information technology curriculum.

Since youth coming to this program had very weak basic academic skills, the curriculum integrated Portuguese and English language learning to strengthen communication skills, math to foster improved logic and problem solving and explicit creativity activities. To complement these elements of the curriculum, AED created a safe, comfortable and professional training environment that fosters creativity, collaborative learning, proactive problem solving, and self-managed learning. In addition to instructor facilitated learning activities, AED, in collaboration with a Brazilian university, provided youth on-line learning modules to learn about Linux and open source software and to build capacity for life-long-learning.

AED established strong public-private partnerships with local and international companies to support the capacity building and employability goals of the pilot and to help meet the material and financial needs of the project. These private sector partners included IBM-Brazil which provided 21 desktop computers, 7 laptop computers, and funding for uniforms and printers. Microsoft Brazil provided the network operating system software, application software and legacy versions of operating system software so that youth could learn to use software that was still commonly used. AED orchestrated a partnership with the Bank of Brazil that allowed the project to establish the training facility on the 9th floor of the Bank's office in Recife. A partnership with the best technical college in the North East of Brazil, IBRATEC,

resulted in all of the pilot project's 50 youth receiving free scholarships to the 2-year advanced technical training program. These scholarships have a value of about $133,000. To provide youth with English language training, AED established a partnership with ABA (a local English as a Second Language school) to provide two language teachers for free to the project.

To ensure that each youth in the program is directly linked to a professional from the job market, AED designed and carried out an e-Mentoring program–-the first such program in Brazil. The e-Mentors were carefully selected from local companies that made agreements with AED to support their e-Mentors and contribute their time to the project. The mentoring relationships lasted the entire year of the project; an unprecedented achievement.

As part of AED's efforts to create a new innovative curriculum and teaching approach, the project team developed and carried out an intense teacher-training program. This started with a two-week workshop that involved working with youth so that the teachers could learn how to use the project-based learning approach and to work in instructional teams and learning facilitators rather than individual lecturers. Recognizing that enabling educators to learn to teach and engage youth in new ways cannot be achieved during one workshop, AED organized, in partnership with a Brazilian university, an on-going professional development process using an on-line learning environment that focused on having the teachers reflect on their experiences, experiment with innovative techniques and create new collaborative learning projects. This continuous teacher-driven professional capacity building process contributed greatly to the success of the pilot project.

One of the most successful features of this pilot project is the electronic or e-Mentoring program. Under this activity, project staff recruited volunteer professionals from local businesses as mentors and matched them to individual youth. Initially, all mentoring activities took place via e-mail, instant messaging and web-based chat. The project's e-Mentoring coordinator developed an e-Mentoring manual and provided on-line training to the e-Mentors to prepare them for their responsibilities. The e-Mentoring coordinator also developed and facilitated a variety of e-Mentoring activities designed to reinforce capacity building and to help the youth develop professional networking skills. A year after the e-Mentoring started, only four e-Mentors have stopped participating and with new volunteers there are now 56 e-Mentors working with our youth. One of the critical success factors for the e-Mentoring program has been the role that the mentors are playing in helping youth make professional contacts and learn about job opportunities.

AED partnered with four Brazilian NGOs to ensure that the pilot project was effectively embedded in the local business and NGO community, to leverage local knowledge and to build the capacity for sustainability. AED selected each NGO of their recognized expertise related to critical elements of the pilot project's design. One organization worked with AED to develop the curriculum and teaching approach, one focused on the e-Mentoring program and building durable partnerships with the local business community. A third concentrated on information technology skills development. The forth NGO provided the math, creativity and employability instructors, and supplied the gender specialist and social worker.

During the one year of formal training activities, only one youth dropped out of the program (he was murdered) even though there was significant pressure on youth from their families to leave the training program to find menial jobs. Critical to this level of participant retention was AED's focus on the family. During the year, the project organized bi-monthly family meetings at which over 90 % of the youths' families participated. This was a time for the parents to gain an in depth understanding of the project, express concerns and ask questions. As a result of these meetings, the pressure on students to leave the program stopped. At the final parent meeting mothers and fathers all talked about how much their children had changed and how glad they are that they didn't stop participating.

Over 71% of the project's 49 youth are now employed in jobs with solid career potential and some youth have been promoted. Forty-five of the project's youth (all those who had graduated from high school) accepted the free scholarships to attend the best two-year technical college in the North East of Brazil. The Dean of this college reported that the project's youth were selected for these scholarships because of the skills they had learned through the training project. College faculty report that the project's youth are some of the best students that they have ever taught. This level of success is testament to the

comprehensive transformation that these disadvantaged youth have undergoing because of their participation in Programa Para o Futuro.

Intel Computer Clubhouses

Intel Computer Clubhouse Network is another model from Intel that specifically targets youth in underserved communities. The project uses technology to help youth acquire tools, and skills they can use in the workforce.

According to Intel, the philosophy of the program is "beyond access." Community-based organizations that are selected to host a Computer Clubhouse are provided with assistance and resources to set up a technology centre, and get extensive training on how to operate an effective technology-based learning program. Staff is trained to involve youth in projects such as creating computer-generated art, music and video, developing scientific formulations, designing animations, building kinetic sculptures and robots, developing web pages, and programming computer games."

Lastly, Intel explains that the computer clubhouse program enables youth to develop technical fluency that can be used for a variety of jobs and industries. As a part of the program, Intel works with sponsors and corporations to provide mentors and internships for Clubhouse members. With experience working on high-end software and hardware, members are encouraged to apply these skills in their careers. See also: http://www.intel.com.

SchoolNet Namibia

SchoolNet Namibia has become a world-wide success story for their methods of delivering ICTs in rural Namibia. Along with delivering technology solutions to schools, another key objective for the organisation is ICT technical skills development for out-of-school youth. SchoolNet Namibia recruits hundreds of unskilled volunteers from the informal settlements and provides training in help desk management, computer refurbishment, networking, and connectivity. To date, over 500 volunteers have been training; private sector partners have then recruited a large number of these volunteers. Others have gone onto tertiary education programmes.

