Use of ICT in Science and Engineering:

A Case of University of Malawi

Harry S H Gombachika
University of Malawi
The Polytechnic
Private bag 303
Chichiri, Blantyre, Malawi
hgombachika@poly.ac.mw

Chipo Kanjo
University of Malawi
Chancellor College
P. O. Box 280
Zomba, Malawi
ckanjo@chanco.unima.mw

Executive Summary

This paper discusses the status and use of ICT in Science and Engineering in higher education in Malawi focusing on the University of Malawi. In addition, it discusses the challenges so that we learn from the achievements so far in the presence of these challenges in order to map the way forward.

Higher education in Malawi constitutes Universities, Teacher Training Colleges, Nursing Schools, Natural Resources Colleges/Farm Institutes, Technical Colleges, Theological Colleges, Secretarial Institutions, Computing Colleges and a number of private Institutions offering courses ranging from Computing, Business Studies, Corporate Governance, and many more. Most of these higher education institutes use ICT facilities.

University of Malawi, which was established in 1965, is based on a federal structure, with a central office and 5 colleges: Chancellor College, Malawi Polytechnic, College of Medicine, Bunda College of Agriculture and Kamuzu College of Nursing. These colleges offer various courses, which include science and engineering.

In pursuant of her academic objectives, the University of Malawi faces several challenges including inadequate and unstable funding, high demand for university places, and shortage of well-qualified human resources. The University has nevertheless responded to some of the challenges through distance and e-learning, parallel programmes, use of ICT and formulation of relevant policies.

In Malawi, access to ICT is very low and concentrated in urban areas. However, through a National ICT policy, the government of Malawi aims at transforming the Malawian society and economy into an information and knowledge-based. In addition, among other things,

the policy provides for improvement of education institutions through ICT and improvement of ICT sector using higher education institutions. Similarly, the University of Malawi recognises and exploits the symbiotic relationship between higher education institutions and ICT. To this end, the University of Malawi uses ICT to enhance the institution activities and processes. On the other hand, the University is being used to increase awareness, skills and expertise in ICT sector. In particular, ICT in Science and Engineering is used to model and analyse systems, simulate systems, calculate and solve engineering and scientific problems, and capture and explore experimental data.

Having said that, ICT in the University of Malawi faces several challenges including inadequate resources such as bandwidth, hardware and software, lack of policies to guide development and exploitation of ICT, and limited ICT awareness and skills. Therefore, in order to realise the potential of ICT, the University should formulate an ICT policy, train staff members on the use of ICT, and provide a conducive environment where novel ideas on the use of ICT are harnessed and exploited.

Acknowledgements

We wish to express our gratitude to Mr Noel Jambo system administrator for Bunda College of Agriculture and Mr Anthony Muyepa of College of Medicine for providing information on current ICT status at Bunda and College of Medicine, respectively.

Table of Contents

1 Introduction

More recently, it has widely been recognised that in education, Information and Communication Technology (ICT) holds the promise of transforming learning in new and powerful ways. This is the case as it allows for a wide range of people to access the content needed to improve their knowledge and professional skills without having to travel distances to a school. Despite socio-economic problems in recent years such as poor national economic performances, weak internal management systems, inappropriate governing structures, and low infrastructure, many institutions of higher learning in sub-Saharan Africa have attempted to exploit opportunities offered by ICT in teaching and learning. These opportunities have been exploited at all levels, from primary to higher education. Malawi's education starts at pre-school level, then primary, secondary and ends with tertiary level. Most of the school going population has primary level as entry point, whilst a few have the opportunity to start at pre-school level. Research has shown that the younger the person, the more one can learn and grasp concepts. Much as one is able to grasp new things at a young age, reality in Malawi in the area of ICT is different. One is hardly exposed to ICTs (particularly the modern ICTs such as computers) in schools at primary level, and only a few secondary schools have ICTs. This paper, therefore, discusses the status and use of ICT in higher education (tertiary level) in Malawi and discusses the challenges so that we learn from the achievements so far in the presence of these challenges in order to map the way forward. The paper starts by describing the higher education situation in Malawi, then reviews current status of ICT in Malawi in general and ICT in Science and Engineering in the context of higher education, particularly in the University of Malawi. Following which the challenges are discussed and this is followed by suggestions on the strategies and methods that may address the gaps considering the challenges.

