



INFORMATION AND COMMUNICATION TECHNOLOGIES

– **IMPROVING RELEVANCE AND QUALITY OF
EDUCATION IN SCIENCE & ENGINEERING**

Sub-Regional Workshop Report

September 2005, Harare - Zimbabwe

ACRONYMS

AAU	Association of African Universities
ADEA	Association for the Development of Education in Africa
ANSTI	African Network of Scientific and Technological Institutions
BREDA	Bureau Regional pour l'Education en Afrique
CCS	Central Computing Services
CITEP	College Information Technology Enhancement Programme
EDI	Education Development Indicators
IBSP	International Basic Sciences Programme
ICTs	Information and Communication Technologies
MIU	Mobile Internet Units
NECF	National Economic Consultative Forum
NESIS	National Education Statistical Information Systems
NUC	National Universities Commission of Nigeria
NUST	National University of Science and Technology
RIRC	Rural Internet Resource Centres
SADC	Southern African Development Community
SAIDE	South African Institute for Distance Education
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VADOC	Vocational and Development Centres
VIHEAF	Virtual Institute for Higher Education in Africa
VIHEP	Virtual Institute for Higher Education Pedagogy
WAN	Wide Area Network

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FOREWORD

Whenever we see or hear the term Information and Communication Technologies – popularly referred to as ICTs in the public domain – the first thing that lights a bulb in our head is computers. This is because ICTs is only associated with new or emerging technologies, yet prior to modern civilisation, the human race was already experimenting with and using some form of technology. The pyramids of Egypt, the communicating drums, horns and cave paintings from many tribes in the African continent, the Indian flute and the animal sounds made by the bushmen of the Kalahari are just a few examples of technology at its best, crude but highly effective.

It is therefore important not to forget where technology has come from and to appreciate progress made in refining the 'old' technologies and discovering new ones. In terms of teaching, learning and research in the field of science and engineering, modern technological tools can still integrate well with some of the cultural practices in a bid to perform the very important function of discovering through communication. This report discusses some of those aspects and looks at how both new and old technologies can be used effectively in improving quality and relevance of teaching, learning and research methods in science and engineering in higher education. The report covers various country presentations and experiences, and looks at the use of ICTs in areas such as music and story telling – the latter can be considered as unlikely source for such intervention. Other areas covered are graphics design, radio programmes, knowledge bases, and virtual tools such as libraries and laboratories, making it a must-read for the inquisitive person.

A quick scan of the recommendations from the workshop indicate the seriousness and commitment exhibited by all those who participated in the workshop, an indication that Africa is ready to gallop if that is what it takes to catch up with the rest of the world. I hope that the lessons learnt as highlighted in the report will add to the all-important process of critically reducing the existing digital gap between developing economies such as Africa, and the rest of the first world.

The information about how you can use various tools to enhance communication in teaching, learning and research processes in higher education is an excellent resource all on its own. I wish you happy reading as we strive to bridge traditional and modern ICT tools in refining quality and relevance of higher education in Africa!



Professor Juma Shabani
Director and Representative
UNESCO Harare Cluster Office

INTRODUCTION

The impact of Information and Communication Technologies (ICTs) on teaching, learning and research in higher education has been increasing steadily in recent years, providing new opportunities for expanding traditional education and research processes and improving both the relevance and the quality of higher education. This workshop is part of the project "ICTs in Science and Engineering in Africa," which is being implemented under the UNESCO projects relating to the cross-cutting theme on "The Contribution of ICTs to the Development of Education, Science and Culture and the Construction of the Knowledge Society".

Workshop Objective

The major objective of the workshop was to enhance learning and research opportunities in higher education, science and engineering in Africa through effective use of ICTs in teaching, learning and research.



OFFICIAL OPENING



A section of participants during the official opening.

WELCOME REMARKS

Mr. Shem Bodo, NESIS IT manager and facilitator of the workshop, welcomed all delegates, and particularly the guest of honour, Professor Levi M. Nyagura (Vice Chancellor of the University of Zimbabwe), Professor Joseph Massaquoi (Director of UNESCO Regional Office for Science and Technology in Africa – UNESCO/ ROSTA and Coordinator of African Network of Scientific and Technological Institutions – ANSTI), Mr. J. J. Mhlanga (Secretary General of the Zimbabwe National Commission for UNESCO) and Professor Juma Shabani (Director and Representative of UNESCO Harare Cluster Office).

Welcome remarks from Professor Juma Shabani, Director and Representative of UNESCO Harare Cluster Office

In his opening remarks, Professor Juma Shabani, welcomed delegates and informed them that the meeting had been jointly organized by the UNESCO Harare office together with various partners who included the Zimbabwe National Commission for UNESCO, UNESCO/ROSTA, UNESCO BREDa and the National Universities Commission of Nigeria (NUC).

He conveyed greetings from the Dakar office and presented apologies on their behalf for not being able to take part in this meeting. He also informed participants that the delegates from the NUC would join the group in the last two days. A proposal was then made for a programme revision.

He explained that this workshop was a small meeting of experts, and would be hands on, and hoped that participants' capacities in the use of ICTs in science and engineering would be strengthened. He encouraged participants to share information and explained that capacity building could not just be done in workshops. He hoped that from this meeting a number of follow up actions would emerge. He expressed the hope that through virtual discussion forums participants would also continue building each other's capacities after the workshop.

Professor Shabani informed participants that he hoped that deliberations from this meeting would lead to the finalisation of an existing draft manual on ICTs. He highlighted that the outcomes of the meeting included familiarising participants with existing technologies, strengthening capacities in the use of ICTs and strengthening their ability to develop national virtual libraries for teaching, learning and research in science and engineering. The workshop would include visits to the University of Zimbabwe and the Harare Institute of Technology, to how ICTs are being used in Zimbabwe. He hoped that these would be taken as preliminaries for additional interactions. In closing he wished the participants fruitful deliberations.

Remarks by Mr. Josiah J. Mhlanga, Secretary General of the Zimbabwe National Commission for UNESCO

The Secretary General of the Zimbabwe National Commission for UNESCO thanked Professor Shabani, the main convener of the meeting and, on behalf of the government of Zimbabwe and the National Commission, extended a warm welcome to all delegates. He commended the collaborative planning strategy adopted in organising the workshop, saying that this was a cost effective manner of organising events such as this, as well as providing an opportunity for information sharing. He expressed confidence that that the workshop objectives would be achieved with the expertise of the resource persons.

He noted that in the past Africa had depended on using expertise from overseas, but now there was more to be gained from the south-to-south collaboration of experts. His main concern now was that through the brain drain the south was becoming a training ground for the west, and he called on key stakeholders to improve conditions of service for those remaining. Lack of modern facilities was also a major factor in retaining personnel. He suggested that ways be found to encourage those in the Diaspora share their expertise in their home countries during sabbaticals. He also requested UNESCO to assist in topping up salaries for personnel where institutions and government could not afford to do so.

The Secretary General also remarked on the two visits, and encouraged participants to find time to visit other places in Zimbabwe. He also informed them of the housing initiative the Zimbabwean government had embarked on. He expressed hope that they would gain first hand information on Zimbabwe, and from their experiences would become ambassadors of good will for Zimbabwe on their return.

Remarks by Professor Joseph Massaquoi, Director of UNESCO/ ROSTA

Professor Joseph Massaquoi, Director of UNESCO Regional Office for Science and Technology in Africa UNESCO/ROSTA and Coordinator of ANSTI, indicated that the goal of this workshop was to promote use of ICTs in higher education, learning and research, with special emphasis on science and engineering. He stated that this was an important issue in Africa. He cited the example of Nairobi where there were shortages of crucial resources such as textbooks, and that ICTs provided the potential to enable access to low cost educational materials. Secondly, in Africa ICTs can address the lack of adequate human resources, as they enable staff to teach anywhere and at any time.