E-Rate

The E-Rate is a federally-managed program that provides significant discounts on telecommunications technologies to schools and libraries in the United States. Discounts range from 20 percent to 90 percent and are based on the percentage of students participating in the federal school lunch program who are served by the school or library. The E-Rate is administered by the Universal Service Administrative Company (USAC), a private, not-for-profit corporation that is responsible for ensuring universal service to telecommunications services throughout the country. USAC's Schools and Libraries Division (SLD) is specifically responsible for providing telecommunications discounts to America's schools and libraries.

The E-Rate is funded by money from the Universal Service Fund (USF), which was created in 1993 to ensure that all Americans could afford telephone services. With the passage of the Telecommunications Act of 1996 and the Federal Communications Commission's subsequent implementation of the E-Rate, the fund was expanded in 1997 to support telecommunications services at schools and libraries. Local and long-distance telephone companies are required to contribute to the fund.

Services covered by the E-Rate include Internet access, videoconferencing services, high speed data connections, phone service and certain types of internal wiring and network equipment. Computer hardware, electrical upgrades and many other services are not covered by the program.

Schools can apply for E-Rate funding individually or in groups (such as districts or state wide consortia). The application process includes several steps:

- Prepare and submit a technology plan that meets specific SLD criteria, including a clear technical and educational strategy for implementation telecommunications services.
- Submit Form 470, describing the specific services being sought.

- Collect bids from local vendors for these services and select vendors during a mandatory 28-day competitive bidding period.
- Submit Form 471, notifying the SLD of the contracted vendors and the specific costs involved.
- Receive notification from the SLD of those services that have been approved for discounts.
- Begin implementing services. Once services are completed, discounts are disbursed directly to vendors. These discounts appear on the bills submitted to the school or library.

The E-Rate has thus far been structured as a series of funding-year cycles, with each cycle offering an application window ranging from 75 to 90 days during which institutions can submit Form 470 and begin the application process. Funding decisions are then made in waves, beginning with those institutions receiving the highest discounts and with the most basic services (such as telephone service and Internet access). Waves of funding continue to be made until all requests are met or until the budget is depleted. See also: http://www.benton.org/e-rate.

Potential impact of solar electricity

A strategy by the Ministry to support primary schools without mains electricity in acquiring solar panels could be worth exploring as the means to open a range of technologies to rural schools – technologies which in some cases, such as the radio receivers, are already in place and ready for use. Solar is a source that has already proved itself. Beyond the initial investment, there are no running costs, and while a modest budget is needed for occasional maintenance of panels and accessories, the cost should be relatively small. Solar is also clean, by contrast to used batteries which are unsightly and an environmental hazard, and in many areas sunshine is in unlimited supply for much of the year.

While cost-effective over longer periods, the main issue with solar is the initial cost, and some creative thinking is needed in terms of how to deal with this. Interestingly one primary school visited as part of the Suba District case study used part of its vote for Electricity, Water and Conservancy towards the installation of a solar panel.

It is recommended that these observations on sources of electrical power and the implications for access to available technologies, as well as the forthcoming findings from the KIE/WorldSpace study, are considered in the context of longer term strategies for primary school empowerment

Other Best Practice Resources

Commonwealth of Learning: http://www.col.org
Based in Canada, the Commonwealth of Learning is an inter-governmental organization formed by the Governments of the Commonwealth. The organization is a major participant in the field of ICT and education, and there are numerous resources available on their site.

One World: http://www.oneworld.net
A portal for news and resources on ICT and education in the developing world, this site is has a useful search engine.

UNESCO Asia and Pacific Regional Bureau for Education:
http://www.unesco.org/bangkok/education/ict/
A primary resource for those interested in ICT and Education in Asia, this site has excellent links, resources, and an up-to-date project database.

InfoDev: http://www.infodev.org
A program of the World Bank, InfoDev has quite a lot of quality information on e-learning, distance education, and also commissions' reports on these topics.

Techknowlogia: http://www.techknowlogia.org

THE resource on education and technology as developed by a leader in the field.

Development Gateway
http://www.developmentgateway.org
Project documents and articles on education and technology projects from around the world. Some excellent analysis is provided, and new information is continually added.

Policies for Integrating Information and Communication Technology into Education: High Level Seminar and Work Shop for Decision-Makers and Policy-Makers from Asia and the Pacific. UNESCO Institute for Information Technologies in Education. 2003
http://policy-seminar-bkk.iite.ru
This seminar and Work Shop was attended by Ministries from 10 countries in Asia, and was hosted by UNESCO in Bangkok.

Information and Communication Technologies in Teacher Education: A Curriculum for Schools and Program for Teacher Development Paris: UNESCO. 2003
http://www.unesco.org/education/just_published_en/index.shtml
UNESCO proposes a framework for ICTs in teacher education, describes the essential conditions that must be met for successful technology integration and provides guidelines for the development of a strategic planning process. This publication also identifies important strategies for managing the change process for teacher education.

Jayaweera, Wijayananda. Access in Rural Areas: Some Lessons. Bangkok: UNESCO. 2001.
http://www.aptsec.org/seminar/meeting-2001/ecs2001/EC-09-UNESCO.doc
UNESCO's Regional Communications Advisor for Asia developed a short brief addressing some of the policy and government issues that prevent the implementation of rural access programs. A few interesting case studies are highlighted.

Milne, Claire. Improving IP Connectivity in Developing Countries. Geneva: ITU. April 2002.
http://www.itu.int/osg/spu/ni/ipdc/workshop/Chair_report.pdf
This report from the ITU outlines some of the issues involved in further expanding IP connectivity in developing countries, and making access more cost effective. The report was a result of a workshop under the ITU New Initiatives project.

Haddad, Wahib and Alexandra Draxler, Editors. Technologies for Education: Potential, Parameters, and Prospects. UNESCO and AED. 2003
http://www.aed.org/publications/TechnologiesForEducation/TechEdBook.pdf
Co-published by AED and UNESCO, this report explores how information communications technologies can promote improvements in educational reach and delivery, content, learning outcomes, teaching, quality, and pertinence in developing countries.

