



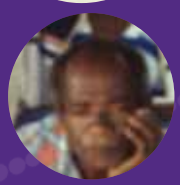


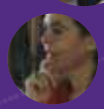

ICTs for Higher Education

COMMONWEALTH of LEARNING

United Nations
Educational, Scientific and
Cultural Organization

World
Conference on
Higher Education 2009

ICTs for Higher Education

Background paper from the Commonwealth *of* Learning

UNESCO World Conference on Higher Education
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Foreword

It is a pleasure to present this short text on Information and Communication Technologies (ICTs) in Higher Education as one of the background papers for the 2009 World Conference on Higher Education (WCHE) which has the overarching theme *The New Dynamics of Higher Education and Research for Societal Change and Development.*

Since the World Conference in 1998, the transformation of the global landscape of higher education has been even greater than was forecast at that event. In no area is this truer than in the use of ICTs. The 1998 Conference was held just before the period which transformed the web into a thoroughly interactive technology with major implications for the core functions of higher education.

We are grateful to UNESCO's partner, the Commonwealth of Learning, whose mission focuses on technology-mediated learning, for preparing this summary of the impact of ICTs in the three traditional components of the mission of higher education institutions: research, community service and teaching. The paper also describes how the use of ICTs has facilitated access to higher education by making possible the administration of larger and more complex institutions.

The paper takes a global perspective but focuses particularly on the implications of ICTs for developing countries. It is addressed particularly to policy makers and institutional leaders but will be of interest to all those attending the WCHE.

WCHE 2009 Executive Secretariat
Georges Haddad, Director
Division of Higher Education, UNESCO

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Introduction

This paper is intended primarily for an audience of newly appointed ministers, officials and institutional heads in higher education in developing countries. It examines the roles that information and communications technologies (ICTs) can play in strengthening the three traditional strands that make up the mission of higher education institutions (HEIs): research, service to the community, and teaching.

We begin by emphasising the need for institutional and national policies to support the use of ICTs in research. We then look in some detail at the role ICTs can play in reinforcing the development role of higher education institutions (HEIs) in their communities - an aspect of higher education's mission that is often neglected.

Given the steadily expanding demand for higher education in developing countries, we examine the role of ICTs in improving quality, widening access and cutting costs in the teaching function. The paper highlights, with examples, current trends in the use of ICTs and the new dynamics that they are creating in higher education. ICTs are a driver of change but, without good policy and careful planning, can have unintended consequences.

After a brief review of the essential elements of ICTs (hardware, software, connectivity, the Internet) the review is structured around their applications in the four key operational functions of HEIs, namely research, community engagement, teaching, and administration. For each function we review the role of ICTs in terms of: 1) the possible benefits; 2) the likely challenges; 3) the policies required; 4) implementation strategies.

We do not make generalisations about costs because the key issue is usually the local opportunity cost, not the cost of the technology. There will be many occasions when choices have to be made between investing in ICTs and spending the money in more conventional ways. These trade-offs are not at all the same in rich and poor countries because relative costs are very different. Since ICTs operate in a global market costs are similar around the world - although communications costs (e.g. broadband connections) are often higher in developing countries - even in absolute terms. The costs of face-to-face teaching and administrative staff, however, vary greatly between countries.

ICTs: The Basics and the Trends

Summary

In this section we explain the basics of ICTs. The key trend is a steady decrease in the unit cost of computing power. This makes it useful to distinguish three types of user hardware: 1) powerful personal computers (PCs and Macs); 2) netbooks costing <$500; and 3) new generation cell phones. Netbooks, in particular, take advantage of the trend toward cloud services, whereby software is accessed through the Internet as needed rather than stored in the user's device.

Software falls into two categories: proprietary software which does not allow users to access the basic operating code and modify it; and open source software which permits users with coding skills to make modifications. We outline criteria for choosing between open and proprietary software.

The power of information technology is greatly enhanced by communication technology. This means that connectivity (through wireless, cell phone technology or over cables) is the crucial feature that allows access to the Internet and the World Wide Web. These common platforms have stimulated an explosion of social software and cloud services that have made the Internet a highly interactive medium and created new dynamics in computer use. As computing power and communications have improved, mobile devices play an increasingly important role, notably in the developing world.

More speed with lower costs

Computing power continues to increase in speed while costs are being driven down, thus allowing computer users to run more complex programs and graphic-rich applications. These improvements, coupled with the expansion of broadband Internet

connections, are providing for richer entertainment and learning environments, including virtual worlds and an increasing use of Internet telephony and video conferencing. Connectivity that only a few years ago regularly used dial-up connections over hard-wired telephone lines has been rapidly moving over to coaxial cable connections in industrialised countries and to 3G connections via cellular networks in both industrialised and developing countries.

The One-Laptop-Per-Child project, originated by the Massachusetts Institute of Technology with the aim of creating a $100 laptop, stimulated an entirely new market segment that computer manufacturers had not seemed to anticipate. Before this stimulus they preferred to keep the price constant and add more power. Now we see that millions of users are willing to give up processing speed and graphics capacity in the interests of enjoying the benefits of a low-cost, lightweight machine. While these machines gained an initial market share using specialised Linux (open source) installations, they started to "fly off the shelves" once new models were sold with the Windows XP operating system preinstalled.

The constant expansion of the availability of computers and access to the Internet has been driving the availability of cloud computing. Cloud computing, or the provision of services online to computer users, includes services such as folders for data and a host of programs that exist on the Internet that can used by users from any internet-connected computer.

Mobile technology and digital natives

Until recently those wanting to harness ICTs for development have focused on getting personal computers into the hands of learners around the world. However, the cellular phone networks report that nearly half the world's population now either owns a cell phone or has access to one. A growing number of HEIs are experimenting with how to capitalise on this technology, especially in developing countries (e.g. University of Pretoria). Meanwhile, students are using mobile technology liberally for personal purposes (often during lectures!), while their instructors have little idea of how the technology could be applied to improve teaching and learning.

Today's students (digital natives) have a different way of approaching and using technologies like cell phones and computers that their teachers (digital immigrants) still need to come to terms with. Educators need to gain an understanding of the virtual worlds that their learners move in so that they can better understand how to interact with them in ways that make sense to digital natives.

Computing in the clouds

Cloud services have only just started to become truly useful and show potential for freeing users from having to own their own computer. With cloud computing, users are able to save a document on a computer in a computer lab, edit it from their Internet-enabled cell phone, format it on their home computer and publish it to the Internet for public viewing or sharing with their class.