Professor Massaquoi provided a background to this workshop, indicating that since 2002 UNESCO has continued to engage all disciplines to pursue its mandate of addressing the pressing issue of eradicating poverty. In this regard he indicated that UNESCO/ROSTA was pursuing the use of ICTs, with its main focus being capacity building.

He further elaborated that his organisation had carried out research to assess needs of 5 universities in Africa, in order to identify requirements. The main findings indicated that the issue of ICT policies, Internet connectivity, and training of staff to develop relevant content were common needs in these institutions. Using this pilot research, a meeting was held with stakeholders from all over Africa to discuss these issues. The meeting found that there was a need for training programmes on ICTs. So far ANSTI has produced and distributed over 200 CDs. They have in addition held two Regional Train the Trainer workshops and sponsored national workshops in countries as diverse as Ghana, Ethiopia and Zambia. ANSTI is also converting several science and engineering texts into electronic format. In closing, Professor Massaquoi thanked Harare UNESCO Cluster Office for hosting the meeting.

OFFICIAL OPENING REMARKS

Professor Levi M. Nyagura, Vice Chancellor of the University of Zimbabwe, officially opened the workshop. He spoke of the importance of ICTs, and also explained that

throughout history education has been the main determining factor of the progress of human civilisation. Education in the modern world is an instrument for development and the improvement of human welfare.

As economic competition grows more intense in a globalised world, education has become the major advantage, a vehicle for producing competent knowledge workers and a way for countries to attract jobs and investment. Raising the level of educational attainment is also a way of tackling poverty and deprivation. Education shapes the destiny of a nation and provides instruments for developing human capabilities. He indicated that today time and high staff turnover were major problems. It is now no longer possible to conceive of education without ICTs, as they offer tremendous new possibilities for research and wider communication.

Professor Nyagura stated that the use of ICTs applied to all facets of the learning process, but he argued that ICTs were particularly relevant to some particular disciplines. He considered that this had led to the development of distorted ICT policies, especially in the developing world. The lack of ICTs in the education sector, could be attributed to a shortage of funds to buy equipment, poor training and lack of motivation of teachers. Teachers need to adopt ICT as a dynamic learning tool. He stressed the need for more use of ICTs in science and engineering because education in these subjects is capital intensive in terms of the high costs of infrastructural requirements, equipment and unit cost per student. In his speech the Vice Chancellor cautioned participants not to overlook the issue of quality in their deliberations.

He highlighted that there was need to look into the issue of the small number of women in science and engineering in Africa. In his closing remarks, he recommended various measures which could be taken by stakeholders, institutions of higher learning, the international community and intergovernmental organisations, as well as governments and national authorities. He believed that through partnerships and collaborative efforts based on principles of cross-cultural, equitable and non-commercial development, the digital divide between higher education institutions in developed, developing and least developed countries could be bridged.

Box 1: Emerging issues from Speeches and Opening remarks

1. Brain drain and strategies of tapping expertise from those in the Diaspora.
2. Quality versus promotion of ICTs.
3. Need for institutions to collaborate more through mailing lists and discussion forums.
4. Need for institutions to actively participate and tap into ANSTI programmes and resources in development of ICTs.
5. Enrichment to the draft manual.
6. Identification of centres of excellence.

PRESENTATIONS

Presentation on UNESCO's Programme in Science and Technology in Africa

Professor J. Massaquoi in his presentation provided an overview of the UNESCO regular programme and the extra budgetary activities his office was engaged in. UNESCO/ROSTA was primarily involved in two major programmes in the Natural Sciences, the Science, Environment and Sustainable Development programme and secondly the Capacity Building in Science and Technology development programme. He provided information on the programmes, particularly the capacity building in Science and Technology programme, whose target group was universities, university staff and research institutions.

Professor Massaquoi further deliberated on ANSTI, a regional cooperation network for human resources that solicits financial support in order to augment UNESCO's capacity building programme. Established in 1980 by UNESCO through the help of UNDP and the German government, its aim is to develop high-level human resource capacity to undertake research and training in relevant areas of science and technology. To date ANSTI has a membership of 105 institutions from 35 countries. The main activities carried out by ANSTI include:

- Offering Training and Research Fellowship awards;
- Conducting seminars and workshops;
- Producing publications and disseminating information; and
- Awarding conference grants.



*Professor Juma Shabani
(center) with participants
from Zambia.*

To date, ANSTI produces several issues of the African Journal of Science and Technology and its textbook writing programme has published over 12 textbooks in basic science and engineering. Professor Massaquoi described the ANSTI database, which had information on science and technology institutions in Africa, Postgraduate training programmes and mailing lists of scientists. He explained ANSTI's project for the promotion of the use of ICTs in science and engineering education and the achievements to date. He encouraged participants to visit the following websites www.ansti.org and www.anstiweb.org for more information.

Presentation on International Basic Sciences Programme (IBSP)

Professor Juma Shabani provided an overview of the IBSP project, a UNESCO project whose main objective is to build national capacities for basic research, training, science education and popularisation of science through international and regional cooperation. The project seeks to transfer and share scientific information and excellence in science through North-South and South-South cooperation.

Some Implementation strategies for the project include:

- Promoting networks of national, regional and international centres of excellence, as well as between institutions in developed and developing countries.
- Cooperation with the International centre for theoretical physics.
- Implementation of recommendations emerging from the International year of Physics.
- Advancing research training for women and young scientists.
- Sharing of scientific information and improvement of science education.

Professor Shabani emphasised that it was important for UNESCO member states and partners to participate in the IBSP. He informed participants that in July 2004 a call was made for project proposals, and of the 252 proposals received only 20 were from Africa. For the 2005-2007 year, the scientific board has already selected 39 projects. He encouraged participants to seriously maximize and tap into existing funding initiatives promoting science and engineering.



Emerging Issues from the Discussion

Infrastructure

- Participants raised the issue that communications infrastructure, poor connectivity, and bandwidth issues were a major problem that their institutions and countries confronted, and asked whether ANSTI and UNESCO could mobilise funds for communication infrastructure to benefit science and engineering institutions.
- Professor Massaquoi stressed the importance of collaboration and encouraged institutions to mobilise themselves and press their governments to improve the communication infrastructure. He also encouraged them to work together in negotiating for reductions in the price of computer software and equipment with the corporate world. UNESCO is currently working on policies for ICT, and member countries were encouraged to consider these as they addressed some of the issues raised.
- Problem with Bandwidth was viewed as an issue to be addressed in the National ICT Policy, and universities should actively participate in the development of these policies.

National ICT Policies

- ICT policies both at National and Science and Engineering Institutions are very crucial and there is need for countries to develop these if they are to progress in promoting the use of ICTs.

Software Development

- The issue of lack of capacity in software development in Africa was raised, and there were deliberations on the benefits of making use of existing free open software versus developing capacities.
- Costs of software can also be cut when institutions work together and request for reduced or discounted prices with communication system companies. Professor Massaquoi highlighted that at one of the Association of African Universities (AAU) meetings, universities had suggested that they join forces to make purchases. ANSTI indicated that it could initiate and foster the development of software.

Centres of Excellence

- Identification of Centres of Excellence was crucial in order to enable continued learning and expansion of best practice initiatives in Africa.

Brain Drain

- The issue of the brain drain was also identified as it erodes any progress made in capacity building of personnel in the science and engineering field.
- Though not documented, it is believed that 90% of personnel trained do not leave Africa. It is also believed that 60% always return to the place where they were trained, and so the brain drain is not as serious as believed by many. Professor Shabani informed participants that UNESCO and the World Bank were currently working on documenting the issues of brain drain to which there is currently no solution.
- There is need to further explore ways of encouraging those who have moved to the Diaspora to share their expertise. Professor Massaquoi, informed participants of experiences of one UNDP project that sponsored experts in the Diaspora to teach in their home countries.