Potashnick, Michael, and Joanne Capper. Distance Education: Growth and Diversity. Washington DC: World Bank. 1998
http://www.worldbank.org/fandd/english/0398/articles/0110398.htm
Distance education is becoming increasingly popular as economic forces encourage, and new technologies facilitate, its spread. What advantages does it offer, and what should course providers consider before embarking on new ventures?

Networking for Innovation in Technology and Teacher Training. Washington DC: World Bank.
http://www.infodev.org/projects/education/248teacher/index.htm
Documents from a World Bank Info Dev project provide case studies on experiences in establishing an international network of countries engaged in innovative approaches to training teachers with the use of

technology, and/or are training teachers to use computers and the Internet as tools enhance student learning.

Regional Distance Learning Network for Information Technology Washington DC: World Bank.
http://www.infodev.org/projects/education/025ritsec/index.htm
Documents from a World Bank Info Dev project looks at effectiveness of distance learning, and on-line education programs in the Arab Region and outlines some issues that can determine or prevent successful learning, and sustainability.

Global Information and Communication Technology Report 2002-2003. Insead, World Economic Forum and the World Bank. 2002.
http://www.weforum.org/site/homepublic.nsf/Content/Global+Competitiveness+Programme%5CReports%5CGlobal+Information+Technology+Report+2002-2003+-+Readiness+for+the+Networked+World
This is the most comprehensive assessment of "networked readiness" – how prepared an economy is to capture the benefits of technology to promote economic growth and productivity. As the world experiences an economic slowdown, the Report highlights that the use and application of information and communication technologies (ICT) remain among the most powerful engines of growth. This year's Report benchmarks the performance and monitors progress in networked readiness of 82 countries.

Ten Steps for establishing a Sustainable Multipurpose Community Tele-centre Paris: UNESCO.
http://www.unescobkk.org/ips/ebooks/documents/tensteps/index.htm
Ten Steps for establishing a sustainable Multipurpose Community Telecentre (MCT) is intended to assist communities to walk through the basic requirements which need to be addressed when setting out to open and operate a successful MCT. It is a generic process only.

Rumble, Greville. Analysing Costs and Benefits for Distance Education Programs. Canada: Commonwealth of Learning Knowledge Series. 2001
http://www.col.org/Knowledge/pdf/ks_costs.pdf
Distance education systems are generally thought to be more cost-efficient than traditional face-to-face education. This report explores this understanding with some developing world cases.

Mann, Dale, Charol Shakeshaft, Jonathon Becker, and Robert Kottkamp. West Virginia Story. Milken Exchange. 1999
http://www.mff.org/edtech/projects.taf?_function=detail&Content_uid1=151
The findings suggest that West Virginia's Basic Skills/Computer Education program has had a positive impact on learning. West Virginia has had across-the-board increases in state-wide assessment scores in all basic skills areas, and their NAEP (National Assessment of Educational Progress) scores have gone up. This is the first study of a long-term technology education program.

Telecenters: How did we lose the plot? Washington DC: Development Gateway Organization. 2002
http://www.developmentgateway.org/node/133831/sdm/docview?docid=440944
"Telecentres are a 19th century industrial response to a social and communications problem." This article from the Development Gateway highlights the issues behind telecenter projects being less successful than they could have been. Invaluable evidence is provided here for future project planners, as specific problems and mistakes are identified, along with case studies of what went wrong and how. Finally, links to best practice models are included for a thorough picture of the workings of a successful and sustainable telecenter.

Community Telecenters: Assuring Impact and Sustainability. Washington DC: World Bank.
http://www.developmentgateway.org/ict/telecenters
This highlight section from the Development Gateway website focuses on community telecentres, in particular, on their sustainability and effectiveness. An interview with Motoo Kusakabe is provided here, and several research papers and articles discussing case studies that may serve as examples of best

practice, both in development impact and in financial sustainability. Finally, a number of links provide access to the myriad of resources on community telecentres available on the Internet, making this, in all, an invaluable resource for all those involved in the planning and running of telecentres.

Bridges.Org Toolkit for NGO Application of ICT
http://www.bridges.org/toolkit/index.html
Bridges.org is an international non-profit organization with a mission to help people in developing countries use information and communications technology (ICT) to improve their lives. The free IT guide offers information on a wealth of free resources for individuals, NGOs and businesses to use computers and the Internet.

Appendix C: Web Resources

e-Content Adaptation

TEEM
http://www.teem.org.uk/
TEEM provides teachers with free access to independent, classroom-based evaluations of educational Digital Resources. Because TEEM-trained classroom teachers write these evaluations, readers can be sure that they are receiving impartial, thorough and reliable advice. Materials are used in the classroom, before evaluations are written using clear frameworks. Once edited, the results are published on the TEEM website, where there are currently 730 titles. The web site is searchable by subject, topic, product, publisher, and curriculum focus.

Eisenhower National Clearinghouse (ENC)
http://www.enc.org/
ENC specializes in identifying and disseminating high-quality mathematics and science material to improve K-12 education. The ENC collection of math and science curriculum resources is the most comprehensive in the U.S.A., containing over 18,000 resources collected from federal and state agencies, professional organizations, commercial publishers, local school districts and individuals. This collection includes software, videotapes, CD-ROMs, useful Internet sites and print material. ENC constantly receives submitted material from different sources. ENC staff carefully scan vendor catalogues, search various web sites, hold discussions with educators and staff working in professional organizations, read different journal and magazine reviews, and take into account suggestions coming from publishers and users on an ongoing basis. Staffs watch videotapes, load and use software material, and make an effort to track and include any available evaluative information that can provide users with links to that information. This type of information is usually found next to the products' catalogue records. Not all records will contain evaluation information.

California Learning Resource Network (CLRN)
http://www.clrn.org/search/
CLRN has a database that includes a wide range of contentware (video, CD, DVD, software, Internet) covering many subjects. Existing resources are reviewed by trained experts against a set of standards and criteria and those deemed acceptable are included in the database. CLRN has an elaborate mechanism that allows search for contentware by subject, Grade level, media type, instructional setting, language, and instructional mode (e.g., tutorial, simulation, demonstration, problem-solving, skill building, etc.)