Hand held devices have advanced the potential for making computing truly portable by inventing improved touch-sensitive screens that help to predict what the user is typing on the small screens, communicate wirelessly with the Internet, transmit data wirelessly to printers and other people devices. Synchronising via the cloud and directly with other devices and computers now makes these devices effectively a form of "connective tissue" between computers where they are available.

Often called social networking, this technology has allowed people to meet, interact and share ideas and interests with one another. These applications have become popular and have already found their way into informal learning settings. Now there is considerable interest in the use of social networking in formal education, especially in open and distance learning.

A study on the effective use of social software in further and higher education in the UK to support student learning and engagement has shown that there is growing interest in social dimensions of learning (Minocha, 2009). This has led institutions to adopt virtual learning environments (VLEs), which incorporate collaboration and communication tools such as wikis, blogs, forums and chat. More recently, publicly available web-based social networking tools such as Facebook, GoogleDocs, Delicious, and Flickr have also been adopted in teaching and learning.

During its development since 2004 The Virtual University for the Small States of the Commonwealth has been developing course materials using a combination of face-to-face and cloud computing approaches. This allows these small states to engage with each other despite the vast distances between them.

Open source or proprietary: What counts is what's most cost-effective!

There has been intense competition in some HEIs between Free Open Source Software (FOSS) and proprietary software. Strong interest groups on each side present this as an all-or-nothing choice, but the sensible approach is to use what is

appropriate when it is appropriate. Free software is not free to run (free is used as in 'free speech' rather than 'free beer') and proprietary software may be suitable, but too expensive to buy. A total cost of ownership calculation, including the cost of servers, programming and IT support staff time, needs done when comparing the suitability of software. The ability to integrate data usage between multiple computer programmes without having to re-write the programming is important. Sometimes, proprietary packages that have integration in their design might be most appropriate. The stability of having a programme that works reliably may be paramount while the ability to have programmers rewrite the core program code might be most appropriate in other situations.

ICTs in Research

Summary

Applications of ICTs are particularly powerful and uncontroversial in higher education's research function. Four areas are particularly important. First, the steady increases in bandwidth and computing power available have made it possible to conduct complex calculations on large data sets. Second, communication links make it possible for research teams to be spread across the world instead of concentrated in a single institution. Third, the combination of communications and digital libraries is equalising access to academic resources, greatly enriching research possibilities for smaller institutions and those outside the big cities. Fourth, taking full advantage of these trends to create new dynamics in research requires national policies for ICTs in higher education and the establishment of joint information systems linking all higher education institutions. For these applications high bandwidth is the key priority since it allows computing power to be aggregated by linking equipment together.

Promoting better quality research

The application of ICTs in academic research has grown steadily in the past 10 to 15 years in both developing and developed countries, although there are wide variations in usage both within and between countries and regions. These variations reflect the vision and commitment of the leadership of HEIs to deploying ICTs in research; the funds and people available to sustain investments in ICT infrastructure and support systems; and the existence of helpful national and institutional ICT policies.

Data processing

The most straightforward use of ICTs in research is in data processing. The unprecedented growth in bandwidth and computing power provide opportunities for analyzing/processing huge amounts of data and performing complex computations on them in a manner that is extremely fast, accurate and reliable. Computer data processing not only frees researchers from the cumbersome task of manually analyzing data but more importantly facilitates quick and accurate analysis of huge amounts of data from national samples or even multi-national samples covering tens of thousands of respondents.

Analysis and projections of climate change using vast amounts of weather data that would have been impossible even five years ago are now performed routinely. Data from the monitoring of the learning achievement of school children undertaken periodically by Ministries of Education of many countries, some of which have sample sizes in hundreds of thousands, can be processed quickly and accurately only through the use of powerful computers. It would be unthinkable to process data from such huge samples manually without sacrificing accuracy and speed! It is also computing power that permits the speedy and accurate processing of population data generated from periodic national censuses in nearly all parts of the world.

Searching text

Another important dimension of ICTs in research is the use of online full text databases and online research libraries/virtual libraries which are the direct outcome of the growth in telecommunications networks and technology. These databases and libraries provide researchers with online access to the contents of hundreds of thousands of books from major publishing houses, research reports, and peer- reviewed articles in electric journals. Examples include: the Questia Online library which provides access 24/7 to "the world's largest online collection of books and journals in the humanities and Social Sciences"; EBSCO Publishing's EBSCOhost Online Research databases; and the Online Books Page hosted by the University of Pennsylvania libraries which provides free online access to books and includes an index of thousands of online books and links to directories and archives of online texts.

Use of these online databases and libraries by academic staff has grown rapidly in the higher education systems of many countries. With support from UNESCO, the Hewlett Foundation and other development partners some countries have established their own national virtual libraries. Examples include the National Virtual library of Nigeria which was established by the National Universities Commission to promote access to the most recent publications in nearly all the disciplines offered by Nigerian universities. Apart from making the most current publications available to researchers, they also provide opportunities for the dissemination of research, particularly through on-line electronic journals.

Linking researchers globally

ICTs are also being used to transform research from something done by individuals or teams in particular HEIs to an activity involving the instantaneous sharing and the collaborative generation of new knowledge by networks of researchers located around the world. This is facilitated by speedy telecommunications and the emergence of social networking sites, wikis, communication tools and folksonomies (the practice and method of collaboratively creating and managing tags to annotate and categorize content. that catalyze online collaboration and sharing among users) (http://en.wikipedia.org/wiki).

The major impediments to the effective use of online databases and online research libraries/virtual libraries include: the high cost of bandwidth, particularly in Africa; lack of well conceived national and institutional ICT policies, the high cost of hardware and software and the absence of sustaining services and systems.

Importance of national and institutional policy

The examples we have discussed show that use of ICTs for research and teaching by the faculty of HEIs is increasing rapidly. However, ICT infrastructure requires major financial investment, which is best done on the basis of well conceived national and institutional policies. National ICT policies should articulate a vision and a strategic framework for harnessing the potential of ICTs to address a country's development challenges. For the education sector it should provide a sense of focus and direction and spell out clearly how improving the ICT capacity of the education sector can help to address issues of access, equity and quality at all levels. Such a national policy should provide a framework that can be a basis for developing ICT policies by HEIs.