2 Higher education in Malawi

Higher education in Malawi constitutes universities and a number of tertiary institutions. Compared to secondary schools, we have much fewer institutions offering higher education. These include Universities, Teacher Training Colleges, Nursing Schools, Natural Resources Colleges/Farm Institutes, Technical Colleges, Theological Colleges, Secretarial Institutions, Computing Colleges and a number of private Institutions offering courses ranging from Computing, Business Studies, Corporate Governance, and many more. Most of these higher education institutes use ICT facilities. Although there seems to be several institutions of higher learning options after secondary education, the greatest challenge is that demand and supply levels do not match. In the case of government institutions, the supply depends on space (ie. bed space and classroom space), where as for the privately owned institutions, other factors have to be considered such as cost.

2.1 Universities

Currently, Malawi has two public and two private universities, however, up to 1990s, the country had only one university – University of Malawi. University of Malawi, the first public university in Malawi was established in 1965, Mzuzu University is the second public university and was established in 1998. Livingstonia University (established in 2003) and Catholic University (established in 2005) are the two private universities in Malawi.

The University of Malawi is based on a federal structure, with a Central Administration Office in Zomba and 5 colleges: Chancellor College in Zomba, Malawi Polytechnic in Blantyre, College of Medicine in Blantyre, Bunda College of Agriculture in Lilongwe and Kamuzu College of Nursing in Lilongwe and Blantyre. The colleges tend to have their main academic focus. For example, the Malawi Polytechnic focuses on Information Technology and Systems, Engineering, Commerce, Applied Sciences, Education, and Media Studies. Chancellor College focuses on pure

Sciences in the faculty of Science- which includes Computer Sciences; Social Sciences and Political Science in the faculty of Social science; Education faculty; Arts in the faculty of Humanities; and Law in the faculty of Law. College of Medicine offers medical courses, which include community health and medicine. Bunda College of Agriculture offers agricultural related courses such as irrigation engineering, agriculture engineering, environmental, animal and crop science courses etc. Finally, the Kamuzu College of Nursing offers nursing courses.

Mzuzu University offers education courses – both science and humanities and health and environmental courses, and Livingstonia University has started with education courses.

2.2 Other Tertiary Institutions:

In addition, there are other institutions that offer degree programmes, namely: National College of Information Technology (NACIT), privately owned Share World, African Bible College (ABC), and CBET owned by BUMAS International. The government of Malawi through the Ministry of Information and Tourism owns NACIT. In addition, Malawi has other institutions offering higher learning which include: the Domasi College of Education (DCE): an institution that trains secondary school teachers to Diploma level; several Teacher Training Colleges (TTCs) spread across the country: some government owned, others owned by Churches and NGO like the Humana from People-to-People. Technical Colleges (Technician and Artisan Training), Malawi Institute of Education, Nursing and Health Sciences Schools, Theological Colleges are amongst the higher education institutions as mentioned earlier. Furthermore, the country has privately owned institutions of higher learning, which offer courses ranging from Management, Corporate Governance, and Information Technology. Currently, the trend is that more information technology offering Institutions are mushrooming compared to Institutions offering other courses.

2.3 Educational Challenges of University of Malawi

Firstly, in the early years, the University of Malawi was funded mainly through donor financial support; as such, the university was well supplied in terms of books, laboratory equipment and materials. However, in the early 1990s, the donors reduced funding to Malawi, which meant that funding to the University was affected. Currently, the University is funded mainly through the government of Malawi subvention. This source of income is unreliable and most of time inadequate. This has negatively affected the teaching and learning activities in the University of Malawi. The areas that have greatly been affected by low funding levels are science and engineering. Courses in these areas are expensive to run because they require expensive laboratory equipment and materials for experiments and practical sessions. Furthermore, textbooks used in Science and Engineering courses are generally expensive. The implication of this situation is that the once interesting courses in science and engineering, through laboratory experiments, have been reduced into a series of lectures; consequently, the courses in science and engineering have become abstract.