Best Practice in Education Portals
The Commonwealth of Learning and SchoolNet Africa
http://www.col.org/Consultancies/02EducationPortals.htm
This report reviews a range of existing education portals on the Internet on the basis of an elaborate set of criteria. Detailed summaries of these reviews are provided, in addition to a tool for evaluating online education software.

The Educational Software Selector (EPIE Institute)
http://www.epie.org/epie_tess.htm
This instrument has a searchable database that includes reviews of 19,000 instructional software packages. Each review provides a general description of what the software does, indicates what knowledge and skills are to be developed, and references other published reviews of the software. The software packages can be searched by computer type, subject, grade level (pre-school through college), the teaching/learning approach used, key words, and price. ***Available on CD-ROM with quarterly updates and on a*** Web ***site that can only be accessed by subscribers.***

American Library Association's Notable Children's Websites
http://www.ala.org/alsc/ncwc.html
This is a portal to high quality educational websites for children. Items are evaluated and authorized by committee. The portal is searchable by key word and Learner's level (pre-school, elementary, Middle school).

Children's Software Revue (CSR)
http://www.childrenssoftware.com
This website has more than 6,000 reviews of contentware, titles and is updated continually. That can be searched and accessed via the Children's Software Finder™ database, which is available for CSR subscribers only.

DirFile: Home of FREEWARE Software
http://www.dirfile.com/education.htm
The database covers subjects such as, Language, Literature, Mathematics, Music, Science, and Teaching Tools.

Curriculum Online (UK)
http://www.curriculumonline.gov.uk/
The site includes multimedia commercial and free software in a searchable database. It can be searched by curriculum subject, grade level, key word, cost (priced or free.)

The Gateway to Educational Materials
http://www.thegateway.org/
The Gateway to Educational MaterialsSM is a searchable database that contains detailed descriptions of over 40,000 educational resources found on various federal, state, university, non-profit, and commercial Internet sites. Many of these items are free.

Education Network (EdNA) - Australia
http://www.edna.edu.au/
EdNA Online provides a searchable database of web-based resources useful for teaching and learning.

Free Software on CD
http://tinyurl.com/x2ti
This site offers a limited range of free contentware on CDs. The client has to pay for shipping and handling only.

Teaching Resources

These web sites usually include lesson plans for different subjects and levels, teaching tips, learning activities, references to content-ware and links to other sites.

Examples of teaching resources can be found in the following web sites:

PBS Teacher Source
http://www.pbs.org/teachersource
The site offers more than 3,000 lesson plans and activities on arts and literature, health and fitness, social studies, mathematics, science, technology and early childhood, in addition to a guide for educational television programs.

Carol Gossett's Kindergarten Connection
http://www.kconnect.com
This site offers lesson plans, book reviews, tips and links to other resources.

700+ Great Sites

http://www.ala.org/parentspage/greatsites/amazing.html
This site has a list of "amazing, spectacular, mysterious, colourful web sites for kids and the adults who care about them." The site has links to a variety of resources for teachers in general in topics such as arts, science, literature, and history.

BrainPop
http://www.brainpop.com
Brain Pop is an interactive site that includes quizzes, activities, information and a large selection of movies on science and technology. Using cartoon animation, the movies explain in simple words and graphics the process of photosynthesis or fuel formation, or other physics, chemistry and biology topics, including health education. The site also has a selection of movies about technology, such as how radio works, what is the binary system, and others.

Maths Year 2000
http://www.mathsyear2000.org
This site is pleasant for the eyes and rich in information related to mathematics. It includes games and activities at different levels of complexity, history, book reviews, tests, a database that can be used for classroom practice, and links to other math-related sites.

TESL: Lessons
http://www.uottawa.ca/~weinberg/french.html
These sites link to lesson plans, exercises, and other resources for teaching languages to non-native speakers.

Discovery Channel School
http://school.discovery.com/
Provides lesson plans, ideas for learning games, Web links, and e-mail discussions.

Simulations

These sites may be used by teachers and students to supplement the curriculum and enhance the teaching/learning process. They may also be used as building blocks in created multimedia modules that cover curricular units.

The web is full of simulations that cover different elements of science and mathematics. Below is a list of web sites that offer such simulations:

http://www.public.iastate.edu/~abc/java/lessons.html
http://www.phy.ntnu.edu.tw/java/indexPopup.html
http://www.ericharshbarger.org/java/
http://lectureonline.cl.msu.edu/~mmp/applist/applets.htm
http://webphysics.davidson.edu/Applets/Applets.html
http://www.mste.uiuc.edu/java/default.php
http://www.walter-fendt.de/ph14e/index.html
http://www.sciencesshareware.com/
http://www.exploratorium.edu/climate/index.html
http://www.explorelearning.com/
http://www.myphysicslab.com/

Exploration

The web offers unique opportunities to explore scientific phenomena, inspect volcano sites, dive into the oceans, go on nature expeditions, and joint scientists in field trips. This feature of the web expands the horizons of the learner and brings the world into the educational institution. Instances of explorations

offered by the Internet may be integrated into the teaching/learning process and/or used for individual or group research.

The web offers many opportunities for exploration. Below are some examples:

MadSci Network
http://www.madsci.org/
Based at the Washington University Medical School, USA, the site includes a network of actual scientists that answer questions posed by students. The questions and answers can be accessed through a search engine. The site also has descriptions of experiments (not online) that teachers and students can replicate, and links to virtual museums, libraries and sites related to science.

The Virtual Blackboard
http://www.virtualblackboard.com/
The site provides (for free) virtual web tours for K-12 students on different subjects including history and social studies, mathematics, science, technology, language, music and fine arts. It also offers tutorials on how to create individual virtual tours (teachers can download the software for free to test, but individual licenses are sold in the U.S. for US$25).

Science Learning Network
http://www.sln.org
A consortium of twelve science museums around the globe is producing high quality inquiry-based k-6 science learning modules that are made available through this site. The topics tend to be related to current events or otherwise of interest to students. Some of the modules can only be used interactively on the Web, but others can be used in classrooms.