An **institutional** and or **sector wide** higher education ICT policy that seeks to promote the effective use of ICT in research should *inter alia*:

- Identify the specific ways in which the application of ICTs will significantly enhance the research capabilities of higher education institutions and the sector as a whole;
- Enhance bandwidth/connectivity through the acquisition of suitable hardware, software, and the establishment of LANs, WANs, and Virtual Private Networks for effective coordination and efficient utilization of resources.
- Promote collaboration among higher education institutions in all ICT-related activities. Collaborative strategies such as SURF in the Netherlands and JISC in the UK which are organizations for promoting partnership for ICT and network services in higher education are examples of this. A similar strategy, on a relatively small scale but with potential for further growth, is the Research and Education Network of Uganda, (the consortium of Makerere, Kyambogo and Mukono universities). Such consortia (especially those that cover many institutions), will facilitate the achievement of economies of scale (through large volume procurements) and help reduce the costs of bandwidth which is very high in developing countries, particularly Africa. The ICT policies must also have very clear strategies for sustaining services and systems.
- Build the capacity of faculty and other relevant personnel on ICT including both basic and advanced skills, and the use of ICT in research. Incentive systems that promote the use of ICTs by academic staff should also be implemented.

ICTs in Community Engagement

Background

The economic policies of governments in both the developing and developed world have long been oriented towards growth. Scholars like Huq (1995) and Sen (1991) have helped to shift their focus from national-income accounting to people-centred policies and development. But development is a complex phenomenon that does not fit into a neat policy and application jacket. Sen (1991) helped to create a framework for development through his capability and functioning approach, which provided conceptual clarity and was also amenable to statistical comparisons. As Sen (1991) points out, the objective of development is to enhance the quality of human lives by 'expanding the range of things that a person could be and do (functioning and capabilities to function, such as to be healthy and well nourished, to be knowledgeable, to participate in the life of a community.)'

It is important to place of higher education in the context of development and to recognize the scope of ICTs in reinforcing the role of higher education in development process. This section focuses on the generative and developmental role of HEIs.

The generative role of HEIs and ICT

The last two decades have seen a critical examination of the role HEIs in economic growth and social development. In addition to teaching and research, contributing to regional economic growth through innovation is now perceived as the third role of universities. The university-industry-government linkage is seen as a triple-helix model through which effective transfer of technologies leads to economic growth.

ICT cannot be the single determining factor influencing the generative and developmental roles of HEIs. It can only play a role once HEIs are geared with appropriate frameworks, so a discourse on the role of ICT requires a broader understanding of the status of HEIs in economic and social development.

Links of HEIs with industries and government vary from region to region. In developed countries linkages are often strong, but HEIs in many developing countries have more limited scope because there is less industry and innovation. The following table indicates the different patterns of university-industry linkages as well as in research and development systems.

	South Asia	Africa	Latin America	Western Europe	USA
University Industry Research Collaboration (in 1-7 Scale)	2.92	2.72	2.84	4.49	5.60
Patents Granted by USPTO (between 2002-2006)	64.84	4.51	15.13	538.24	94216.80
Number of Articles in Scientific Journals (2005)	3093	137	834.08	5704	205320
Total R&D Expenditure as % of GDP (2006)	0.50	0.37	0.28	1.93	2.68
Computer Per 1000 People (2005)	18.00	32.41	84.58	522.67	760.0
Internet Users Per 1000 people (2006)	31.0	39.0	185.83	552.67	690.0
Price Basket for Internet (US$ Per Month) 2005	10.59	45.39	26.92	26.14	14.95
ICT Expenditure as % of GDP, 2005	5.25	5.72	6.06	5.58	8.70

Source: http://info.worldbank.org/etools/kam2/KAM_page3.asp

The enormous differences in the R&D systems between various regions are clearly evident in this table. According to the Milken Institute Tech-Pole Index the HEI location has on influence on the technology transfer and HEI intellectual property is absorbed more readily in regions with an existing technology industry base. Most HEIs in developing countries are in regions with an inadequate technology-industry base. Any assessment of the role of ICT in HEIs in influencing technology transfer and economic growth needs to note this context.

In developed countries the universities have acquired a strong foundation in technology transfer. The Bayh-Dole Act in the US helped universities there to strengthen their intellectual property rights and led to a spurt in patenting and technology transfer. Networking institutions such as the Association of University Technology Managers (AUTM) have enabled universities to retain a dominant position in research and development. There is ample evidence that ICTs have played a major role in university-industry partnership and technology transfer. AUTM has strong ICT-based network linking more than 3,000 experts in technology transfer.

ICT has also played a major role in university and industry partnership in Europe. The University of Minnesota's MBBNet (a web portal of the state's virtual biomedical and bioscience community) in collaboration with Zurich MedNet (a web based information source covering 400 universities, companies and institute) offers links to more than 1,300 organizations in the area of technology transfer.

The emergence of Bioinformatics as a separate discipline indicates the symbiotic relationship between academic research and technology transfer using modern ICT. Bioinformatics is an ICT-assisted interface discipline focusing on data management systems of life sciences particularly molecular biology, genomics etc and enables the scientists, industries and development agencies to access data and facilitate technology transfer. Because of their R&D facilities, ICT infrastructure and University-Industry linkages HEIs in North America and Europe have greater strength in bioinformatics than Africa and Latin America.

Region	Universities Offering Bioinformatics Courses
Africa	8
Asia	49
Europe	57
Middle East	5
North America	153
Australia, New Zealand	16
South America	3
Online Courses	13

Source: http://www.nslij-genetics.org/bioinfotraining/

In an interesting report about the eReadiness of HEIs in Kenya, KENET (2007) has come to the following conclusions:

- HEIs are not ready to use ICT for eLearning.
- ICT is not yet a strategic priority for HEIs.
- ICT strategies have not been aligned with educational and development goals of the HEIs.

