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New technologies for teaching and learning: Challenges for higher learning institutions in developing countries

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ABSTRACT

The application of Information and Communication Technologies (ICTs) is already changing the organization and delivery of higher education. The pedagogical and socio-economic forces that have driven the higher learning institutions to adopt and incorporate ICTs in teaching and learning include greater information access; greater communication; synchronous and asynchronous learning; increased cooperation and collaboration, cost-effectiveness and pedagogical improvement. However, ICTs have not permeated to a great extent in many higher learning institutions in most developing countries due to many socio-economic and technological circumstances. This paper discusses new learning and training technologies considering their pedagogical, cost and technical implications. It also discusses challenges for integrating these technologies in higher learning institutions with examples from Tanzania, and giving best practice approaches for addressing each of the challenges.

Keywords: *information and communication technology, e-learning, teaching and learning technologies, higher learning institutions, developing countries*

INTRODUCTION

Developments in Information and Communication Technologies (ICTs) have impacted all sectors of society, including the education sector. In higher education, application of ICTs in form of e-learning is already changing teaching and learning processes. There are many pedagogical[1] and socio-economic factors that have driven higher learning institutions to adopt e-learning. These include greater information access; greater communication via electronic facilities; synchronous learning; increased cooperation and collaboration, cost-effectiveness (e.g. by reaching different students and in greater numbers) and pedagogical improvement through simulations, virtual experiences, and graphic representations. Both trainers and learners can choose more appropriate applications which are flexible in time, in place, personalized, reusable, adapted to specific domains and more cost-efficient (Fisser, 2001; Pelliccione, 2001).

On the other hand, there are a number of challenges that face universities in developing countries as they seek to implement the e-learning systems. AAU (2001) asserts that African universities which should be in the forefront of ensuring Africa's participation in the ICT revolution, they are themselves unable and ill-prepared to play such a leadership role. This is because of the information infrastructure of African universities which is poorly developed and inequitably distributed.

This paper discusses the application of ICTs in teaching and learning by reviewing the e-learning context, and then focuses on the pedagogical, cost and technical implications of different ICTs that can be used for e-learning purposes. Few examples are also picked from some universities in Tanzania. Challenges for integrating these technologies in higher learning institutions in developing countries are discussed, giving best practice approaches for addressing each of the challenges.

E-LEARNING IN CONTEXT

E-learning refers to the use of ICTs to enhance and support teaching and learning processes. It is the instructional content or learning experiences delivered or enabled by electronic technologies and it incorporates a wide variety of learning strategies and technologies. E-learning ranges from the way students use e-mail and accessing course work online while following a course on campus to programmes offered entirely online (Commission on Technology and Adult Learning, 2001; OECD 2005). It is thus an alternative solution, which enlarges accessibility to training and becomes essential to complement the traditional way of teaching (i.e. face-to-face).

E-learning encompasses a continuum of integrated educational technologies. At one end are applications like PowerPoint, which have little impact on learning and teaching strategies or the organization. At the other end are virtual learning environments (VLEs), and managed learning environments (MLEs), which can have significant impact upon learning and teaching strategies, and upon the organization (OSU, 2003; Julian *et al,* 2004). Broadly, OSU (2003) views the continuum of e-learning as the educational technology from the supplemental use of technology in the classroom, through blended or hybrid uses comprising a mix of face-to-face and fully online instruction, to fully online synchronous and asynchronous distance learning environments delivered to remote learners.

In the supplemental use of ICTs to complement traditional learning experiences, the instructor teaches all sessions in the classroom but with the occasional use of technology, such as Web-based activities, multimedia simulations, virtual labs, and/or online testing (Arabasz and Baker, 2003). Blended learning denotes a solution that combines several different delivery methods, such as collaboration software, web-based courses, computer communication practices with traditional with traditional face-to-face instructions (Mortera-Gutierrez 2005). On the other hand, distance learning is conducted solely online where interaction may be synchronous or asynchronous (OSU, 2007). Synchronous learning requires the teachers and students to interact at the same time though they may be dispersed geographically. On the other hand, asynchronous learning allows teachers and students to interact and participate in the educational process at different time irrespective of their locations (Chen *et al.,* 2004). Actually, the use of synchronous with asynchronous activities is determined by the available technology, cost, and maintenance and is adjusted to suit each course, instructor and audience (Graziadei *et al.,* 1997).