Amazing Travel Bureau (National Geographic Society)
http://www.nationalgeographic.com/crittercam/index.html
The site provides expeditions for exploration of nature.

MaMaMedia.com
http://www.mamamedia.com/areas/romp/home.html?src=sdwr
The site allows for exploration of different countries of the world.

Interactive Mars Habitat
http://www.exploremarsnow.org/
This web site shows how it might be feasible for a manned expedition to live on Mars.

Museums and Exhibitions

The web offers valuable opportunities to visit world renowned museums and exhibitions. These virtual visits can be used for individual/group research or for supplementing the curriculum. The web offers many opportunities for tours of museums and exhibits. Below are some examples:

Nobel e-Museum
http://www.nobel.se
The Nobel e-Museum is an online hall of science and culture. The site "has a unique way of introducing the Nobel Prizes that goes beyond the mere presentation of facts. These introductions, aptly called "Educational", are made in the form of games, experiments, and simulated environments ready to be explored and discovered. The productions are aimed at the young, particularly the 14-18 age groups, who may know about the Nobel Prizes and the Prize winners but often lack a deeper understanding about the prize awarded works."

Virtual Libraries Museum Pages
http://www.icom.org/vlmp

This site provides links to many of the world's art museums having parts of their collection on the Web.

World Art Treasures
http://www.bergerfoundation.ch/
This site provides an extensive collection of photos of great art in the Middle East, Asia, and Europe.

Virtual Tours
http://www.virtualfreesites.com/museums.html
This site links to other sites that "present over 300 Museums, Exhibits, Points of Special Interest and Real-Time journeys which offer online multimedia guided tours on the Web."

The Louvre Museum
http://www.louvre.fr/louvrea.htm
The site traces the history of the Louvre, presents a selection of the works of art from each of the seven departments of the museum, and offers a virtual tour of about 50 rooms of the museum.

Educational Games and Activities

The web offers a vast amount of educational games – many of them animated and simulated - puzzles and individual activities. They may be used to motivate students as a new concept is introduced or to apply what has already been learned.

Below is a sample of web sites that provide educational games and activities:

Chateau Meddybemps
http://www.meddybemps.com
This site contains games, stories, book reviews and guidelines for parents and teachers of young children, particularly children from pre-school to Grade 3.

FunBrain.com
http://www.funbrain.com/kidscentre.html
This site, from the Learning Network, includes educational games for children of different ages, as well as information for parents and teachers. The quiz lab gives teachers access to quizzes on math, language, history and other subjects and allows them to create their own quizzes. The basic lab is free but access to the advanced lab requires an annual fee.

Words and Pictures (Phonics)
http://www.bbc.co.uk/education/wordsandpictures/
"A fun packed site for 5-7 year olds with poems, games and activities to help with reading and writing."

Alfy: The Kids' Portal Playground
http://www.alfy.com
The site is for early elementary children and includes java-based games and other resources (Macromedia Shockwave Player required - a free download)

Quia: Where Learning Takes You
http://www.quia.com/
Most activities in this site are geared to children in upper elementary school years and above (for instance, in mathematics, activities range from two-digit addition to algebraic equations). Some of the resources are accessible only to subscribers.

Jeux Pour Enfants
http://www.jeuxpourenfants.org/
This site has interactive games for children from pre-school to age 10. The games are divided by age group and include puzzles, colouring, and others.

Reference Materials

The web acts as a reference library for teachers and students. It includes a wide range of books, articles, and reference documents, such as dictionaries and encyclopaedias. The web reference materials have at least two advantages over hard copies:

- There are usually hyperlinks that take the reader in one click to a related text within the document or to another document.
- The web is searchable with very high speed.

Below are two "library" web sites:

The Internet Public Library
http://www.ipl.org/
This site serves as an index of links to Books, Magazines and Newspapers, dictionaries, encyclopaedias and other reference materials. All are available on the Internet.

On-Line Books Page
http://digital.library.upenn.edu/books/
The Online Books Page is a website that facilitates access to tens of thousand of books that are freely readable over the Internet.