Among 18 universities in South Africa, only three universities have formal policies, strategic plans and regulatory framework for using ICT for education and development. According to UNESCO:

> *The following were identified as weaknesses relating to ICT facilities which adversely affect the use of the technology for research purposes: poor infrastructure; few computers (a low ratio of computers to staff/ research students); and the high cost of connectivity which makes high-speed internet service unavailable. Furthermore, staff are unable to access journals online in order to update the knowledge on recent developments in their fields of research. The problems of ICT facilities require strong institutional policy as well as a regional approach for joint negotiations on the cost of bandwidth. With respect to the access to journals online the problem is two fold, the internet connectivity and the cost of the journals. Universities with internet facilities should look for freely available e-journals (UNESCO, 2006)*

In spite of drawbacks such as poor infrastructure and low levels of industrialization and technology utilization, there are some interesting initiatives in developing countries:

- INOVA in Brazil: The State University of Campinas (UNICAMP) has established a unit for transfer of technology called INOVA. INOVA's patent database is available online. Patents are organized by market sector and can be searched by key word. This structure has helped to simplify the localization of the available technologies by sector, which is useful for INOVA's commercial team and also for external customers (industry or investors). With the help of INOVA the university has successfully transferred many technologies and is expected to operate at the same level of technology transfer as many successful universities in USA and Europe.
- SunSpace in South Africa: The SunSat satellite programme of Stellenbosch University developed SunSpace, South Africa's first satellite. Nearly 100 students were involved in the project and over 50 Masters and PhD degrees were awarded. In February 1999 SunSat was launched by the American space agency, NASA, and the satellite successfully operated in space, fulfilling all mission objectives. The University has established a company which manages the operation of the SunSat. The initiative has the potential to provide a Geographical Information System for strengthening the sustainable development of Africa (Source: http://www.sunspace.co.za).
- Technology Parks in India: In addition to the Indian Institutes of Technology and Deemed Universities, India has 1346 Engineering Colleges and 1244 polytechnics approved by All India Council of Technical Education (AICTE). ICT infrastructure is one of the parameters on the basis of which the engineering colleges are approved. These institutions, in addition to other colleges of science and technology, are playing a major role in the development and management of technology parks. The following table (Krishna, 2007) shows the involvement of the HEIs in Technology Parks:

Region in India	Sectors/Areas	Universities/HEIs
Bangalore	ICT Software, Bio-pharmaceutical, Space and Aerospace Industries	8 universities and 50 colleges
Hyderabad	ICT Software, Biotechnology, Pharmaceutical	9 universities, 45 colleges
Delhi	ICT Software, Biotechnology	9 Universities, 110 colleges
Chennai	ICT Software, Telecommunication, Automotive	8 universities, 55 colleges
Pune	ICT Software, Telecommunication	7 universities, 35 colleges

The HEIs have good linkages with Technology Parks through ICT networks. The government and industries are providing ICT connectivity, infrastructure and tax concessions.

The developmental role of HEIs and ICT

The developmental role of an HEI can be seen from its initiatives and impacts in addressing social issues such as poverty, inequality, gender, environment and empowering the poor and marginalized sections of the society to play a major role in the developmental process.

In addition to contributing to social and economic policies and planning through theoretical perspectives, policy research and evaluation studies, HEIs have also played a role in directly reaching communities and society. Extension as a discipline has given agricultural colleges and universities a long tradition of reaching farming communities The State Agricultural Universities in India were modelled after the Land Grant colleges and these institutions played major role in green revolution.

Similarly medical colleges and universities, through their community health programmes, reach large number of people in the communities. Over a period of time, HEIs along with civil society have questioned the conventional transfer of technology models in the developmental process and have begun to emphasise indigenous knowledge and interactive learning empowerment of the communities. In many countries programmes like National Social Service (NSS) and youth programmes are raising students' awareness of the social dimensions of development. Unlike University-Industry linkages and technology transfer, which are continuously monitored, the linkages between HEIs and community have yet to be tracked in a systematic manner.

Agricultural and medical institutions have exploited the potentials of radios in their community outreach programmes. With the spurt in ICTs, HEIs - particularly universities - are involved in ICTs for Development (ICT4D) through projects and programmes. This has also led to the emergence of a specific discipline called Community Informatics. Some of the ICT4D initiatives are:

Programme/ Project	Region/ Countries	Institutions	Nature of ICT4D
NetTel@Africa	Africa	13 Universities	Building the capacity of various stakeholders in ICT4D
Telecentre Project	South America	The University of La Frontera (URFO)	Community-based telecentres with a network of 32 centres
TeNet	Asia/India	Indian Institute of Technology Madras	Low cost ICT options with last-mile reach operating as business models.
SPIDER	Asia/Africa, Latin America. Europe	More than 35 universities	The Swedish Program for ICT in Developing Regions (SPIDER) focuses on supporting developing countries in harnessing the benefits of ICTs for growth, development and poverty alleviation.
Telehealth	Bangladesh	BRAC University	In association with Grameenphone, the capacity of local health workers and traditional health practitioners enhanced using mobile phones and telecentres.
Learning for Livelihood of Commonwealth of Learning	Commonwealth countries	20 universities and 8 colleges & institutes	Using ICT based Open and Distance Learning building the capacity of the poorer sections of the society to negotiate with stakeholders and strengthen livelihood
Skill Development of Commonwealth of Learning	Commonwealth Countries	120 polytechnics in Africa	Strengthening the capacity of polytechnics through ICT in reaching the poorer section of society through concepts such as assessment of prior learning
EduLink	Africa and Europe	6 universities in Africa and 3 universities in Europe	Building the ICT4D capacity in Africa
Village Resource Centre	India	CT So 23 universities in India	Providing contents and information to the rural communities in India through satellite based communication system.

In addition to above there are many other initiatives all over the developing and developed world which have strengthened the role of HEIs in ICT4D. While there are limits to the lessons we can learn from all the projects because of different levels of monitoring and evaluation, the specific challenges of universities in ICT4D has been well brought by the study of Colle (2005) in Africa. Based on survey among faculties and staff in 13 universities, Colle found that while there is an interest in ICT4D there are doubts about the support universities will provide in terms of policies and eReadiness.

Skills development is another important area in which ICT could be used effectively. Attempts are being made to strengthen the ICT framework for Technical and Vocational Education (TVET). The emerging discourse on the role of skill development in addressing poverty and developmental issues indicates the potential role of ICT4D. King and Palmer (2007) argue that skill systems, particularly TVET, left to the market will tend to favour non-poor and more-educated: 'Worldwide it seems to be the case that the more educated are the ones who get most access to further training. Those with minimum education levels do not get access to skills training.' The Commonwealth of Learning has initiated activities to strengthen the role of integrating prior learning into the formal skill development process.

ICT can play a major role in integrating skill development as a component of a poverty alleviation strategy. GTZ has recommended Nine Generic Building Blocks for a VET Intervention Aimed at Pro-Poor Growth (2007). The role of ICT4D in TVET and skill development could be perceived vis-à-vis these building blocks.