E-LEARNING TECHNOLOGIES

Functionally, e-learning includes a wide variety of learning strategies and ICT applications for exchanging information and gaining knowledge. Such ICT applications include television and radio; Compact Discs (CDs) and Digital Versatile Discs (DVDs); video conferencing; mobile technologies; web-based technologies; and electronic learning platforms. This section discusses what these ICTs entail and their pedagogical, technical and cost implications.

Television (TV) refers to a receiver that displays visual images of stationary or moving objects both live or pre-recorded and mostly accompanied by sound which is electronically captured, processed and re-displayed. Likewise, this applies to the term radio – both live generated sound as well as pre-recorded sound. Both TV and radio can improve teaching and learning process in different ways such as by showing processes and activities that may not otherwise be available to the learner. However, digitalization has taken over analog audio and video systems.

Compact Discs (CDs) and Digital Versatile Discs (DVDs) are based upon laser technologies for writing and reading data. They provide a way in which a large amount of multimedia training

material can be stored and made available to end-users: CD-ROM can store up to 1GB while DVD can store up to 17 GB. CD-ROM and DVD-based products can be linked with online information sources. This hybrid approach provides the user with access to media-rich up-to-date information.

Video conferencing is a system where two or more participants, based in different physical locations, can see and hear each other in real time (i.e. live) using special equipment. It is a method of performing interactive video communications over a regular high-speed Internet connection. A videoconference can be either two-way (point-to-point) or multipoint, linking three or more sites with sound and video. It can also include data sharing such as an electronic whiteboard where participants can draw on, or text based real time 'chat'. Interactive whiteboard is simply a surface onto which a computer screen can be displayed, via a projector (Department for Education and Skill, 2004).

Mobile e-Learning (sometimes called 'm-Learning') is a new way to learn using small, portable computers such as personal digital assistants (PDAs), handheld computers, two-way messaging pagers, Internet-enabled cell phones, as well as hybrid devices that combine two or more of these devices into one (Hunsinger, 2005). These technologies have enormous potential as learning tools.

World Wide Web (WWW) is set of software tools and standards that allow users to obtain and distribute information stored on a server and connected to Internet. WWW is a decentralized information system, in which anyone can add new information whenever he/she wants. Lecture notes and other teaching materials are placed on the WWW and linking useful websites to these resources for students to access. In the recent years, web and Internet technologies have matured significantly by providing a uniform access media for both asynchronous and synchronous learning. This phenomenon has significantly increased the popularity of on-line learning (Chen *et al.,* 2004). The usage of web technologies in e-learning are further enhanced with the web 2.0, which is a set of economic, social, and technology trends that facilitate a more socially connected Web where everyone is able to add to and edit the information space (Anderson, 2007). These include blogs, wikis, multimedia sharing services, content syndication, podcasting and content tagging services (Anderson, 2007).

E-learning platforms (sometimes called learning management systems (LMS)) are applications used for delivery of learning content and facilitation of learning process. They are developed for administration and teaching in tertiary education. This software enables the administrators and lecturers to treat enrolment data electronically, offer electronic access to course materials and carry out assessments (OECD, 2005). The activities managed by the LMS vary from instructor-led classroom training to educational seminars to Web-based online training. In addition to managing the administrative functions of online learning, some systems helps create, reuse, locate, deliver, manage, and improve learning content. These systems are called Learning Content Management Systems (LCMS) (Rengarajan, 2001). LCMS actually provide tools to deliver instructor-led synchronous and asynchronous online training. The LCMS provides tools for authoring content as well as virtual spaces for learner interaction (such as discussion forums and live chat rooms). Rengarajan (2001) emphasizes the importance of integrating both LMS and LCMS because they share different levels of administrative interests in the same entities. Lack of smooth integration between the products results in a broken solution with administrative conflicts.