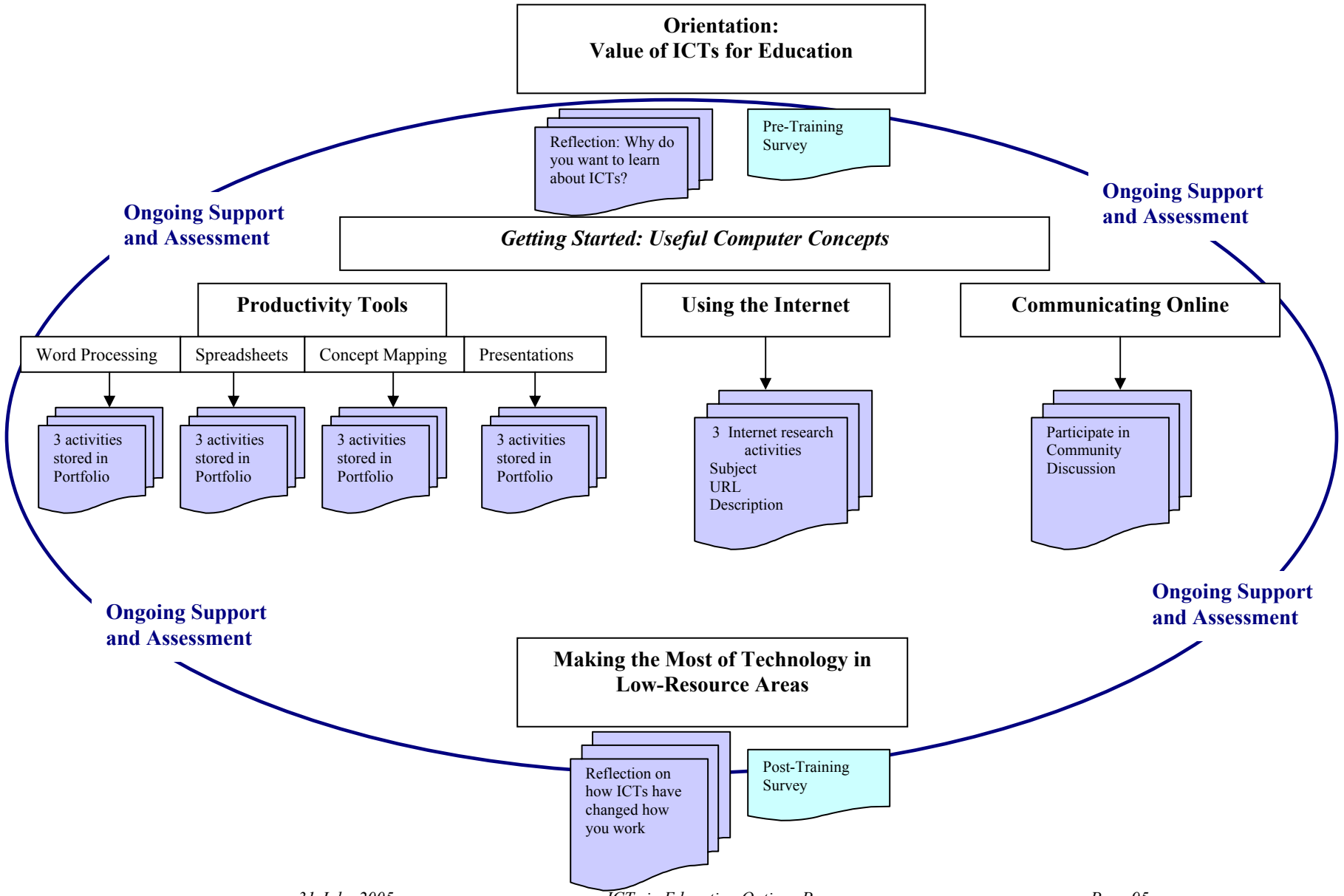
Appendix D: Content Evaluation Form

Content-ware Title:				
Rating of Statements	Not Applicable N/A	False 0	Partially True 1	True 2
1. Content Suitability				
Content is in line with curriculum				
Content is in line with content of corresponding item(s) from "Database of Required Contentware"				
Content is logically structured				
Content is well presented				
Content is appropriate for targeted learner's level				
Content is accurate				
Content is clear				
2. Suitability for Instructional Usage				
Suitable for the ICT-fostered learning objectives				
Suitable for the ICT-fostered teaching objectives				
Suitable for usage modality				
3. Context Suitability				
Product is free of cultural, racial or gender bias				
Materials (such as animations, photos, etc.) are culturally acceptable				
The language is sensitive to gender and culture				
4. Pedagogical Suitability				
Feedback is offered where needed				
New concepts and terms are explained clearly				
Learning activities are varied in interactivity				
Learning activities are diverse in difficulty				
Sequence of topics and activities is easy to follow				
5. Suitability of Technology				
The technology used is most suitable for presenting content of Curriculum unit				
Appropriate media (sound, video, animation, etc,) are used for the different concepts or activities				
Multiple approaches and activities are presented to accommodate diverse learners				
6. Functionality				
The product runs without problems				
The quality of the output is acceptable				
Multimedia complements textbooks and manuals				
Blueprint is clearly included to help learners get an overview of the content				
Media (e.g. videos, animations, simulations, etc.) are clear and run well				
Media elements are well integrated and appropriately placed				

The product is attractive and interesting				
7. User-friendliness				
Operating instructions are easy to follow				
Operating instructions are appropriate for the user				
Facilitators can learn to use the content effectively and independently within a short period of time				
End-users can learn to use the content effectively and independently within a short period of time				
There is a HELP function				
8. Browser-based Usability (when applicable)				
Navigation is easy, intuitive, and user-centred				
There is a sitemap that links all the components				
The is a functional search facility				
Icons, navigational commands, and other prompts are easy to use				
The site loads quickly				
Graphic size is acceptable and does not take long to download				
Screens are attractive and easy to read				
Overall Assessment				
O Suitable for adoption O Suitable for adaptation O Useful as background resource during process of developing new similar content				

Appendix E: ICT Foundations Model

ICT for Educators Training Framework for Technology Champions



ICT for Educators Training Framework

Orientation: Value of ICT for Education

This is the introductory session and should be very participatory. The objective is to have the participants start thinking about the following questions:

- What are your preconceived ideas about computers and technology?
- Why is ICT important or valuable to you?
- Do ICTs fit in your educational context?
- Why do you want to learn computer skills?
- What are some ways we might use this new technology in cluster schools?

Getting Started: Useful Computer Concepts

This session can be combined with the Orientation. It is a "hands-on" or applied introduction to computers, the Internet and the computer labs. It is not lecture-based. Participants are applying what they learn during the session. The objective is to provide the participants with the language to talk about computers and to dispel any myths about safety. All participants receive a booklet with screenshots and pictures. Not a lot of time should be spent talking about difficult computer science concepts, hardware, etc., but participants should feel more comfortable around computers and know the lab rules.

Productivity Tools: Computer technology applications that make doing your work easier and faster

These sessions are practical. Provide participants with scenarios of real-life educators from Kenya using the applications to get their work done. Brainstorm with participants about what they need to do and how the applications will help them. STRESS: Computers make your work much easier because you don't have to re-write everything each time you use it.

- Word processing – e.g., lesson plans, letters, consent forms
- Spreadsheets – e.g., calculate student averages, attendance records, etc.
- Presentations – e.g., create slides for overhead projector or transparencies
- Concept Mapping – e.g., visual aids, science charts, word maps, etc.

Using the Internet

This session is all about exploring the Internet for good resources. The Internet opens up a world of new resources, gives you access to information from anywhere at anytime. Instructor should prepare a list of URLs that will be useful for Kenya educators and teach them how to use search engines.

Communicating Online:

This session can be combined with "Using the Internet." Participants will get new email accounts, and enrol into online discussions.

- Email, Listservs
- Chat and Discussion Forums

Making the Most of Technology Use in Low Resource Areas

This is the wrap-up session where participants start reflecting how technology can be used when there are no computers in the classrooms. They should fill out the post-training survey at this time.