Skill Development for Poor in TVET: Role of ICT in Nine Generic Building Blocks

No	Blocks	Description of the Block	Role of ICT
A	Foundation		
1	Enabling Environment	Appropriate Policies and Action Plans vis-à-vis Pro-poor approach	Involvement of stakeholders, Policy design, evaluation decision-making and monitoring
2	Financing Mechanisms	Access of TVET to poor people	Assessing financial and economic viabilities
3	Adequate Infrastructure	Physical and equipment infrastructure as well as appropriate trainers, governance and administration	e-Governance, Monitoring and evaluation, decision-making
4	Linkages	Linkages between a VET initiative and other aspects of the social and economic functions in a society or community. Position in the social and economic value chain	Business association linkages, strengthening enterprise building linking to credit and market
B	Ist Level		
5	Networking	Mobilization, Livelihood Coalition	Horizontal Transfer of Knowledge
6	Empowerment Content	Participatory and Collaborative Content Development	Collaborative Learning Content Management System
7	Appropriate Methodology	Interactive Learning Process	Interactive Learning, Group and Community Learning
C	IInd Level		
8	Complementarity	Synergy between various interventions	Strengthening forward-backward linkages with TVET
9	Monitoring and Evaluation	Involving stakeholders in M&E, decision making	On-line M&E and decision making tools

There is a need for understanding the framework in which the ICT4D by HEIs operate. Operationalizing development using ICT requires clear perspectives and well-defined roadmap. This paper proposes a framework to analyse ICT4D by the HEIs. The following matrix puts forward three basic elements of development: Accessing Development Infrastructure, Knowledge Management, and Empowerment. There are three stages of process in operationalizing the elements: They are: inform, interact and transact.

Process Through ICT Elements	Inform	Inform	Transact
Accessing Development Infrastructure			
Knowledge Management			
Empowerment			

Accessing Development Infrastructure: This refers the role of ICT in helping target communities and groups in linking with various development institutions, schemes, programmes and projects etc. Initiatives such as e-governance, e-government, telemedicine, technology, connectivity etc would fall under this element.

Knowledge Management: This refers to the institutional process by which communities identify, create, represent, distribute, enable adoption and internalize as norms and values of insights and experiences which flow through vertical and horizontal sources. Learning, extension, training, etc. would fall under this element.

Empowerment: This is the process of increasing the capacity of individuals or groups to make choices and to transform those choices into desired actions and outcomes. The target community's ability to negotiate with various stakeholders and initiate self-sustaining development activities for sustainable livelihood is the important dimension of empowerment.

ICT could act at three levels vis-à-vis these three elements. In the first stage of the process, *inform*, information is provided about the three elements. In the second stage of the process, interact, two-way communication systems between the target communities and the developmental organizations including HEIs are established using modern ICT. Transact refers to the process of accessing development infrastructure and knowledge institutions through ICT and transforming this access into desired actions.

In the absence of a comparative database, it would be difficult to arrive at an understanding regarding the status of ICT4D in HEIs. However based on the reports and various case studies, following hypothetical conclusions could be arrived at:

- A large number of projects of HEIs operate within a limited framework on ICT4D.
- Most of them are in the area of informing about access to development institutions and knowledge management. Some projects enable the target communities to interact with various agencies using ICT4D.
- Very few projects are involved in the process of transacting and providing opportunity for achieving empowerment.

HEIs, ICTs and society: Next steps

- Many HEIs do not have well-defined policies and action plans regarding their generative and developmental roles in the society. Most of their policies are inward looking, focusing activities within institutions and giving little emphasis to linkages with external stakeholders. Though HEIs in developed countries have policies on the generative role, there are controversies about balancing long-term academic research with short-term technology transfer projects. There is a need to strengthen HEIs in policy development strategies vis-à-vis generative and developmental role.
- In the absence of strong policy framework, ICT is seen more as an infrastructure and not as a tool for strengthening these generative and developmental roles. Hence, in addition to a general policy framework, specific policies and plans for integrating ICT for generative and developmental roles should be defined.
- Most of the ICT4D initiatives are *project-based* and mostly supported by external development agencies. These projects are initiated through the interests of particular individuals. In many developed countries, patents and royalties have encouraged faculties to get involved in the generative role. Very few HEIs have taken steps to recognize the contribution of faculties and staff in the developmental role. If ICT4D is to be internalised, recognition of developmental role is crucial and appropriate policies are required for internalising it.
- The capacity HEIs to perceive and operationalize ICT4D is vital. The approach is still based on a beneficiary-benefactor relationship.

- Most of the discussions on ICT4D by HEIs are oriented towards connectivity and technology issues. Digitising and populating ICT with contents are some of the areas on which HEIs could concentrate. In particular, issues such as standards in content creation and management in many local languages should be addressed. For example, FAO has evolved AGROVOC, a structured multilingual thesaurus for agriculture. Its main role is to standardise the indexing process in order to make searching simpler and more efficient, and to provide the user with the most relevant resources. At present it is available in 23 languages. Universities and other HEIs could play major role in developing such standards in many languages of developing countries.

Other applications of ICTs in community service

Finally, ICTs can facilitate action research in communities and make it possible to involve the general public in research, for instance by collecting data or pooling the power of hundreds of personal computers. The expansion of multi-media centres, ICT kiosks and cyber cafés into rural areas creates new possibilities for extension services and the application of university research. Higher education has also been instrumental in the development of community informatics. Emerging technologies like Second Life, Facebook, YouTube, Flickr, Blogger, Twitter and LinkedIn, which at first seemed to be entertainment devices or toys, are proving useful in the relationships between the academic world and its community stakeholders. Such developments have created the new role of knowledge 'infomediaries', who take advantage of ICTs to facilitate linkages between universities and communities.

ICTs in Teaching

Summary

Academics have taken to the use of computer in teaching much more readily than they adopted earlier audio-visual media. This is because the strength of computers is their power to manipulate words and symbols - which is at the heart of the academic endeavour. There is a trend to introduce eLearning or online learning both in courses taught on campus and in distance learning. Distance education and eLearning are not necessarily the same thing and can have very different cost structures. Whether eLearning improves quality or reduce cost depends on the particular circumstances. ICTs in general and eLearning in particular have reduced the barriers to entry to the

higher education business. Countries and those aspiring to create new HEIs can learn from the failures of a number of virtual universities. They reveal that ICTs should be introduced in a systematic manner that brings clarity to the business model through cost-benefit analyses.

The emerging context

With many developing countries envisioning a future in which they hope to become learning societies built on knowledge economies, higher education has a signal role to play in development strategies in the pursuit of such aspirations.