IBSP

- A question was raised on why UNESCO received a very low number of proposals from Africa. Lack of information sharing was identified as a major impediment and it was suggested that institutions develop a database with a mailing list of those in the science and engineering field, to enhance information sharing.

Experience of Zimbabwe on the use of ICTs in Education Science and Technology

Engineer S. Kundishora, General Manager of the Zimbabwe Academic & Research Network and National ICT Project Coordinator briefly defined ICTs as a generic term referring to technologies that are used for collecting, storing, editing and passing on information in various forms (A.K. Jager and A.H. Lokman, 1999). ICTs have three key components that are distinct but interrelated and these are Information, Communication and Technology. Points highlighted in his presentation:

- Zimbabwe does not have an integrated and coherent national Information and Communication Technologies (ICT) policy.
- The absence of this policy inhibits coordination, harmonisation, and full utilisation of the existing infrastructure and its capacity, as well as initiatives to implement ICTs by various sectors of the economy.
- Zimbabwe also has limited access to ICTs due to factors such as inadequate infrastructure, little or no local production of application software for the different sectors of the economy and lack of skilled ICT personnel in all sectors.
- Zimbabwe lags behind in the networked global economy.

Box 2: Zimbabwe's e-Readiness Survey

In addressing the above challenges the Government of Zimbabwe, in conjunction with the National Economic Consultative Forum (NECF), and with support from the United Nations Development Programme (UNDP), embarked on a National Information and Communication Technologies Project whose main goal is to produce a National ICT Policy Framework and Strategy. The Ministry of Science and Technology Development is executing the project.

The first phase of this project was the e-Readiness survey which was conducted to assess the country's readiness to become a knowledge society and is now complete. The second phase of the project is the e-Period, which has just started and involves publicising ICTs as well as the findings of the first phase in order for the nation to know, support and participate in ICT development and utilisation. The third phase is the drafting of the national ICT Policy Framework and Strategy

- Various government initiatives in promoting ICTs include the establishment of a Wide Area Network (WAN) through the Ministry of Finance and Economic Development housed at Central Computing Services (CCS).
- Such a WAN has a potential to provide infrastructure for e-Government and e-Governance countrywide.
- Government has also embarked on a rural electrification programme to provide the supportive infrastructure required for ICT.
- In its effort to create an enabling environment the Government has created a competitive market by liberalising the telecommunication sector as well as other parastatals.
- The Government has also reduced import duties (from 15% to 5%) for computers and peripherals in order to promote increased ownership through lower prices, and thus facilitate universal access.

- Internet use has increased over the years and, according to UNCTAD 2003 statistics, Zimbabwe recorded the biggest increase of 400% in the number of Internet users between 2001 and 2002.
- In the education and training sector, several initiatives exist, geared at increasing access in the e-education and training sector such as Zimbabwe Science Network (ZimSciNet), Better Schools Programme in Zimbabwe, World Links for Development (WorLD) programme, Capacity Building for Information Technologies in Education in Developing Countries (CapBIT), a UNESCO project on Education Development Indicators (EDI) operating within the framework of "Strengthening the National Education Statistics Information System" (NESIS), Ministry of Higher and Tertiary Education projects on Education Management Information System and College Information Technology Enhancement Programme (CITEP).
- Access to computers in schools is expected to increase as a result of a computerisation initiative embarked on by His Excellency President R. G. Mugabe, a programme supporting computerisation in high schools in the country. The initial phase has seen two rural schools in each province receiving 10 computers and two printers. The project in its second phase has now covered the whole country.
- For more on the Zimbabwean experience participants were encouraged to visit the following sites www.zarnet.ac.zw and www.ict.org.zw

Emerging Issues from the Discussion

- In Zimbabwe, lack of adequate skilled human resource and infrastructure is a major challenge. Teachers still perceive and teach ICT subjects with a bias towards commerce and industry. ICTs have not been considered as a teaching tool in science and engineering.
- Power shortages are a major problem in Africa, and consideration of other sources of energy such as solar power is crucial. The sub region is currently facing serious power shortages, and strategies are needed to address this, including the construction of new hydro power stations.
- Coordination in handling ICTs is a challenge in countries where policies and strategies of promoting ICTs are handled in different line ministries. Mozambique has a National ICT policy and is currently facing challenges in this regard. In Zimbabwe the Ministry of Transport and Communication handles communication while the Ministry of Science and Technology is handling the ICT policy.

Presentation on Virtual Laboratories and Instruments

Mr. Shem Bodo's presentation discussed the use and creation of virtual laboratories. A virtual lab is a computer-based exercise designed to emulate hands-on experience. They are "simulators", which enable students to work in an experimentally rigorous setting:

- Research has shown that virtual laboratories provide a cost effective approach to a working understanding of experimental science.
- The idea of virtual laboratories is to do experiments with equipment that is not physically present in the same place as the user.
- There are two main types of virtual labs: the remote and simulated.
- Some reasons for building virtual laboratories include:
 - Providing wider access to expensive or rare equipment
 - Making use of equipment which is less expensive to repair if damaged by a novice
- These laboratories are made possible because of the presence of a collection of emerging technologies, ranging from distributed data handling and distributed computing to multicast network infrastructure.
- Mr. Bodo cited the various requirements for creating virtual laboratories and participants had an opportunity to participate in solving scientific problems in a virtual laboratory at the following sites: <http://www.nsimonco.com/vlab/index.htm> and <http://www.hhmi.org/biointeractive/vlabs/>



Mr. Shem Bodo (center) responding to a question raised by a participant

THEMATIC DISCUSSIONS

Mr. Shem Bodo introduced a discussion on how to use ICT tools to promote science and engineering. The discussion centred on four tools; graphic design, radio programmes, music (audio visual) and story telling.

Discussion on Graphics Design

Using the UNESCO DigiArts project as an example, Mr. Bodo gave a brief overview of this initiative, which aims at promoting use of ICTs in art. The project seeks to uplift the graphic artist using these new technologies in promoting more visibility in their work. Using graphics design, participants were asked how they could use ICTs in their disciplines.

- In geometric engineering, graphic design as an ICT tool would be useful when illustrating three dimensional aspects as it was difficult to draw these on a blackboard. With ICTs, one can draw a spherical triangle and use colourful illustrations.
- In the discipline of statistics and modelling, the University of Zimbabwe has currently been using free open source software to model three-dimensional variables. However there is need for simpler software for younger students.
- An example was provided of the use of digital signal processing where one University was able to process the 1966 World Cup from black and white into to colour.
- The music industry has made great strides in using graphic design, and there is a need to learn from them
- Creativity is required in the development of hybrid software of graphic design that will be relevant to different science and engineering disciplines.
- Need for experts in graphic design to customise existing software programs and develop programs with the user in mind.
- In Mathematics, use of software's such as Maple, MathCAD, Mathematica have been useful and powerful in producing 3 dimensional mathematical spheres. The Mathematica website provides information on aspects of mathematics for all levels, and even has information on secondary education.

Box 3: NUST Example

The National University of Science and Technology (NUST) in Bulawayo, Zimbabwe in a project funded by CIDA used ICTs to encourage girls to take up science subjects at University. The project was implemented in a town called Hwange and using Software downloaded from the Internet developed illustrations that showed them different aspects of science subjects. Students in their secondary education were targeted mainly Forms 1 to 3. Interest in sciences has improved and figures of female students taking up science subjects at NUST have risen from 20% to 34%.