Use of the Portfolio for Assessment

A digital portfolio is a folder which holds the assignments for each training participant. This shows not only participation, but also active learning and application of skills. During each session in order for the participant to get a certification of completion, they must submit work to their portfolio (noted on the diagram). Trainers should also have a copy of their pre and post-training surveys in the portfolio.

Ongoing Support and Assessment

Provide continuous support via e-mail to the instructors. All instructors should provide a weekly report regarding the training with pictures and any testimonials from participants.

Appendix F: Hypothetical Examples Demonstrating Application of the Total Cost of Ownership Approach (TCO) to Analysis for Comparison of Different Policy Options

In this Appendix, illustrative examples of the use of the spreadsheet for calculating Total Cost Of Ownership (TCO) are computed to demonstrate the power of the tool. The examples presented are: (1) establishing a small-scale, in-school computer centre for the teachers in some Kenyan Schools and operating it for five years, (2) deployment to schools of a single radio and batteries to listen to occasional educational radio broadcasts over five years, and (3) establishing 20-seat computer labs in schools and operating them for five years. These examples are not meant to be accurate estimates of the true cost of undertaking projects like these, but rather are conceptual exercises to help demonstrate the application of the TCO tool in different contexts.

Hypothetical Case 1: Teachers Usage Setup

In this scenario, it is assumed that a school with 2 streams of approximately 700 students and a population of 12 teachers is to be equipped with 4 computers connected to the Internet for the teachers' usage. All the computers are to be placed in the common staff room (existing) for easy access to all. The 5 years cost of ownership gives a good idea of the cost issues which require critical attention. Note the Opex costs vis-à-vis Capex costs.

	5-years TCO US$	Year 1	Year 2	Year 3	Year 4	Year 5
Capital expenses						
Deployment of ICT	**12,433.16**	**12,433.16**	**-**	**-**	**-**	**-**
Access devices (incl. server)	2,840.00	2,840.00	-	-	-	-
Display devices	2,040.00	2,040.00	-	-	-	-
To-school connectivity	3,000.00	3,000.00	-	-	-	-
In-school connectivity	1,300.00	1,300.00	-	-	-	-
Software and applications - License fee	140.00	140.00	-	-	-	-
Peripherals	520.00	520.00	-	-	-	-
Electricity devices	313.16	313.16	-	-	-	-
Infrastructure (-room based)	-	-	-	-	-	-
Furniture	460.00	460.00	-	-	-	-
Room construction	-	-	-	-	-	-
Air-conditioning and curtains/blinds	-	-	-	-	-	-
Electrical system modification	600.00	600.00	-	-	-	-
Security - Renovation and alarm system	1,220.00	1,220.00	-	-	-	-
Content	**2,500.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**
Off-the -shelf materials	2,500.00	500.00	500.00	500.00	500.00	500.00

Technical support - Warranty	**122.00**	**122.00**	**-**	**-**	**-**	**-**
Total Capex	**15,055.16**	**13,055.16**	**500.00**	**500.00**	**500.00**	**500.00**
Operating expenses						
Deployment of ICT	**38,146.94**	**7,611.79**	**7,611.79**	**7,611.79**	**7,611.79**	**7,611.79**
Access devices consumables	-	-	-	-	-	-
Display devices consumables	88.00	-	-	44.00	-	44.00
To-school connection fee	11,368.42	2,273.68	2,273.68	2,273.68	2,273.68	2,273.68
Peripheral devices consumables	12,480.00	2,496.00	2,496.00	2,496.00	2,496.00	2,496.00
Electricity fee	4,736.84	947.37	947.37	947.37	947.37	947.37
Security - security employees	9,473.68	1,894.74	1,894.74	1,894.74	1,894.74	1,894.74
Technical support and maintenance	**1,925.00**	**285.00**	**410.00**	**410.00**	**410.00**	**410.00**
Maintenance fee	650.00	30.00	155.00	155.00	155.00	155.00
Technical support	-	-	-	-	-	-
Insurance	1,275.00	255.00	255.00	255.00	255.00	255.00
User training	**3,136.84**	**707.37**	**607.37**	**607.37**	**607.37**	**607.37**
Initial training	100.00	100.00	-	-	-	-
Ongoing training	1,300.00	260.00	260.00	260.00	260.00	260.00
Student ICT training	1,736.84	347.37	347.37	347.37	347.37	347.37
Total Opex	**43,208.78**	**8,604.16**	**8,629.16**	**8,673.16**	**8,629.16**	**8,673.16**
Grand total	**58,263.94**	**21,659.32**	**9,129.16**	**9,173.16**	**9,129.16**	**9,173.16**

Table 1: Examples of calculation of costs associated with placing 4 PCs for teachers' usage in an average school

Hypothetical Case 2: Radio based ICTs Setup

One radio per school is assumed in this scenario. It is also assumed that where electricity is not available, 6 batteries per month will be sufficient to power the radio during the stipulated learning hours.

	5-years TCO US$	Year 1	Year 2	Year 3	Year 4	Year 5
Capital expenses						
Deployment of ICT	**151.58**	**151.58**	**-**	**-**	**-**	**-**
Access devices (incl. server)	151.58	151.58	-	-	-	-
Display devices	-	-	-	-	-	-
To-school connectivity	-	-	-	-	-	-
In-school connectivity	-	-	-	-	-	-
Software and applications - License fee	-	-	-	-	-	-
Peripherals	-	-	-	-	-	-
Electricity devices	-	-	-	-	-	-
Infrastructure						
Furniture	-	-	-	-	-	-
Room construction	-	-	-	-	-	-
Air-conditioning and curtains/blinds	-	-	-	-	-	-
Electrical system modification	-	-	-	-	-	-
Security - Renovation and alarm system	-	-	-	-	-	-
Content	**2,500.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**
Off-the -shelf materials	2,500.00	500.00	500.00	500.00	500.00	500.00
Technical support – Warranty	**-**	**-**	**-**	**-**	**-**	**-**
Total Capex	**2,651.58**	**651.58**	**500.00**	**500.00**	**500.00**	**500.00**
Operating expenses						
Deployment of ICT	712.00	142.40	142.40	142.40	142.40	142.40
Access devices consumables	-	-	-	-	-	-
Display devices consumables	-	-	-	-	-	-
To-school connection fee	600.00	120.00	120.00	120.00	120.00	120.00
Peripheral devices consumables	-	-	-	-	-	-