The accounting firm KPMG recently released research which estimates, conservatively, that the real rate of return on investments in the education and research functions of universities yields 15% or more for university training and 20%-40% for public university research. This finding should give countries confidence to increase their investments in higher education. No knowledge economy can function without ICTs. Therefore, it is imperative that higher education institutions afford their graduates the literacy and competencies that their future work environments are likely to demand of them. Furthermore, being ICT-rich gives an HEI a competitive advantage in recruiting students.

In many countries, demand for higher education far outstrips supply and Governments and institutions are turning more and more to the use of ICTs to bridge the access gap. It is too early to say whether the role of ICTs in the teaching function of higher education is truly transformative, or whether it is simply a repackaging of previous pedagogy.

Benefits and challenges of ICTs

Learning and course management systems are useful in generating and managing a variety of student support services and products, such as course outlines, digitally-recorded classroom material, discussion groups, laboratory manuals and lab assignments, lecture notes, live lectures for later viewing and re-viewing, links to course specific websites, online tutorials, supplementary readings, and virtual office hours for teacher-student consultations. Virtual libraries, where they exist, are a particular boon to students as they cut down on costs of acquiring expensive textbooks, journals and reference material.

Tools are also now available on the Internet to assist both teachers and students to manage writing assignments to detect and avoid the pitfalls of plagiarism and copyright violations.

One of the great benefits of ICTs in teaching is that they can improve the quality and the quantity of educational provision. For this to happen however, they must be used appropriately.

While using ICTs in teaching has some obvious benefits, ICTs also bring challenges. First is the high cost of acquiring, installing, operating, maintaining and replacing ICTs. While potentially of great importance, the integration of ICTs into teaching is still in its infancy. Introducing ICT systems for teaching in developing countries has a particularly high opportunity cost because installing them is usually more expensive in absolute terms than in industrialized countries whereas, in contrast, alternative investments (e.g., buildings) are relatively less costly.

Inexperience in procuring institution-wide hardware and software and attendant services may cost institutions dearly as they may end up with wares that are outdated and subject to unworkable but binding supplier contracts.

Using unlicensed software can be very problematic, not only legally but in the costs of maintenance, particularly if the pirated software varies in standard formats. Even under ideal circumstances of licensed hardware and software acquisition, lack of capacity in equipment maintenance can pose serious implementation problems. Clear policies and procedures for procuring computer hardware and software are necessary to prevent such problems.

Even though students can benefit immensely from well-produced learning resources, online teaching has its own unique challenges as not all faculty are ICT literate and can teach using ICT tools. Even those who are may not be keen on teaching online because of the extra time and effort involved.

A related issue is the readiness of students to learn online. Limited ICT resources may cause institutions to put their energies into making their students ICT literate as a foundation step but the lack of enhanced teaching methods (using multimedia resources, for example) may lead to inferior learning outcomes for students.

Introducing eLearning

The introduction of eLearning in education engendered high expectations that it would transform the organization and delivery of higher education. It prompted significant investments in starting up new virtual universities by universities in Europe and the United States including New York, Columbia and Cornell Universities and the US Open University. Numerous Virtual Universities such as the UK e-University, the Digital University in the Netherlands, the Bavarian Virtual University, the Virtual University in Finland, the Net-University in Sweden and the African Virtual University were launched.

However, in most cases these virtual universities and eLearning experiences have failed to achieve the desired levels of sustainability and would not survive without massive government support. The OECD's 2001 Report contended that despite the investment of up to $16 billion made in eLearning by the OECD countries, there was no evidence that it led to any significant improvement in teachers' performance and or students' learning outcomes nor had it enhanced quality and access to education on the scale predicted initially. In its 2005 report, the OECD concluded that ICT in higher education had more impact on administrative services than on teaching. The reports attributed the failure of eLearning to its inability to be relevant to local needs and cultures.

This does not imply a complete retreat from eLearning/online education but requires a re-conceptualisation of eLearning so that it achieves a difficult balance. On the one hand it must recognize the importance of the effective interaction of students with content, fellow students and teachers/tutors during the learning process. On the other hand, if it is not to increase institutional costs there must be some substitution of capital for labour, as occurs in traditional open and distance learning (ODL). For this reason HEIs that already operate through ODL (e.g. open universities) can more easily introduce eLearning cost-effectively than those that try to graft it onto classroom teaching.

The instructional success of eLearning is dependent on the development of appropriate pedagogies and an integrated use of ICT based on students' prior learning experiences. Its failure can be traced to its conception of learning as the transfer of knowledge instead of seeing learning as an active process of knowledge creation. Therefore, there must be a paradigm shift from an emphasis on stand-alone

courses and resource-based learning to a process that promotes interaction, communication, collaboration and construction.

However, the economic success of eLearning must be based on some substitution of technology for labour and the development of a learning system that cuts costs through specialisation and division of labour. The 'lone-ranger' approach to eLearning, where each instructor tries to convert their own course into an online format is not likely to be effective, economic or sustainable. Introducing eLearning without increasing institutional costs is a serious challenge, particularly for public institutions.

The need for generating policies

The importance of overarching and guiding telecommunications and ICT policies at the national level, particularly as they relate to ICTs in education, cannot be overemphasized. Not only do such policies enable institutions and networks of institutions to generate their own internal ICT policies, strategies and plans, they also foster an appropriate allocation of resources. In institutions, they determine staffing issues and faculty roles and how these can be made sustainable.

In response to increased demand for higher education, many countries are witnessing the mushrooming of higher education institutions, both private and public. Bricks and mortar may be a necessary part of the accommodating infrastructure for this expansion but they are not sufficient to meet and address all the access issues in the sub-sector satisfactorily. Nationally, where the infrastructure exists, many institutions working together could tap into an ICT network to facilitate collaboration and sharing to cut down on costs and optimize the returns gained in the use of ICTs. ICT networks are critical for the successful implementation of ICTs in education; well-articulated policies will ensure that such access is possible.

UNESCO Bangkok has developed an *ICT-in-Education Toolkit* (see www.ictinedtoolkit.org) that Governments can use in drafting ICT policies in education.

Strategies for introducing ICTs

Apart from having enabling telecommunications and ICT policies, governments and higher education institutions will need to develop strategies for effective ICT and media deployment and sustainability. A relatively less costly medium that has not been

fully exploited in some jurisdictions for educational purposes is the radio. Recognizing the potential reach of this medium, 27 tertiary education institutions in Nigeria have received government licences to operate *campus radios* for teaching, research and entertainment.