Issues Emerging from the Discussion

- In using ICTs to promote artists, a suggestion was made for a virtual exhibition to be organised for local artists. Using ICTs, galleries could collaborate with institutions of higher education to create sections that show sculptures virtually, attracting funding for young scholars.
- Use of quiz maker was encouraged to develop content that is unique to a specific country.
- Institutions need to explore more open source software relevant in science and engineering.
- In promoting use of ICTs, programmes can even be taught using vernacular languages. In Malawi the Mathematical Sciences Department taught a computer course to rural women in Chichewa.
- Dr Enock Jonathan cited an example of Dr Temba Dlodlo from NUST who has generated terminologies for teaching physics in Zulu and is currently developing software in Zulu.
- There was debate on the need for Africa to build capacities to invent relevant software versus continued use and dependence on open software developed in the West.
- The ANSTI coordinator's response to the issue of capacity building was that although this was necessary, he felt that institutions should first develop their capacity to address specific problems of the software currently being used. He encouraged institutions to use existing software and learn to customise them.
- Institutions should develop collaboration with other open source users across the world. Signing up for open source discussion forums is one way institutions and programmers can share experiences across the world.
- Institutions should work collaboratively with the corporate world in ensuring

that the curriculum produces software engineers with relevant skills.

Discussion on Music

- Science and engineering institutions ought to learn from the music industry where ICTs have been used successfully to produce music virtually.
- Institutions can make use of musicians to produce music that promotes learning of science and engineering.
- Music could also be used to advertise the use of ICT tools. In one polytechnic in Singapore music was being used to promote ICT use in engineering and science.

Way forward

- There is need to identify centres of excellence.
- Institutions need to influence policy and develop a curriculum that is relevant.
- UNESCO was tasked to advocate to governments and institutions to develop policies that take into consideration the relevance of the curriculum. UNESCO could initiate dialogue on such issues at government level.
- Emphasis was made that institutions should play a role, as lecturers can influence the quality of graduates produced, though the curriculum developed therein.
- Institutions should develop databases that document graduates' works, for example at the University of Zimbabwe, Honours students develop software as part of their projects. Though not published, abstracts through virtual listing of these projects can be done at institutional level.
- Institutions should have curricula that produce graduates with entrepreneurial skills.

Quality

- Look into Accreditation of courses to ensure quality assurance.
- Affiliate to relevant bodies in the field of science and engineering in order to ensure that standards are maintained at institutions.

Discussion on Radio Programmes

- There was a general consensus that use of ICTs in the form of radio programmes enhances learning and teaching, especially in Africa where resources are limited and access to students in some areas is difficult.
- Radios are cheap and have wide coverage.
- In Zimbabwe, radio broadcasts were once a common means of transmitting education programmes, and these should be re-adopted, especially in rural areas.
- Need to harness use of ICT tools such as cell phones for educational purposes; these are now popular with rural folk in some African countries.
- In Malawi, education broadcasts by radio are common and in Mozambique, literacy training is conducted by radio.

Way forward

- Institutions need to further explore the use of radios in promoting use of ICTs in their respective countries, especially in reaching out to the younger generation.
- Need to come up with curriculum content for radio broadcasts. A suggestion was made to develop the curriculum together with a complementary module that would be distributed to schools to ensure quality.
- Science and engineering institutions should closely collaborate with disc jockeys, psychologists and educationists in developing content that is suitable and relevant.
- Radio broadcast may not always be efficient and there is a need to explore the use of television to enhance the visual element, especially in science experiments. In South Africa a science programme called Mindset was cited as a good example.

The discussion noted that maintaining the 'physical touch' in science experiments was important. Visuals are also important, and where possible radio broadcasts should be linked to practice in a laboratory.

Discussion on Story telling

- In Africa, story telling is a popular tradition and the meeting agreed that it was important to explore how it could be used for promoting ICTs.
- Story telling has potential to preserve traditional science and engineering.
- Stories can be formatted to promote use of ICTs. Story telling is already

common at book fairs with, for example, skilled persons speaking on the issue of HIV and AIDS.

- An example was cited of a poet telling of the history of ICTs, and how already in movies stories of the ICT world are shown.
- At the University of Zimbabwe books for the blind are converted to audio using ICTs and this too can be adopted in promoting science and engineering.

Way Forward

There is need:

- For institutions to further explore story telling in promoting the use of ICTs.
- To harness creative people, and with the guidance of experts, institutions can develop CD ROMs on science and engineering.
- To identify and document areas of best practice.

COUNTRY PRESENTATIONS

Table 1: Summary of Country Presentations

COUNTRY	ISSUES	ICT POLICY
MALAWI	<ul style="list-style-type: none"> ◆ Malawi currently has 4 universities and 5 other tertiary institutions. ◆ Challenges faced by higher education include HIV/AIDS, brain drain, shortage of teaching resources and materials. ◆ Distance learning is used in institutions. ◆ There is use of ICT in teaching and learning; software development, information retrieval and access of on line journal ◆ E-learning conducted through NetTOM and NetTEL http://elearn.nettelafrika.org, E-Learning tool (KELW) and CISCO courses ◆ Have problems of poor connectivity, low bandwidth and viruses 	<p>Have no national ICT policy. Lack of ICT policies in Higher Education institutions.</p>
BOTSWANA	<p>The CUIS project</p> <ul style="list-style-type: none"> ◆ The CUIS project is co-sponsored by the Botswana government and UNDP ◆ The project contributes to Vision 2016 objective of making Botswana a globally competitive environment ◆ A pilot project was conducted to promote use of ICTs in villages. ◆ Services offered at centres included internet, communication (fax telephone), small business support services, E-Health, E-Governance and local content information. ◆ Findings on usage revealed that major users were between the 15-40 years age group with the least being in the over 50 category. ◆ Patronage by gender indicated a male predominance in use of services ◆ Most common services utilized at these centres were not internet or access to local content but photocopying. ◆ Overall the project objective of promoting access to local content was not met and this pilot project is under review. ◆ Plans to promote the local content are under way. 	<p>Have draft national ICT Policy.</p>
ZAMBIA	<p>Zambia's draft ICT policies prioritizes on 13 pillars; human resource, education, access media content and culture, ICT sector, telecommunications and infrastructure, e-governance, e-commerce, agriculture, health, tourism, youth and women, legal and regulatory framework and security</p> <ul style="list-style-type: none"> ◆ The SUNRISE model shall be as part of implementation strategy. ◆ In the education sector the policy goal is to integrate ICTs in the education systems and develop the Nation's research and development capacity to support facilitate and contribute to the development of key sectors in the economy ◆ Strategies for implementation in the education sectors are clearly laid out 	<p>Have a National ICT Policy</p>
MOZAMBIQUE	<p>The Mozambique ICT policy was established in 2000 and its implementation strategy was approved in 2002.</p> <p>Main objectives of the policy is to reduce poverty, fight against illiteracy, promote governance and access to information, promote favourable business and legal environment</p> <ul style="list-style-type: none"> ◆ Initiatives implemented to achieve above objectives include the Provincial Digital Resource Centre ◆ SchoolNet-internet project for schools ◆ GovNet-Government Electronic Network ◆ Community Media centres and the ◆ Mozambique Institute of Information and Communication technology project. <p>General National statistics reveal that student enrolment in sciences is low as well as research output in basic sciences.</p> <p>Generally in the use of ICTs, Mozambique faces various challenges in the science and engineering sector.</p>	<p>Have a National ICT Policy</p>

Following the country presentations, UNESCO Harare Cluster Office Director tasked countries to produce report on the status of ICT use in their countries. These will form part of a publication and enrich the draft ICT manual. See Annex 3 for format

Emerging Issues from Discussion on Country Presentations

Mozambique

- There was concern about the high number of school dropouts, low enrolment at University and high illiteracy rate, all of which greatly impede the development and use of ICTs.
- The UNESCO funded Community Multimedia Centres project targeted at the rural areas will be ending in December but the government hopes to continue the project.



The participant from Mozambique (left) responds to one of the concerns raised

Malawi

- Malawi indicated that they were facing challenges with their networks, which were developed in an ad hoc manner. Because there was no computer centre, they relied on the Maths and physics department. A suggestion was made for the Malawi institution to have a centralised computer centre to deal with issues. This would make it easier for planning future networks

and coordination of activities.