Many e-learning platforms (both LMS and LCMS) currently available are based on either proprietary e-learning software (PES) or open source e-learning software (OSS). OSS usage in implementing e-learning systems is more emphasized in developing world due to the challenges faced when implementing the PES. Coppola (2005) describes two characteristics of PES that

make it ill-suited: (1) the rapidly escalating cost of proprietary software leaves too little of an institution's ICT budget available for creative exploration, once the software has been installed and minimally supported; (2) reduced flexibility to adapt to institutional culture, teaching practices, and disciplinary uniqueness occurs when software development is driven by mass market economics.

Open source software offers the potential to reduce the cost of the software while providing the universities greater control over its destiny. Elimination or reduction of license leaves more budgets available to invest in adapting and managing the software; offers reliability, performance and security over proprietary software due to the availability of the source code, which allows vulnerabilities to be identified and resolved by third parties and it is easy to customize (Wheeler 2003; Coppola, 2005). Some of the widely used open-source e-learning software programs are the Claroline and Moodle.

PEDAGOGICAL, TECHNICAL AND COST IMPLICATIONS OF E-LEARNING TECHNOLOGIES

e-learning technologies	**Pedagogical implications**	**Technical implications**	**Cost implications**
TV/Radio	Effective use of TV/radio depends on three key moments in the application: before, during and after the viewing session and give instructions, explanations, questions or evaluation before and after each moment	Equipments are needed depending on the objectives and the scope of the training application, which includes audiocassette, video camera, PCs, editing software, distribution channel and receiving and displaying equipment.	Costly in terms of TV/radio production, which includes, animation and graphic designers, hardware, access to the broadcast network
CD/DVD	• Simulation for self-study • Used with the presence or remote support of the trainer	Hardware that meets their specifications - graphic screens, MPEG[2] cards, CD or DVD reader and appropriate software	Costs are higher than for printed materials - replication downloading free products or buying ready-made products can lower the costs.
Web-based technologies	Permanent accessibility (24 hours, all days of the week), speed, direct communication, links to related topics and up-to-date notes.	• Fast computers with sound cards and reliable Internet connection are required. • The following team is needed for implementing web-based training: (a)	Hardware, technical expertise and Internet subscriptions costs

		Instructional designer familiar with computer delivered instruction; (b) A programmer or author to use the authoring tool; (c) A graphic artist; (d) A subject matter expert; (e) A webmaster for maintaining the programme on the server.	
videoconferencing	• New pedagogical methods required to provoke interaction • Require small groups • Both trainers and learners require some basic training	Required equipment : (i) Sound proofing and controlling the lighting conditions; (ii) Audio-visual peripherals – TV monitor or video projector, camera(s), microphone(s) and sound playback; (iii) Videoconferencing codec (Rollabout) (iv) Multimedia PC (with PCI-based as well as software based videoconferencing codec) and (v) More bandwidth is needed for higher-quality images	There are two types of costs: setting up the videoconferencing system and operational costs.
e-learning platforms	▪ Adding and changing content as course is progressing. ▪ Template for inclusion of course content. ▪ Support multimedia presentation of course content while others are text based. ▪ Complex	(i) Server platform hardware requirements; (ii) Client platform hardware requirements; (iii) Operating system/cross platform; (iv) organization/ registration/ administration; and (v) The learning content should be in	▪ Hardware cost implications ▪ Cost for maintenance ▪ Operational costs (technical and administrative support) ▪ License fee (annual fee).

	structuring of content allowing for multiple links and cross-reference possibilities.	standard formats that can easily be stored, accessed and distributed. Such formats include HTML, PDF, RTF, GIF, JPEG and MPEG.	

E-LEARNING AT HIGHER LEARNING INSTITUTIONS IN TANZANIA

As it is the case with other African countries, the implementation of e-learning platform in Tanzanian universities is still very low despite of the opportunities that are provided by the open source technology and the conducive environment created by the government. In 2003, the Tanzania government enacted National ICT policy and the Tanzania Communications Regulatory Authority Act (URT 2003). These two major actions made it possible that by 2007 licenses for two basic telephone service provider, four land cellular mobile telephone operators, one global mobile personal communication service (GMPCS), eleven public data communication companies, nine private (dedicated) data services companies, and 24 public Internet service providers (ISPs) were issued (TCRA 2007). The government has also abolished all taxes related to computers and allied equipment, and reduced license fees and royalty payable by the telecommunication operators (Mutula and Ahmadi, 2002; National Committee for WSIS Prepcom II 2003; URT 2003).