Where capacity is lacking for the proper assessment of ICTs and their benefits, institutions would do well to, first, mount training workshops in the areas of ICT procurement, contracting and the total cost of owning particular systems, which includes acquisition, installation, power supply, maintenance, allied material and equipment, replacement, training, recycling, etc.

Such training should be undertaken within the context of a technology plan that includes long term budgeting or funding scenarios, acquisition, maintenance, replacement and possible sharing, at least coordination, of ICT usage with other institutions. For governments, it is important for an education ministry to liaise and coordinate efforts with other departments in the country, e.g., Finance, Telecommunications, Industry & Commerce and Economic Development.

In developing internal capacity in the use of ICT in teaching, learning, and research, teachers need to be involved in designing particular ICT initiatives to ensure their relevance and effectiveness. Rather than introducing ICT wares across the institution all at once, it is prudent to test the efficacy of a technology at, say, the departmental level before deploying it institution-wide. Such piloting, if successful, will reassure institutional policymakers of the soundness of the technology in facilitating improved teaching and, on the part of students, more and better learning outcomes. On the other hand, this must not lead to each department adopting its own IT solutions. Students appreciate having some consistency in the platforms (say for eLearning) that they will find in different parts of the HEI.

Pitfalls

The four most common mistakes in introducing ICTs into teaching are: i) installing learning technology without reviewing student needs and content availability; (ii) imposing technological systems from the top down without involving faculty and students; (iii) using inappropriate content from other regions of the world without customizing it appropriately; and (iv) producing low quality content that has poor instructional design and is not adapted to the technology in use.

Technology is of little use if the pedagogical skills needed to effectively and optimally use it are lacking. It is important, therefore, that serious consideration be given to content preparation before deciding on the most appropriate way to deliver it to students. When this is accomplished, teaching is likely to improve in ways that foster more and better learning. Institutional policies and procedures for adopting and adapting technology must be in place and faculty and students involved in at least assessing content vis-à-vis the technological mode to deliver it. Where expertise is lacking in conducting such assessments, training should be introduced to ensure that the implications of technology adoption and use are clearly understood and accounted for in short and long-term planning.

It is essential more generally to provide prior training for faculty when introducing ICTs since students are often more familiar with these technologies than they are. A new dynamic is that institutions are adopting cloud services which are of three basic kinds: 1) free social software (Wikipedia, Wikieducator, etc); 2) free online services (Facebook, Blogger, etc); and, 3) subscription online services (Basecamp, Surveymonkey, etc). Subscription services may sometimes represent good value because users can buy only what they need without having to run and maintain their own servers. Note that the business model for some online services is still evolving and may lead to user fees for services that are now free.

The promise of Open Educational Resources (OERs)

OERs are educational materials and resources offered freely and openly for anyone to use and under some licenses to re-mix, improve and redistribute. They are the expression of an Internet empowered worldwide community effort to create a global intellectual and educational commons. In Africa, for example, one of the most successful collections of OERs are those developed and. Disseminated by the Teacher Education in Sub-Saharan Africa (TESSA) Consortium. It has 18 member-institutions in nine African countries. TESSA has developed a wide variety of audio and text materials (online and print) that provide support to primary school teachers and teacher educators in Africa. MIT's Open Courseware project and the UK Open University's OpenLearn site are the best known examples of open content in higher education in the industrialised world.

OERs have great potential for improving the cost-effectiveness of eLearning, since the creation of high quality courses ab initio is a costly process. However, institutions that

specialise in eLearning, such as the Asian e-University, now find that most of the quality content that they need is already available as an OER somewhere, and all they need do is find it and adapt it to their own context and needs. However, Institutions should develop appropriate policies and train their staff about the related technical, pedagogical and legal (copyright) issues if they are to take full advantage of OERs.

Another network that is creating and taking advantage of OERs is the Virtual University for Small States of the Commonwealth (VUSSC), a collaborative initiative of the Ministers of Education of 32 small states. They share training events and collaborate on the creation of eLearning courses that all can use. This is facilitated by a Transnational Qualifications Framework that has also been developed by the VUSSC. The VUSSC is an interesting example of south-south cooperation at the leading edge of the applications of ICTs in teaching.

ICTs in Administration

HEIs have engaged ICTs in administration since the early seventies. This early uptake of ICTs included systems for: student admission and records, examination results and transcripts, finance database, human resources database and management information.

The rapidly increasing student population in higher education accelerated the need for ICTs to process, store and retrieve data in a fast, systemic and accurate fashion. In the 2008 edition of *Education at a Glanc*e, OECD revealed that, on average, 57% of school-leavers in OECD countries went on to university in 2006, compared with 37% in 1995. The need to manage this increasing student intake and monitor students' progression through the education system required HEI administrators to turn to ICTs for solutions. Similarly, the growing power, effectiveness and potential of ICTs also meant that technology could provide possibilities that did not exist three decades ago. Some examples of new ICT applications that became available to administrators include: eGovernance, online registration by students, online access to course outlines and materials, online assignment submissions, online examinations and online discussion forums with students and instructors.

As a result of applying ICTs in university administration, a dynamic new shift occurred in higher education. Large and complex institutions could be created (e.g. the UK Open University with 200,000 students) and function in a highly efficient and user-friendly manner.

Using ICTS in higher education administration is fundamentally about harnessing technology for better planning, setting standards, effecting change and monitoring results of the core functions of universities. More and more universities are looking into developing ICTs applications that will:

- improve on the quality and capacity of management information systems to support strategic decision-making and policy implementation;
- stimulate and facilitate free flow of information throughout the higher education system; and
- respond to the needs and demands of the younger generation (especially the digital natives) for better and increased access to university services and information through the web.

There are multiple benefits of ICT application for the university administration, students and instructors.

Administration

First, ICT technology can process voluminous records quickly, meticulously and impeccably. Second, technology can generate reliable and consistent records. Third, records and data produced are searchable and quickly retrievable. Fourth, digital records save space, a premium cost to institutions. Fifth, technology saves human resources for data entry and servicing student admission and registration. With advanced scanning technology, completed application forms can be read into the databases in a matter of seconds. Other software like Learning Management Systems (LMS) (e.g. the open source Moodle used by Athabasca University and many other institutions, including those in the VUSSC network mentioned earlier) allow students to register for courses directly online, pay online and get course information online. Sixth, technology can expand the geographical boundary for student intake and facilitate cross-border higher education.

Students

There are many benefits for students in terms of increased flexibility in registering for courses/classes online, accessing course outlines and content online, interacting with students and instructors online through chats or online discussions, submitting assignments and writing examinations.