- There is need for Malawi institutions to develop institutional policies and to use an IBM server in improving the issue of connectivity at the University.

Botswana

- The Botswana pilot project ends in December 2005 and, based on recommendations, the government will decide whether to extend the project to the whole nation.
- Reason for low e-mail use and the small number of female users at the centres is unknown
- In view of promoting science and engineering, it is unknown whether any material on science issues was downloaded but schools were invited to utilise these centres.
- The project was initiated in consultation with the community. A base line survey was conducted before setting up the centres and so the project is strictly community based.
- Low Internet usage by community is attributed to technophobia. Suggestion was made that for future projects communities be trained on use of ICTs. However, trained personnel with University Diplomas are in attendance at the centres.
- The e-mail facility is at times not accessible due to technical problems which have not yet been resolved.
- A suggestion was made that Botswana considers multimedia usage of community centres and include usage of radios as in the Mozambican example.

Zambia

- A suggestion was made for Zambia to reconsider its draft policy taking into consideration issues that have been raised on the quality of education programmes.
- Zambia should engage in wider consultation with stakeholders and include the corporate sector in finalising the draft.

Other Issues

Dr. Enock Jonathan informed participants of the 2nd International Technology workshop to be held in June 2006 (more at <http://globalappropriatetechnology.com/conference2006/conference.php>).

Presentation on Higher Education Knowledge Base on Open and Distance Learning

Introduction

- Professor Shabani introduced Carol Roos from the South African Institute for Distance Education (SAIDE) to present the knowledge base. He indicated that the development of this framework could be useful and could be applied to the field of science in engineering.
- The initiative was started in 2000, and three regions: the Baltic, Asia Pacific and Africa are participating.
- To date, Africa is leading and hosting the site of the Asia Pacific and Baltic Regions. In addition 14 National Commissions for UNESCO in the Southern African Development Community (SADC) region held a meeting this year in Maun, Botswana, where this issue was discussed - progress reports should be sent to Ministers to obtain resources.
- There is still a need to train people in how to use these tools particularly in uploading documents.
- UNESCO Harare Office last year organised a training workshop on knowledge bases and more training is scheduled to take place in Nigeria, Mali, Malawi and Botswana.
- Professor Shabani informed participants that initially this initiative was for 2 years but funds have been secured for 2006-2007. The issue of sustainability is still being looked into and there are plans for fundraising activities, and to engage more partners in the region doing similar work to collaborate in this initiative.
- There are also plans to extend this initiative to the Arab and Latin American regions.

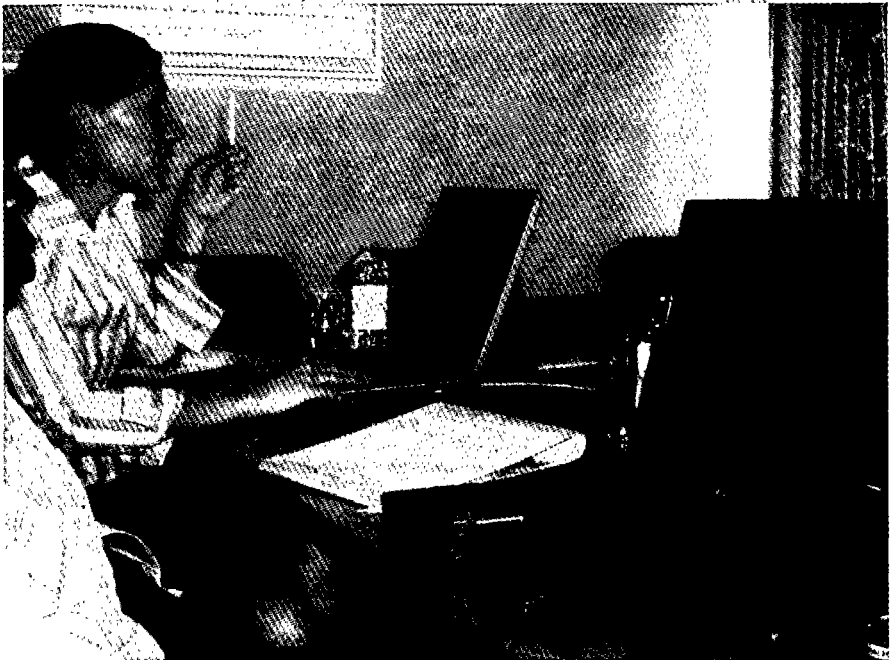
Presentation by Carol Roos

- In her presentation, Carol Roos centred on the development and use of the UNESCO Harare knowledge base, which she explained, was built on a knowledge matrix database system.
- SAIDE has developed an English and French version of the knowledge base and in future will be translating it into Portuguese and Swahili.

- The major problem is finding good resources. In Africa most relevant documents are found in hard copy and it has proven difficult to access them.
- Currently the knowledge base has resources mainly from Sub-Saharan Africa and other resources from other parts of the World related to distance learning.
- SAIDE hopes to create more knowledge bases targeted at specific subject areas.

Advantages of the Knowledge Base

Carol Roos explained further how documents are uploaded. There are no restrictions when uploading based on the type or size of files. The issue of copyright was raised and SAIDE explained that in the upload of documents, copyright issues are addressed. There are also measures taken to contact authors for permission. They have so far not experienced problems with viruses. Carol emphasised that SAIDE was very careful about copyright issues. Their software is not open source but in the development of the knowledge base, Microsoft gave them proprietary rights.



Carol Roos presenting on Knowledge bases.

Basically the knowledge base on distance education has resources on the theory and

practice of distance learning. Its comparative advantage is that one is able to search for resources according to specific criteria compared to the World Wide Web. In addition SAIDE have managed to access interesting hard copy resources, which have been scanned and can be viewed at <http://www.africaodl.org/>

Another advantage of using the knowledge base is that changes made at the back end are effected immediately. In terms of life span of resources, they are kept permanently, and time is taken to weed out dated documents.

In the case of institutions, it was suggested that in the science and engineering field there is need for development of subject specific knowledge bases.

Quality

Quality is guaranteed. Even when working papers are uploaded, all resources are quality controlled by an Information Coordinator who has been working in this area for 10 years. As to the abuse of downloaded publications, this is beyond the control of SAIDE. SAIDE is confident that they have been able to upload quality information through the rigorous process adopted when checking documents. Where the Information Coordinator is unable to verify the quality of a document she passes it on to other experts. It was suggested that SAIDE allow users to rate publications.

Way Forward

There is a need for institutions to publicise this initiative. The knowledge base can be further developed into other sub domains, as the ability to do so is developed.

Presentation on Decision Support Tool

The Decision Support Tool aims to aid distance-learning developers in the region. It is a generic questionnaire, which can be used across the world. Its advantage is that it can improve the service provided by institutions, and because it is built into the knowledge base matrix, it can be adjusted to suit specific needs.

This tool is still in its initial phase of development and SAIDE hopes to get feedback on the tool from participants.

Comments on Presentation

The tool was developed by the University of Malaysia and is believed to have included best practices in its development. A suggestion was made for SAIDE to consider other best practices to ensure a quality product.

Suggestions to SAIDE

- The questionnaire should be built into a tree-type branching structure so that follow up questions relate to certain responses. If this is not possible, it would be good to add similar questions to check the validity of the responses.
- Explanations of the questions can be included under a pop-up help function as in Windows.
- In order to make it more user friendly, the tool can include a set of functionalities to guide people on which areas to build on and link them to other institutions that can assist.