Secondly, recently education policies have tended to focus on primary and secondary levels. This means that most of Government of Malawi resources earmarked for education sector are channelled to primary and secondary school levels activities and programmes. In addition, the policies in education have inadequately acknowledged the role of ICT although education has been recognised in the National ICT policy. This means that although policy makers in ICT have recognised the role education plays in ICT, policy makers in education have not yet fully recognised the role ICT plays in education.

Thirdly, demand for higher education is greater than supply, which is normally determined by bed and/or classroom space. For example, out of approximately 4300 students who qualified for University education in 2005, only 20% were admitted into the University of Malawi.

Finally, there is shortage of human resource due to brain-drain and HIV/AIDS epidemic. Some lecturers, once trained, leave the university of Malawi for greener pasture in other Universities in the region or overseas. Furthermore, the University of Malawi loses some well-qualified lecturers due to HIV/AIDS related deaths.

Having said that, the University of Malawi has responded to some of the challenges in various ways. Firstly, the University offers some of its programme through distance education. More recently, the university has started offering some courses through e-learning. For example, the Malawi Polytechnic has introduced a diploma programme in Transportation Operation and Management under the NetTom programme and has proposed to start a postgraduate diploma in ICT management in 2006 under the NeTTel programme. These programmes enable the University to extend access of university education to those who otherwise would be unable to access university education because of limited bed and classroom spaces or because they are working and the demands of their work may not allow them to attend classes.

Secondly, the University of Malawi offers courses through a parallel programme. In this context, additional students are admitted into the University; however, the students are required to pay economic fees and do not demand bed space. This has extended access to university education to a wide portion of the population and supplemented the university revenue, which is used to modestly supplement staff salaries and buy teaching and learning materials. However, the parallel programme has exacerbated the problem of classroom space.

Thirdly, the University of Malawi encourages the use of ICT in Teaching and Learning. To this end, some lecturers at every college use ICT in preparing and delivering lectures. Students on the other hand are encouraged to use ICT in their assignments and reports. Most recently, the University of Malawi

has revived its University wide ICT committee as a way of ensuring common ICT standards and policies within the University of Malawi.

Finally, the University of Malawi is in the process of formulating an HIV/AIDS policy that aims at mitigating the effects of HIV/AIDS on University operations. I addition, the University plans to include an HIV/AIDS module in the curricula for all programmes in the University.

3 ICT Situation in Malawi

ICTs are available mostly in institutions of higher learning, and organizations that reside in urban areas. There is remarkably shortage of ICTs in the rural areas where about 80% of the population reside. In cases where ICTs are available, either they are not easily accessible or they are not affordable. As a consequence, most people do not have access to ICTs simply because they are poor, illiterate, or have other more pressing needs such as food, housing, and health care including the HIV/AIDS pandemic.

In terms of access, in a country with a population of about 12million, there were only 85000 telephone lines, 135100 mobile phone subscribers, and 36000 Internet users recorded by 2003. These figures indicate that only 1.1% of the total population had mobiles and only 0.3% of the country population had access to Internet by 2003. In the case of the telephone lines, though the number of lines is only 0.7% of the population, this percentage could be higher considering the fact that several people could share one telephone line. However, even if each telephone line were to be shared by ten people, only 7% of the population would have access, which is still very low. The non-availability of the ICTs is mostly due to lack of the core infrastructure such as power supply and telephone lines, particularly in the rural areas. In areas where the power supply is present, it is unreliable, especially during rainy season due to frequent blackouts, and these tend to sabotage ICT projects implementation, which are largely electricity-driven. The life span of ICT equipment is also adversely affected by these blackouts and fluctuations in power levels.

3.1 ICT National Policy

The Malawi national ICT policy was drafted and is still under discussions. The policy was formulated through a nation-wide consultative process involving key stakeholders in the public sector, private sector and civil society reflecting the nations commitment to pursue an ICT-led socio-economic development agenda. The policy takes into account the aspirations and provisions of key socio-economic framework documents including the Vision-2020, Malawi Poverty Reduction Strategy Paper (Ministry of Finance and Economic Planning 2002), communication sector policy, and Malawi Science and Technology Policy statement (National Research Council of Malawi 2002).

The mission of the ICT policy is to transform the Malawian society and economy into a predominantly information and knowledge-based middle-income economy by modernising its key development sectors using ICT (Ministry of Information and Tourism 2005).