In the case of higher education, among ten universities, only the University of Dar es salaam (UDSM) has managed to implement the e-Learning platform in Tanzania. UDSM has implemented e-learning platform by using WEBCT and Blackboard, which are e-learning proprietary software. While, other universities such as Sokoine University of Agriculture (SUA), Mzumbe University and Open University of Tanzania (OUT) possess basic ICT infrastructure such as Local Area Network (LAN), Internet, computers, CDs and DVDs facilities that form the basis for the establishment of e-learning platform.

UDSM implemented the e-Learning system through the financial support from the Flemish University Council. The major problem that UDSM face in the implementation of TEIL project is the issue of software license. It is from this fact that University of Western Cape (UWC) in South Africa initiated a KEWL (Knowledge Environment for Web-Based Learning) project for developing e-learning platform. Currently the UWC has started another project called KEWL - NextGen project under AVOIR (African Virtual Open Initiatives and Resources). AVOIR is a network of African universities working on Open Source applications. Their primary work at the moment is in developing a next-generation of the KEWL learning management software originally developed at the University of the Western Cape in South Africa. The University of Dar es ealaam and Sokoine University of Agriculture are partners in this project. Video conference facility (available at UDSM Computing Centre and Tanzania Global Learning Centre (TGLC) also offers open and distance learning to university students and community at large in Tanzania.

Sokoine University of Agriculture (SUA) has also started implementing e-learning platform by using Moodle software. Moodle is a course management system (CMS) - a free, open source software package designed using sound pedagogical principles, to help educators create effective online learning communities. Moodle is also a CMS designed to help educators who want to create quality online courses. The software is used all over the world by universities, colleges, schools and organizations.

Another Tanzanian university, the Open University of Tanzania (OUT) provides an alternative to conventional university education and gives opportunity to those who are working full time and those with household commitment to acquire higher education. Although the university has the basic ICT infrastructure (such as Internet, computers, local area network), it still uses traditional way with face to face meeting to impart knowledge to its students who are spread in all regions of Tanzania. OUT has enacted its own ICT policy, which guides on how to use ICT to fulfill the functions of the university that are teaching, research and consultancy. Currently, there are some initiatives to use an Open Source learning management system called Atutor for students, starting with the B.Sc (ICT). If the pilot implementation will be successful then other degree programmes will also be offered through the blended e-learning and distance learning.

ICT IMPLEMENTATION CHALLENGES IN HIGHER LEARNING INSTITUTIONS

Despite of the achievements revealed by some of the Tanzanian universities in implementing ICT for teaching and learning processes, these universities still face a lot of challenges in undertaking such a process.

Lack of systemic approach to ICT implementation: Integration of ICTs in the functions of any organization is a complex process that needs to be fully conceptualized and defined from the beginning. However, this is not the case in many higher learning institutions in developing countries as most of them have embraced the ICT integration process without clear plans to guide the way. The institution ICT policy and strategic plan should be defined to provide a framework for the development and implementation of specific ICT projects. The diversity and competing interests of different stakeholders in the institution should be recognized when developing ICT policy and a strategic plan. The following issues, amongst others, should be taken into consideration: (i) ICT infrastructure already in place; (ii) ICT skill levels in the institution; (iii) number of staff and students in each department and projected growth; (iv) academic management process: curriculum development, assessment methods and administration; (v) cost-effectiveness analysis (including hidden costs) and the choice of proper technologies for the needs of the institution; and (vi) staff development in new technologies

Awareness and attitude towards ICTs: It is important for all stakeholders in the institution to know the existing ICT facilities and services and their importance in relation to their specific tasks. However, according to Tusubira and Mulira (2004), there tends to be some vague knowledge about ICTs, some interpreting them as simply advanced technologies that require a lot of money and very advanced skills. They are not appreciated as a means of creating efficiency and cost-effectiveness. Lack of awareness goes along with attitude. Positive attitude towards ICTs is widely recognized as a necessary condition for their effective implementation (Woodrow 1992). Full involvement of all stakeholders in the implementation process is a key to addressing awareness and attitude problem. Formally organized awareness programmes, visits to similar institution where success has occurred, and short trainings can contribute to raise the awareness and change the attitude of stakeholders towards facilities and services.