Instructors

The mushrooming capabilities of LMS are allowing institutions and instructors to create and maintain comprehensive, searchable, retrievable and reusable records of content development and content dissemination. More effective class management can be done through the use of virtual space in interacting with students, supporting learning needs, monitoring student progress and maintaining an account of student performance and results.

Challenges

While the potential benefits of ICTs for administration are substantial, there are associated challenges that decision makers should be aware of before introducing technology changes.

As the goal is for seamless transfer of data from the point of student registration to registry, finance, student services, human resources and so forth, the respective systems or databases involved in the process must be able to communicate with each other intelligently. Reliability and security are of the essence.

As access to registration and course content are web-based, this leads to the debate about security over the net. The difficult question to grapple with is how to widen access without giving away internal security to possibilities of hacking and virus attack? How strong a firewall and a back up are required in order that the "cardiovascular function" of institutions can be foolproof?

Another important consideration is how can the services provided by universities through ICTs be accessed by all the students they serve? In Africa, where the penetration of the Internet stands at 5.6% compared to the world's 26.6%, any technology deployment for learning and academic services will need to address the issue of connectivity by students and instructors. Fortunately, the IT landscape of countries is improving continuously which also requires that institutions need to monitor the situation regularly to keep up with the pace of technology changes.

Other challenges are people related. The wide adoption of ICTs calls for mindsets and skill sets that are adaptive to change. An attitude of resistance to change attitude is often caused by the lack of appreciation of the benefits brought by ICTs and by the fear that technology will replace jobs, which it should if it is to be cost-effective.

Institutions investing in ICTs will need to underpin changes with a training and capacity building plan for a workforce that is heads on, hearts on and hands on with ICTs.

Implementation strategies

The purpose of using ICTs in administration is to support the business strategies and processes of the HEI. Thus a perquisite for any application is absolute clarity about the steps in each business process and how they related to each other. This sounds simple but it is not - and is the reason that so many administrative software projects experience time and cost overruns. IT algorithms are not very forgiving of fudges in the process and programming is held up while they are clarified and turf battles within the administration are resolved.

A new challenge in merging business processes is to link existing student record systems, which usually employ proprietary software, to the learning management systems for eLearning, which are often based on open source software such as Moodle. This is essential if eLearning is to have any hope of achieving cost-efficiency gains.

Another key to the successful use of IT in HEI administration is extensive user consultation, which should be a facet of clarifying business processes. Clerks and others who provide the interface with students will be understandably nervous at the prospect of a change in the IT systems that they use all day long. If the new system delivers well on their wishes implementation will proceed very smoothly. Transparent and inclusive system development processes take time, but reap bountiful results in the long run.

While not always possible, a pilot phase or dummy runs to iron out any likely bugs and glitches will contribute greatly to results and success. Phased roll-out is easier for managing results if the change is wide-ranging and far-reaching. There should be a clear time table for change and for each milestone to be underpinned by sufficient preparation, training and help desk/hotline support. An integrated monitoring and evaluation plan will ensure timely collection of user and stakeholder feedback, and any needs for further system/software adjustment and enhancement.

Costs

We repeat the important point made at the beginning of this paper about costs. ICT costs are, by and large, set internationally and any special discount offered by a vendor

should be assessed with this fact and the long term in mind. What changes country by country is the opportunity cost of substituting technology for people. As with the trade-off between eLearning and classroom teaching, replacing every last clerk with an IT system makes no sense if the clerks cost less.

Comparative cost and cost benefit analysis are important and necessary. In choosing Moodle for the LMS at Athabasca University, a task force of 30 faculty and staff members was struck to compare three possible options before making the final decision. Comparison and detailed analysis were done to find out how individual products:

- met the criteria of flexibility and accessibility in servicing students;
- supported instructional design especially in the areas of granularity, templates and modularization and student experience;
- provided the range of needed teaching and learning tools;
- facilitated integration and interoperability with exiting systems administration.

The task force's final decision was made after due consideration of: the cost of the options in their licensing fees; hardware, software costs, costs related to integration with the existing Banner registration system; costs of ongoing support (external and in-house especially required for OERs); and staff training costs.

Conclusions: Key Trends and New Dynamics

The key points which emerge from this review are:

- The integration of ICTs in higher education is inevitable. The very high demand for higher education has stimulated significant growth in both private and public provision. Open universities, which depend on technology-mediated learning, are expanding and multiplying and many conventional HEIs are adopting dual-mode or blended program delivery systems, creating a new dynamic in flexible and life-long learning.
- ICT is moving beyond personal computers to mobile technology, Virtual World, Cloud Computing etc. HEIs should integrate these emerging technologies into their ICT policies and programmes. The choice between open sources and proprietary software can sometimes be hijacked by interest groups and ideologies. The sensible policy is to do what is appropriate when it is appropriate after a careful analysis of long-term costs and benefits. All software use policies should respect national and international copyright laws.
- Institutional and sector-wide higher education ICT policy and planning should identify the specific role of ICT in enhancing research capabilities and provide for adequate infrastructure backed by capacity building. Digital libraries, access to online databases, networking, etc., can be enhanced through inter-institutional collaboration to ensure optimal usage of ICT expertise and resources.
- In many parts of the developing and developed world, HEIs are yet to mainstream policies and programmes on their generative and developmental roles. In the absence of frameworks to define these roles, many ICT activities are simply ad-hoc projects with limited potential to be self-sustaining and self-generative. ICT can add value to the role of HEIs in economic growth and social development if appropriate perspectives and roadmaps are integrated in the policies.

- The strength of computers in teaching is their power to manipulate words and symbols - which is at the heart of the academic endeavour. ICT has also led to the emergence of Open Educational Resources (OERs). These can support the growing trend to introduce eLearning or online learning both courses on campus and in distance education. Whether eLearning improves quality or reduce cost depends on intelligent financial and pedagogical planning. ICTs in general and eLearning in particular have reduced the barriers to entry to the higher education business. Countries and those aspiring to create new HEIs can learn from the failures of a number of virtual universities. They reveal that ICTs should be introduced in a systematic manner with a clear business model in both public and private HEIs.
- ICTs in the form of Management Information Systems are increasingly universal. The wide adoption of ICTs calls for mindsets and skill sets that are adaptive to change. An attitude of resistance to change is often caused by the lack of appreciation of the benefits brought by ICTs and the fears about the displacement of people by technology.

In summary, ICTs do not merely reinforce the infrastructure of higher education but greatly increase our power to implement the academic ideal that knowledge is important.

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