In order to achieve its mission, the policy pursue goals targeting the following:

(a) Developing Malawi's information society and economy,

(b) Pursuing a multi-sectorial ICT-led socio-economic development; and

(c) Developing Malawi's ICT sector.

The policy statement recognises the role ICT plays in higher education on one hand and the role higher education institutions play in popularising ICT. In this regards, among the 14 pillars of the policy, accelerated human resource development and promotion of ICT in education are ranked highly.

The policy, therefore, has put in place several strategies that aim at deploying and exploiting ICT to support the delivery of education among other developmental sectors.

Firstly, the Malawi government aims at modernising Malawi's education system using ICTs to improve and expand access to education, training and research resources and facilities; improve the quality of education and training; and make education systems responsive to the needs and requirements of the economy and society. Furthermore, the policy aims at developing educational management and information systems to improve the quality of management of education institutions.

Secondly, the policy promotes electronic distance education and training and virtual learning systems to complement and supplement face-to-face campus based education and training systems; leverages the use of electronic distance learning networks to enhance the delivery of education; encourages e-learning by promoting Internet access to all educational institutions including schools, universities and colleges; and ensures that all universities and colleges take steps to progressively offer their programmes and courses online to broaden access to higher education to a large section of the population; thus maximising the quality and efficiency of learning process, systems and activities.

On the other hand, the national ICT policy has identified higher education institutions as part of key implementation agencies, players and stakeholders. Towards that end, several strategies are spelt out in the policy document that use Higher education institutions to support ICT.

Firstly, through institutions of higher education, the Government of Malawi aims at having an economy based on a literate society with a high proportion of computer literates; an economy characterised by technology-based knowledge-driven industrial sector backed by cutting-edge research and development activities. Furthermore, the government of Malawi encourages higher education institutions to develop ICT training programmes for management and staff of the Ministry of Education institutions at all levels.

Secondly, the policy aims at promoting basic training in ICT skills; transforming Malawi into an information and knowledge-driven ICT literate nation; promoting ICT awareness and computer literacy within the public at large and developing and restructuring relevant ICT curricula for all levels of education system.

Thirdly, the policy aims at developing human resources to support the deployment and rehabilitation of modern and state-of the art ICT infrastructure.

Finally, through the policy, the government of Malawi aims to support and strengthen scientific research and development within the nation's universities and research institutions as basis for promoting the development of a globally competitive local ICT sector and industry. In addition, it aims to encourage and fund ICT research and development (R&D) in the nation's universities and research institutes; and setup special libraries for various people to access and utilise them.

3.2 ICT in Higher Education

The University of Malawi recognises and takes advantage of the symbiotic relationship between ICT and Higher education. In this context, ICT has been used to enhance educational systems, activities and processes on one hand; the University has been used to increase awareness, skills and expertise related to ICT, on the other.

3.2.1 ICT as a Tool for Higher Education

In general, ICT is used to enhance educational institutions in order to optimise utilisation of resources and maximise the quality and efficiency of learning process, systems and activities.

Firstly, ICT is being used to effectively manage the education activities. Towards that end, constituent colleges of the University of Malawi use ICT to manage students' records, human resource records and accounting

information. However, colleges have developed such information systems without coordination making sharing of information difficult. In addition, the University provides ICT to facilitate effective and efficient communication through electronic communication. However, most communication within the University remains predominantly through hardcopies.

Secondly, lecturers and students use ICT in all colleges to search for teaching and learning materials, and research information on the Internet. In addition, lecturers and students use ICT to access Library information, online databases and journals (such as HINARI, PERI, JSTOR) at all college libraries with varying degree of competence.

Thirdly, students and lecturers use ICT in teaching, learning and research activities. For example, students use packages such as Matlab, MathCAD, SPSS, AutoCAD, VISIO and programming languages such as C, C++, PASCAL, JAVA, VISUAL BASIC in their education activities. Common packages such as Microsoft Office are used to prepare teaching and learning materials, reports and presentations. College of Medicine has adopted a method whereby lecturers are encouraged to have their notes in electronic format, and stored on a server. This enables students to access the notes anytime, and gives room for the lecturer to update the notes. They also are moving towards bringing technology into classrooms (having fixed computers and overhead projectors) so that the lecturer doesn't have to bother with chalk and dusters.