Way Forward on Applicability of this tool

- The tool is useful because its development can be tailor made to suit one's need, for example students reviewing their teacher's performance.
- The way forward is to actively test and publicise this tool and get feedback. Mr. Charles Chimedza from the University of Zimbabwe's Statistics Department indicated that he would assign a student to use this tool and provide feedback.
- There is need for the decision-making to provide an additional guide with information on how users could further improve their skills in areas where scores are low.

COUNTRY EXPERIENCE IN THE USE OF ICTs

Professor Juma Shabani introduced Dr Emmanuel Abina from the National Universities Commission (NUC) of Nigeria. The NUC is the body coordinating all the work of the 74 universities in Nigeria. It is a powerful body involved in funding, accreditation, and quality assurance of university courses. UNESCO Harare Cluster Officer has been collaborating with NUC in the area of higher education and the Virtual Institute for Higher Education in Africa (VIHEAF) initiative. Professor Shabani conveyed apologies on behalf of Professor Peter Okebukola who was absent.

Experience of Nigeria in the Use of ICTs in Education Science and Technology

In his presentation Dr Emmanuel Abina highlighted Nigeria's experience in the use of ICTs. He cited several initiatives, development efforts and challenges faced by the Ministry of Education of Nigeria in the use of ICTs.



Emmanuel Abina presenting the Nigerian Experience.

Highlights from Presentation

- Nigeria has a National IT policy and the National Information Technology Development Agency (NITDA) was setup and mandated to implement the policy.

- The vision of the policy is to make Nigeria an IT capable country in Africa and a key player in the information society by year 2005, using IT as the engine for sustainable development and global competitiveness.
- In bridging the digital divide, over 25 000 Cyber cafés (amongst other initiatives) have been set up to promote ICT use in Nigeria.
- Other developments being implanted to promote ICTs in rural areas include:
 - Rural Internet Resource Centres (RIRC)
 - Mobile Internet Units (MIU)
 - Metropolitan Hotspots Project
 - Rural Telephony Project
 - Vocational and Development Centres (VADOC)
 - E-Village project
- Dr Emmanuel Abina described the Mobile Internet units used as telecentres and Internet centres in rural communities in six geopolitical zones of the country. The buses are assembled with 80% locally made materials. They are used to teach students about ICT.
- The buses will soon be modified into trucks so that they carry 150-200 computers, which when placed on the ground and connected to a solar panel will cater for a large number of students.
- E-Learning initiatives in Nigeria include the:
 - National Virtual Library Project
 - Virtual Institute for Higher Education Pedagogy (VIHEP)
 - National Open University of Nigeria (NOUN)
 - Virtual Institute for Higher Education in Africa (VIHEAF), a NUC-UNESCO joint initiative
 - Intel's e-school project
 - Rural Internet Resource Centres
 - Best Practices in Education
- Though Nigeria faces its own challenge in infrastructure and Internet penetration, the country has successfully closed some gaps through appropriate policies that allow infrastructure deployment all over the country.
- In addition, computers are assembled locally and no government parastatal is allowed to buy from foreign computer companies. A local brand, ZINOX, won a Microsoft award for best computer manufacturer in Central, West and Eastern Africa.
- Despite the various initiatives in promoting ICT use the main reason for its success is the commitment and drive of the Nigerian President.

Main issues highlighted

- Policy is key to the success in the use of ICTs. The Nigerian experience links strong policy with drive from the President.
- Though there are various initiatives in rural areas, centres are not fully utilised due to technophobia, particularly in the Islamic regions of the country.

In another separate presentation, Dr Abina presented a paper on the use of multi media tools such CD-ROMS and DVDs. This session was complemented with a practical session on the use of flash based tools. Sites visited included www.swishzone.com Demo shield www.installshied.com.

Presentation on Virtual Institutes

Dr Emmanuel Abina in his presentation defined a virtual institute as a training site where participants, though not physically present in a brick and mortar enclosure, are able to update their knowledge and skills on a subject using internet protocols as a platform.

He introduced participants to one of Nigeria's most successful e-Learning initiative, the Virtual Institute for Higher Education Pedagogy (VIHEP). VIHEP, founded in 2003, has 12 modules and over 5000 learners have participated in this initiative. The objective of the institute is to provide staff in Nigerian Universities with internet based training on modern methods of teaching and learning in Higher Education. Dr Abina further elaborated on the main features, online teaching through text and rich multimedia, the community experience through the virtual Discussion Forum and online chat room, online assessments and virtual graduation. Visit <http://www.nucvihep.net/> for more information.

Emerging Issues from the Discussion

Credibility of Courses

- On credibility of the institution, a question was raised as to whether there was no bias, in the market, towards considering a graduate who had attended lectures on a campus rather than virtually.
- Credibility in VIHEP is promoted because of the presence of diverse teams working collaboratively to ensure that quality of VIHEP's programmes is maintained.

Strategies put in place to minimise cheating

- VIHEP exams are timed and several checks put in place to ensure that students do not get the opportunity to cheat.
- The project carries more marks than online assignments.
- Marks are awarded for contribution to the discussion forum.
- There is a mechanism for checking the e-mails of those logged onto the

- system.
- For final virtual exams students travel to a nearby centre.

Dr Abina stated that in e-learning, institutions should make the learning experience as rich and clear as possible. Programmes should be user friendly, enabling people to easily reach a learning site. He emphasised that one should never assume a level of literacy exactly the same as the user. As part of his presentation, Dr Abina in a practical session showed the various features of the VIHEP programme and explained the process of developing a virtual institute. He also informed participants that their system contained detection software to identify those who cheat. The NUC is currently working on an improved version of VIHEP and translating it into French and Portuguese languages.



Mrs Margaret Mahapa of Harare office and other participants follow the discussion on Virtual Institutes.

Presentation on Discussion Forums

In another presentation, Mr. Shem Bodo showed how to create an online discussion forum using opensource software. He explained how the Association for the Development of Education in Africa (ADEA) Working Group on Non-Formal Education Discussion Forum was developed and encouraged participants to visit www.phpbb.net to use the software, which allows one to customise an electronic discussion forum.

The forum can run on an Apache server, which is a free, open source program. This program also provides Administrative privileges, and has functionalities that can be modified to suit specific situations. Discussion forums can also be held on an intranet.

Other Links to Open Source Software

1. www.foxserv.net
2. www.sourceforge.net

Presentation and Discussion on Virtual Museums and Libraries

Dr. Abina gave a presentation on virtual museums, indicating that virtual museums are now common for documenting artifacts. During discussions it was felt that virtual museums should be used to stimulate the interest of tourists, rather than providing everything, as this would deprive communities and the tourism sector of much needed visits.

Suggestions to NUC

- Virtual museums should be free for local citizens, but foreigners can be charged. There was a consensus that local cultural traditions should not be sold.
- In future the NUC should consider allowing museums to operate and manage their own virtual library sites.
- NUC should allow museums to maintain exclusiveness to information and NUC should consider offering complementary material such as maps and historical books not readily available in the museums.

Virtual Libraries

In a second presentation, Dr Abina described the development and benefits of virtual libraries, one of which includes solving the problem of textbook shortages in Africa, as documents can now be scanned and easily accessed by anyone. He listed the equipment required for developing a virtual library, stressing that once the equipment is in place these do not require huge amounts of money. He promised to develop virtual libraries for each country in the SADC region.

Professor Juma Shabani further added that IBSP was moving from book donations to digitalisation of libraries, which are now considered a relevant tool.

WORKSHOP RECOMMENDATIONS

In a group work session, participants identified key areas for follow up as a way forward in addressing the main issues raised. Table 2 below summarises these. Participants in addition identified key areas for UNESCO Harare to follow up.



The team forming the first group expands on ideas floated at the initial stages of their discussion...



...as members of the second group finalise their discussion.