Administrative support: Administrative support is critical to the successful integration of ICTs into teaching and learning processes. Administrators can provide the conditions that are needed, such as ICT policy, incentives and resources. The commitment and interest of the top management and other leaders at every level is the most critical factor for successful implementation of ICTs. According to Cameron and Ulrich (1986), a transformational leadership is a leadership that involves a process of fundamental change which is required for the institutions to adapt to changes brought about by the information society[3]. Dwyer *et al* (1997) emphasize that for the integration of ICTs to be effective and sustainable, administrators themselves must be competent

in the use of the technology, and they must have a broad understanding of the technical, pedagogical, administrative, financial, and social dimensions of ICTs in education.

Technical support: This includes issues like installation, operation, maintenance, network administration and security. This is an important part of the implementation and integration of ICT in education system. In most cases however, technical support is not available, which implies that trainers and students require some basic troubleshooting skills to overcome technical problems when using ICTs. However, in most of the developing countries including Tanzania there are very few technical experts to implement and maintain ICTs (Bakari *et al.*, 2001; National Committee for WSIS Prepcom II 2003). Appropriate strategies should be in place to ensure that integration of ICTs in teaching and learning process goes together with the recruitment, training, retaining and retention of required staff.

Transforming higher education: Many institutions fail to integrate ICTs into teaching and learning because they are using ICTs to replicate their traditional practices, content and control. Their plans appear to be driven by ICTs and not by pedagogical rationale and focus (Ehrmann 1995). However, effective integration requires a transformation process where all stakeholders are involved to re-examine their existing structures and practices, as pointed out by Bates (2000: 13), if universities and colleges are to successfully adopt technologies for teaching and learning, many more than minor adjustments in current practice will be required. Indeed, the effective use of technology requires a revolution in thinking about teaching and learning. Part of that revolution necessitates restructuring universities and colleges – that is, changing the way higher education institutions are planned, managed and organized.

Staff development: Integration of ICT in teaching and learning does not only deal with introduction of new hardware and software, but both trainers and the students have to adopt new roles, and change their ICT behaviors and ways of teaching and learning. As Farrell (1999) points, training and workshops are needed not only to improve the skills of the instructors, but also as a means of getting them involved in the process of implementing and integrating ICTs in teaching and learning. For example, faculty staff require training not just in the choice and use of appropriate technologies, but more fundamentally in how people learn and in instructional design (Bates 1997). Pelgrum (1999) recommends staff training to be a continuous process for regular updates with the development of ICTs.

Lack of ownership: It is critical that all stakeholders contribute to and own the policy and the plan. Institution-wide consultations are necessary in the identification of challenges, and in proposing areas for ICT application. Stakeholders must agree on the projects to be implemented, including their role therein. Employees must see ICTs as tools rather than as competitors for their jobs. A related challenge is getting stakeholders in an organization to think for the organization, rather than the natural tendency of considering the interests of their particular departments.

Inadequate funds: Financial resources form a key factor to the successful implementation and integration of ICTs in education. It is obvious that countries with higher financial resource bases stand a good chance than those with limited resources to reap benefits offered by ICTs. In addressing the problem of limited funds and sustaining donor funded projects, higher learning institutions can do the following: (i) adopt freeware and open source software for teaching and learning activities; (ii) continuously press for more funds from their governments; and (iii) diversify sources of funds to have a wide financial base.

CONCLUSIONS AND RECOMMENDATIONS

ICTs provide great opportunity for universities in developing countries to improve their teaching and learning processes. So far most of the universities in developing countries possess basic ICT infrastructure such as Local Area Network (LAN), internet, computers, video, audio, CDs and DVDs, and mobile technology facilities that form the basis for the establishment of e-learning. It is argued that, universities in developing countries should adopt e-learning technologies to improve teaching and leaning processes. Pedagogical, technical and cost issues should be taken into account for each specific technology when integrating ICTs in teaching and learning practices.

Endnotes

[1] The strategies, techniques, and approaches that trainers use to facilitate learning.

[2] Moving Picture Experts Group. The standard for compression and storage of motion video, for example, videos available though the World Wide Web.

[3] A society in which economic and cultural life is critically dependent on information and communications technologies.

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