Fourthly, ICT is used for extending the reach of University programmes through e-learning. As stated earlier on, the Malawi Polytechnic has introduced two distance education programmes through e-learning namely: diploma in Transport Operations and Management under NeTTom and postgraduate diploma in ICT management under NeTTel programme. In addition, Bunda College of Agriculture, Malawi Polytechnic and Chancellor College act as CISCO academies where courses under the CISCO curriculum are offered through e-learning.

Finally, ICT is used in Research; for example Chancellor College has a Wireless Technology Research Group looking into the use of wireless technology in the Health sector

3.2.2 Higher Education as a Tool for ICT

Higher education institutions can be used to popularise ICT in general. Towards that end, the University of Malawi has encouraged the inclusion and use of common computer packages (MS Office packages: Excel, Word, PowerPoint) in the curricula for most programmes in all colleges. The idea is that once the graduates leave the University, they should continue using computers in their various activities. In other words, ICT should be integrated in the students' normal working habits.

The University has approved programmes that train Malawians in Computer Science at Chancellor College, Business Information Systems, and Information Technology at the Malawi Polytechnic. These programmes provide the much needed expertise and skilled human resources necessary to support ICT in the country. Furthermore, the University of Malawi is part of the National Research Education Network (NREN).

Finally, some programmes in the University include ICT as a tool that supplements some courses. For example, AutoCAD is highly used in Architecture, Mechanical and Civil Engineering courses; Matlab and Electronic Workbench are used in Electrical Engineering, GIS and remote sensing is used in Land Surveying and Geography, and SPSS in Social Science.

3.3 ICT in Science and Engineering

In the University of Malawi, ICT is used in various ways, mainly as a tool that supplement traditional face-to-face teaching and learning of Science and Engineering. The usages identified are as follows:

(a) ICT is used to model engineering and scientific concepts and systems in order to develop and encourage an understanding of science and engineering. For example, students at the Malawi Polytechnic use AUTOCAD, Electronics Workbench, Microsim, PSPICE and Matlab to model and analyse engineering systems.

(b) ICT is used to capture and explore experimental data. In this regard, data-loggers are used to collect data; and using charting tools in Ms Excel, Matlab, and SPSS, graphs are plotted to display distributions and patterns; and compare various performance scenarios of Scientific and Engineering systems. For example, at Bunda College, data-loggers are used to collect data on animal and crop science related courses and research while data loggers are used for energy audit and management projects at the Malawi Polytechnic. At Chancellor College ICT is used in data manipulation and in phyisics and mathematical modelling. Furthermore, personal computers coupled with appropriate transducers and actuators are used as measuring instruments such as oscilloscope, voltmeter, spectrum analyser, and function generator.

(c) ICT is used to calculate and solve engineering and scientific mathematical problems. In this regard, computer packages such as MS Excel, Maple, Mathematica and MathCAD are used. In some cases, special programs are written in C/C++, PASCAL, and Basic to solve Scientific and Engineering problems. At Chancellor College, ICT is used to develop software both as part of a course or for use at institutional level.

(d) ICT is also used to simulate scientific and engineering systems and consequently experiment with the simulation models. The models are used for research as well as teaching and learning activities.

(e) ICT is used to support teaching of science and engineering. In this regard, practical sessions, demonstrations or field trips are recorded on videotapes and then played back to students. In addition, some of the lessons are on videotapes and DVDs. Using the audio/video rooms mainly in college libraries; students can watch the tapes at their convenient time. This is mainly used in nursing, medicine, engineering processes, chemical processes, animals and crop sciences courses.

4 Challenges

Realisation of ICT in higher education in general and science and engineering in particular is faced with various challenges and the University of Malawi is no exception.

Firstly, the University has not formulated a policy on ICT; and apart from College of Medicine, no college has prepared its ICT policy to guide the development and utilisation of ICT. The implication of this is that most networks in University of Malawi colleges have evolved in an ad-hoc manner without coordination making sharing of information and resources very difficult. In addition, there is lack of properly documented inventory for ICT resources at all colleges. This makes sharing of resources and experiences of success stories on the use of ICT very difficult.