Table 2: Follow up Actions

ISSUES	FOLLOW UP ACTIONS
Brain Drain	<p>Tap into the expertise in the Diaspora (Brain Gain Concepts) Through:</p> <ul style="list-style-type: none"> ■ Creation of directory of Diaspora brains ■ Locations, personal details ■ Develop discussion forum ■ Sabbatical visits (Block teaching) ■ Virtual Classrooms ■ Video Conferencing ■ Institutional Policy <ul style="list-style-type: none"> ■ Flexibility of timetabling ■ Work permits relaxed or fast tracked by government ■ Participation of relevant bodies <ul style="list-style-type: none"> ■ Training teachers in ICT issues as it should filter down to schools
Quality versus promotion of ICT	<ul style="list-style-type: none"> ■ Set up of Quality assurance task force at an institutional level to evaluate ICT products ■ Policy <ul style="list-style-type: none"> ■ Policy should take quality issues into consideration ■ Policy should address the minimum acceptable standards for all implemented ICTs
Collaboration of institution	<p>Institutions to develop</p> <ul style="list-style-type: none"> ■ Mailing list ■ Discussion Forums
Programmes for ANSTI and IBSP	<ul style="list-style-type: none"> ■ Workshop participants should publicize the activities of UNESCO and its partners
Identification of Centres of Excellence	<p>Institutions should identify Centres of excellence</p>
Infrastructure	<ul style="list-style-type: none"> ■ Promoting local content development ■ Favourable and realistic tariffs for accessing the Internet. ■ Reduction of duties ■ Promotion of local assemblies re. Nigerian experience ■ Publicizing Nigerian and other experience ■ UNESCO should promote and/or engage companies that have favourable equipment rates. ■ National policies should promote local assembling.
Open Source	<ul style="list-style-type: none"> ■ More awareness required on what's existing ■ Need to document best practices ■ Institutions should collaborate and engage in dialogue with Software developers for reduced prices. ■ Buy licences for software through European Counterparts that collaborate with institutions.

Expected Role of UNESCO

1. UNESCO is to aggressively promote its presence through:
 - Sending out flyers about its activities in science and engineering to different institutions;
 - Website; and
 - Sponsoring ICT awareness.
2. In future workshops, UNESCO should organise:
 - Meetings that promote mixed participation by bringing together policy makers and implementers in one forum;
 - National stakeholders' workshops on ICTs in science and engineering; and
 - ICT workshops containing more practicals.
3. An appeal was made to UNESCO to run training sessions in:
 - Internet literacy courses;
 - Development of Multi media resources;
 - Digitalisation;
 - Virtual discussion forums; and
 - Databases.
4. UNESCO should conduct local pilot projects on the use of ICTs in schools.
5. UNESCO, in promoting quality, should come up with:
 - Guidelines on quality assurance;
 - Monitoring and evaluation tools;
 - Develop electronic handbook; and
 - Ensure that issues of quality are addressed at all workshops.
6. UNESCO should design a template to assist institutions in identifying centres of excellence.

Other issues emerging from Discussions

- It was suggested that the issue of low bandwidth be deliberated in National Policies.
- Participants were informed of UNESCO Harare's digitisation project in its

- Documentation Centre where documents are being archived electronically.
- Regarding video conferencing, institutions were encouraged to explore organisations that offered this facility in their countries.
 - On the brain drain issue, Nigeria has already developed a National Volunteers' database and sabbatical programme, which institutions could learn from.

Official closing remarks from Professor Juma Shabani

In his closing remarks, Professor Juma Shabani stressed UNESCO's commitment to addressing the issues raised at this workshop. He indicated the need to set up joint monitoring mechanisms, for follow up of issues. Institutions were encouraged to begin implementation by developing mailing lists and continuing virtual correspondence. Consensus was reached that the deadline for Country Case Studies would be one month, and UNESCO would send out contracts the following week. With those few remarks, Professor Shabani thanked participants for their fruitful deliberations and officially closed the meeting.



Professor Shabani chairs the final discussion session before officially closing the workshop

PROGRAMME

MONDAY 12 September

09.00-10.30 Session 1: Opening Ceremony

- Welcome Remarks by Director and Representative UNESCO Harare
- Remarks by Secretary General, Zimbabwe National Commission for UNESCO
- Remarks by Director, UNESCO/ROSTA
- Opening Speech by Vice Chancellor, University of Zimbabwe

10.30-11.00 Tea/Coffee Break

11.00-13.00 Session 2: UNESCO's Programmes on Science & Technology in Africa and National Experiences

- Overview of UNESCO's Programmes on **Science & Technology** in Africa and Presentation of the African Network for Scientific and Technological Institutions (ANSTI) by J. Massaquoi, Director, UNESCO/ROSTA and Coordinator of ANSTI
- The UNESCO International Basic Sciences Programme (IBSP) by J. Shabani, Director/UNESCO Harare
- Experience of Zimbabwe in the Use of ICTs in Education, **Science & Technology** by Engineer Kundishora, ZARNET Manager and ICT Project Coordinator for Zimbabwe Government.

13.00-14.00 Lunch

14.00-15.30 Session 3: Virtual Instruments & Laboratories
S. Bodo and E. Jonathan – to lead the discussion

15.30-16.00: Tea/Coffee Break

16.00-17.00 Session 4: Virtual Laboratories online Exercise
S. Bodo and E. Jonathan - to lead the discussion

18.30-20.30 Reception offered by UNESCO

TUESDAY 13 September

- 830-1300** **Session 5: Graphics design, Radio programmes, Music (audio visual) and Story telling (with Tea/**
- 1030-1100** **Coffee Break**
- S. Bodo and L. Tlhabiwe – to lead the discussion**
- 13.00-14.00** **Lunch**
- 1400-1700** **Session 6: National Experiences on the Use of ICTs in Education and Science and Technology**
- **Botswana**
 - **Malawi**
 - **Mozambique**
 - **Zambia**

WEDNESDAY 14 September

- 08.30-10.30** **Session 7: Higher Education Knowledge Base on Open and Distance Learning**
N. Bucher and C. Ross
- 10.30-11.00** **Tea/Coffee Break**
- 11.00-13.00** **Session 8: Decision Support Tool (N. Bucher and C. Ross); Experience of Nigeria in the Use of ICTs in Education, Science & Technology**
(P. Okebukola/E. Abina)
- 13.00-1400** **Lunch**
- 14.00-17.00** **Visit of University of Zimbabwe and Harare Institute of Technology**

THURSDAY 15 September

08.30-10.30. Session 9: Multi Media CD-ROMs and DVDs (with

Tea/Coffee Break at 10.30-11.00)

P.Okebukola, E. Abina and S. Bodo

11.00-13.00 Session 10: Virtual Institutes and Museums

P. Okebukola and E. Abina

13.00-14.00 Lunch

14.00-17.00 Session 11: Virtual Libraries & Discussion Forum

E. Abina and S. Bodo

FRIDAY 16 September

08.30-10.30 Session 12: Overview of Database-Integrated Websites

NESIS Team

10.30-11.00 Tea/Coffee Break

11.00-12.30 Session 13: Outstanding Issues

12.30-13.00 Session 14: Closing Ceremony

- Presentation and Adoption of Main Recommendations and Strategies for Way Forward
- Closing Remarks