Electricity fee	112.00	22.40	22.40	22.40	22.40	22.40
Security - security employees	-	-	-	-	-	-
Technical support and maintenance	25.00	5.00	5.00	5.00	5.00	5.00
Maintenance fee	-	-	-	-	-	-
Technical support	-	-	-	-	-	-
Insurance	25.00	5.00	5.00	5.00	5.00	5.00
User training	3,136.84	707.37	607.37	607.37	607.37	607.37
Initial training	100.00	100.00	-	-	-	-
Ongoing training	1,300.00	260.00	260.00	260.00	260.00	260.00
Student ICT training	1,736.84	347.37	347.37	347.37	347.37	347.37
Total Opex	**3,873.84**	**854.77**	**754.77**	**754.77**	**757.77**	**754.77**
Grand total	**6,525.42**	**1,506.35**	**1,254.77**	**1,254.77**	**1,254.77**	**1,254.77**

Table 2: Examples of calculation of costs associated with the deployment of Radios to an average school

Hypothetical Case 3: 20 Workstation Labs in Schools

Each lab consists of 20 workstations, a printer, and a ser4ver. Internet connectivity delivery to school is assumed to be subsidized for academic institutions.

	5-years TCO US$	Year 1	Year 2	Year 3	Year 4	Year 5
Capital expenses						
Deployment of ICT	**22,883.16**	**22,883.16**	**-**	**-**	**-**	**-**
Access devices (incl. server)	11,140.00	11,140.00	-	-	-	-
Display devices	1,020.00	1,020.00	-	-	-	-
To-school connectivity	3,000.00	3,000.00	-	-	-	-
In-school connectivity	1,300.00	1,300.00	-	-	-	-
Software and applications - License fee	410.00	410.00	-	-	-	-
Peripherals	520.00	520.00	-	-	-	-
Electricity devices	313.16	313.16	-	-	-	-
Infrastructure						

	Furniture	3,360.00	3,360.00	-	-	-	-
	Room construction	-	-	-	-	-	-
	Air-conditioning and curtains/blinds	-	-	-	-	-	-
	Electrical system modification	600.00	600.00	-	-	-	-
	Security - Renovation and alarm system	1,220.00	1,220.00	-	-	-	-
Content		**2,500.00**	**500.00**	**500.00**	**500.00**	**500.00**	**500.00**
	Off-the -shelf materials	2,500.00	500.00	500.00	500.00	500.00	500.00
Technical support - Warranty		**478.00**	**478.00**	**-**	**-**	**-**	**-**
Total Capex		**25,861.16**	**23,861.16**	**500.00**	**500.00**	**500.00**	**500.00**
Operating expenses							
Deployment of ICT		**38,102.95**	**7,612.79**	**7,612.79**	**7,612.79**	**7.612.79**	**7,612.79**
	Access devices consumables	-	-	-	-	-	-
	Display devices consumables	44.00	-	-	22.00	-	22.00
	To-school connection fee	11,368.42	2,273.68	2,273.68	2,273.68	2,273.68	2,273.68
	Peripheral devices consumables	12,480.00	2,496.00	2,496.00	2,496.00	2,496.00	2,496.00
	Electricity fee	4,736.84	947.37	947.37	947.37	947.37	947.37
	Security - security employees	9,473.68	1,894.74	1,894.74	1,894.74	1,894.74	1,894.74
Technical support and maintenance		**5,425.00**	**625.00**	**1,200.00**	**1,200.00**	**1,200.00**	**1,200.00**
	Maintenance fee	2,450.00	30.00	605.00	605.00	605.00	605.00
	Technical support	-	-	-	-	-	-
	Insurance	2,975.00	595.00	595.00	595.00	595.00	595.00
User training		**3,136.84**	**707.37**	**607.37**	**607.37**	**607.37**	**607.37**
	Initial training	100.00	100.00	-	-	-	-
	Ongoing training	1,300.00	260.00	260.00	260.00	260.00	260.00
	Student ICT training	1,736.84	347.37	347.37	347.37	347.37	347.37
Total Opex		**46,664.79**	**8,944.16**	**9,419.16**	**9,441.16**	**9,419.16**	**9,441.16**
Grand total		**72,525.95**	**32,805.32**	**9,919.16**	**9,941.16**	**9,919.16**	**9,941.16**

Table 3: Example of Calculation of hypothetical costs of 20 Workstation Labs in Schools model

Hypothetical Case 4: Example of how to use results for comparison of alternative policy approaches

Table 4 reflects the use of the hypothetical TCO figures for comparing different policy options if taken to scale. Assuming 1,000 institutions and using the figures worked out as above, the following table depicts the Capex and Opex costs associated with the deployment of ICTs using each of the presented models. The purpose of this exercise is NOT to compare realistic estimates of the actual cost of each approach, but to demonstrate how the analytic technique can be used to compare disparate approaches.

Item	Model	Description	No. of units per setup	Capex costs for 1000 schools US$	Opex for 1000 schools US$	Totals US$
1	Teachers usage	A setup of 4 w/s for teachers use, interactive with Internet connectivity	4	15,055,160.00	43,208,780.00	58,263,940.00
2	Radios for schools	Radio deployment in schools	1	2,651,580.00	3,873,840.00	6,525,420.00
3	Computer Labs in schools	20 w/s lab setups with Internet connectivity	21	25,861,160.00	46,664,790.00	72,525,950.00

Table 4: Summary of hypothetical data, used for comparison of programs taken to scale for 1000 schools

Note the big difference in this hypothetical example between the Capital expenditure and the Operational expenditures under the different assumptions, which underscores the necessity for careful consideration of not only the investments costs, but running costs as well. These are as presented in the unit based model costs above.