Secondly, most colleges have very limited bandwidth affecting Internet connectivity. In some cases, the limitation of bandwidth is due to the fact that the channel capacities available are not enough, where as in some cases it is due to bottlenecks caused by viruses and Spam. Coupled with limited bandwidth, there is limited number of workstations and peripherals, and powerful servers to support the demands of ICT within colleges. The traditional mindset of depending on donors for financial and material support blinds the University of opportunities available within the institutions.

Thirdly, there is lack of integrated education management information system for use in tertiary institutions in the country in general and in the colleges of the University of Malawi in particular. This makes it difficult to share information and resources. Furthermore, acquisition of proprietary software is very expensive as each college or institution does it separately. A plausible solution could be the use of open source or software under the GNU public licence; however, most people have a feeling that the quality of open source may not be comparable to proprietary software.

Finally, although ICT has been part of the University system for some years, there are still many in the University who are not really aware of the potentials of ICT; as such, issues of ICT play a second fiddle in most committees of the University, and provision of ICT in the university budget takes a back seat. Furthermore, university traditionalists are less willing to take up opportunities that ICT offers.

Having identified the challenges faced in the University of Malawi regarding ICT, we make the following suggestions as a way forward.

(a) A University-wide ICT policy should be formulated that should consider provisions in the National ICT policy and take on board aspirations of various colleges in the University. The University-wide policy should therefore benchmark policies for various colleges in the University.

(b) ICT training should be part of staff development programmes so as to increase the awareness and skills in the use of ICT in Science and Engineering.

(c) Workshops should be organised frequently, where success stories of ICT use in colleges, country and region are shared. This may raise the confidence of other institutions in the use of ICT. Coupled to the sharing of experiences, pilot studies in the use of ICT in various disciplines of the University of Malawi should be conducted to

demonstrate appropriate and relevant use of ICT in Science and Engineering.

(d) Dissemination of information through discussion forums, knowledge bases, list-groups should be encouraged where cases studies of how ICT has been effectively used to enhance educational institutions, activities and processes could be deposited and discussed.

(e) The University should explore means on how it can integrate its resources to acquire large bandwidth, software and hardware by exploiting economies of scale. Furthermore, it should consolidate its position in society in order to influence government of Malawi policies that are conducive to the development of the University in general and ICT sector in particular.

5 Concluding Remarks

The paper has discussed the status and use of ICT in Science and Engineering in higher education in Malawi focusing on the University of Malawi. It has furthermore discussed the challenges so that we learn from the achievements so far in the presence of these challenges in order to map the way forward.

In Malawi, access to ICT is very low and concentrated in the urban areas. However, through a National ICT policy, the government of Malawi provides for improvement of education institutions through ICT on one hand and improvement of ICT sector using higher education institutions. Similarly, the University of Malawi recognises and exploits the symbiotic relationship between higher education institutions and ICT. To this end, the University of Malawi uses ICT to enhance the institution, activities and processes. On the other hand, the University is being used to increase awareness, skills and expertise in ICT sector. In particular, ICT in Science and Engineering is used to model and analyse systems, simulate systems,

calculate and solve engineering and scientific problems, and capture and explore experimental data.

The University of Malawi has made these achievements in the presence of several challenges including inadequate resources such as bandwidth, hardware and software, lack of policies to guide development and exploitation of ICT, and limited ICT awareness and skills. However, in order to realise the potential of ICT, the University of Malawi should formulate an ICT policy, train staff on the use of ICT, and provide a conducive environment where novel ideas on the use of ICT are harnessed and exploited.

6 References

Ministry of Finance and Economic Planning 2002, *The Malawi Poverty Reduction Strategic Paper*, volume 1,

Ministry of Information and Tourism 2005, *Draft Malawi National Policy Document*, Lilongwe, viewed on 27 September 2005 <http://wwww.sdnp.org.mw/ICT/ >

National Economic Council of Malawi 1998, *Malawi Vision-2020*, viewed on 26 September 2005, <http://www.sdnp.org.mw/~esaias/ettah/vision-2020>

National Research Council of Malawi 2002, *National Science and Technology Policy*, viewed on 30th September 2005, <http://www.sndp.org/nrcm/nstp>