PARTICIPANTS LIST

1. Mrs Chipo Kanjo
University of Malawi
Chancellor College, P.O Box 280
Zomba
MALAWI
ckanjo@chanco.unima.mw
2. Carla Moiana
Vladimir Lenine Av 288 31rd
Maputo
MOZAMBIQUE
3. Mr Misheck Phiri
Department of Geomatic
Engineering,
School of Engineering
University of Zambia,
P.O Box 32379
Lusaka
ZAMBIA
mphiri@eng.unza.zm
4. Dr Nomusa Dlodlo
NUST
P O Box AC 939, Ascot
Bulawayo
ZIMBABWE
ndlodlo@nust.ac.zw
5. Mr Isaac Nhamu
Chinhoyi University of Technology
ICT and Electronics Department
P Bag 7724
ZIMABWE
isaac.nhamu@cut.ac.zw
inhamu@yahoo.com
6. Lydia Tihabiwe
Bostwana Technology Centre
P/Bag 0082
Gaborone
BOSTWANA
lydia@botec.bw
7. Mr Gilford T. Hapanyengwi
Computer Centre
University of Zimbabwe
MP 167, Mount Pleasant
ZIMBABWE
gilford@compcentre.uz.ac.zw
8. Odeurs Jos
University of Zimbabwe
Computer Science
Mount Pleasant
Harare
ZIMBABWE
jos@compcentre.uz.ac.zw
9. Mr Charles Chimedza
59 Goodhope Rd, Goodhope
Harare
ZIMBABWE
cchimedza@science.uz.ac.zw
10. Dr Adrian Habanyama
Univesity of Zambia
ZAMBIA
ahabanyama@yahoo.com
ahanya@natci.unza.zm
11. Dr Emmanuel Abina
NUC, Plot 10 Benue Crescent
Area 1, Garki Abuja
NIGERIA
emmanuel@emmanuelabina.com
funsho_ng@yahoo.com
12. Prof G.M Massaquoi
P.O Box 30572
Nairobi
KENYA
J.Massaquoi@unesco.org
jgmmassaquoi@yahoo.com
13. Mr Sergio Machado
MOZAMBIQUE

14. Dr H. Gombachika
Department of Electrical Engineering
MALAWI
hgombachika@poly.ac.mw
15. Dr Enock Jonathan
Harare Institute of Technology
Harare
ZIMBABWE
enock_jonathan@yahoo.com
16. Carol Roos
Neil Butcher & Associates
SOUTH AFRICA
carolroos@tiscali.co.za
17. Prof Juma Shabani
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
j.shabani@unesco.org
18. Mr Shem Bodo
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
s.bodo@unesco.org
19. Ms Margaret Mahapa
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
m.mahapa@unesco.org
20. Mr Tendekai Bhowa
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
t.bhowa@unesco.org
21. Mr Tinashe Mariga
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
m.mariga@unesco.org
22. Ms Margaret Mzumara
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
m.mzumara@unesco.org
23. Ms Memory Zulu
UNESCO Harare Cluster Office
P.O Box HG 435
Highlands
Harare
ZIMBABWE
m.zulu@unesco.org

FORMAT FOR NATIONAL & INSTITUTIONAL PAPERS

1. For national papers:
 - a. Current Status of National ICT Policy;
 - b. The incorporation of ICT (both as a tool and subject within the field of Science and Engineering in Higher Education) in the Science and Engineering policy of the institution, as well as in the National ICT policy;
 - c. Use of ICT in the classroom, for preparing and teaching Science and Engineering: Methodology and Example of tools used;
 - d. Use of ICT to popularise Science and Engineering, especially among groups such as girls, and in R&D – concrete examples where possible.; and
 - e. ICT as a subject in the Institution – what are the subject elements covered?

2. For HIT: To develop and online directory of Virtual Laboratory and Virtual Instruments reference.

USEFUL RESOURCES ON VIRTUAL LABORATORY

Dr Enock Jonathan, Lecturer, Harare Institute of Technology (HIT)

Introductory Remarks

Participants at the *SUB-REGIONAL TRAINING WORKSHOP ON THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTs) FOR IMPROVING RELEVANCE AND QUALITY OF HIGHER EDUCATION AND RESEARCH WITH SPECIAL EMPHASIS ON SCIENCE AND ENGINEERING* sponsored by the UNESCO HARARE Office and held from 12-16 September 2005 at the UNESCO HARARE Offices in ZIMBABWE embraced VIRTUAL LABORATORY as a "best bet technology" for improving both the relevance and quality of science and engineering education and research in Africa.

This reference list of links has been compiled to provide some guidance on the resources available on the web on VIRTUAL LABORATORY in science and engineering education and research.

Useful Definitions of a Virtual Laboratory

Science and Engineering Research

“An electronic workspace for distance collaboration and experimentation in research or other creative activities, to generate and deliver results using distributed information and communication technologies (ICTs).” [Report on Expert Meeting on Virtual Laboratory, International Institute of Theoretical and Applied Physics (IITAP), Ames, Iowa with support of UNESCO/prepared by James P. Vary, Editor – (CII-00/WS/01)]

Science and Engineering Education

- A computer-based exercise designed to emulate hands-on experiences and to provide a working understanding of experimental science.

Why a Virtual Laboratory?

- Wider access to expensive or rare laboratory equipment.
- Sharing of laboratory facilities (i.e. equipment and personnel) that are geographically distributed.
- Enhancing education quality through the incorporation of computer tools such as intelligent tutoring systems.

What are the APPROACHES?

- Remote Virtual Laboratory: User interacts with equipment that is physically in another location via sensors and actuators through a computer (tele-operation, tele-programming) and a communication network such as the Internet.
- Simulated Virtual Laboratory: User interacts with computer models of equipment and its environment to perform experiments.

Requirements List for a successful Virtual Laboratory

What a Virtual Laboratory is NOT

In science and engineering education, virtual laboratories provide a cost-effective approach to a working understanding of experimental science if based on rigorous and research-based models of scientific and engineering processes. However a virtual laboratory is NOT an absolute replacement for nor a competitor with a "Real Laboratory (RL)" / "Traditional Laboratory (TL)" that is, the "get-your-hands-dirty laboratory." A VL is an extension of an RL/TL affording realisation of new opportunities cost effectively, for example, access to personnel and expertise.

Science and Engineering Education

World Web Link	Study Field
http://physicsweb.org/resources/Education/Interactive_experiments/Optics/	Physics
http://www.jhu.edu/~virtlab/virlab.html	Engineering/Science
http://jersey.uoregon.edu/vlab/Piston/	Engineering
http://www.math.uah.edu/stat/	Mathematics (Probability and Statistics)
http://www.ruf.rice.edu/~lane/rvls.html	Statistics
http://neon.chem.ox.ac.uk/vrchemistry/default.html	Chemistry
http://www.civil.ubc.ca/home/coursew3/virlab/	Civil Engineering
http://cee.uiuc.edu/sstl/java/	Earthquake Engineering
http://www.hhmi.org/biointeractive/vlabs/	Medicine
http://lr.chem.cmu.edu/irproject/applets/virtuallab/Download.asp	Chemistry
http://www.chemcollective.org/applets/vlab.php	Chemistry
http://www.microscopy.com/MicroScape/MicroScape.html	Microscopy

Science and Engineering Research

World Web Link	Research Area
http://www.cira.colostate.edu/ramm/vlab/virlabhp.htm	Metereology
http://vlab.psn.cpl/	Analytical Science (Virtual Instrumentation)
http://homer.ornl.gov/VLAB/	Biokinetic and Dosimetric Research
http://www.bio-link.org/lab.htm	Biotechnology
http://vit.ucsd.edu/index1.html	Technology
http://www.tpm.csiro.au/	Microscopy
http://www.ansys.com/assets/testimonials/trane-It.pdf	Research and Development
http://www.sinica.edu.tw/~statphys/computer/vitural_lab.html	Computational Physics

Software Packages

Commercial Software

Commercial Name	Company WebSite
LABVIEW®	http://www.ni.com/labview/
MATLAB® and SIMULINK	http://www.mathworks.com
CircuitMaker®	http://www.microcode.com/
Model ChemLab®	http://modelsience.com/

Free and Open Source Software (FOSS)

Name	World Web Link	Brief Description
White_dune	http://www.csv.ica.uni-stuttgart.de/vrml/dune	Virtual Reality modelling tool supporting 3D modelling and animation.
UNESCO Virtual Laboratory Toolkit	http://virtuallab.tu-freiberg.de	Software tool for establishing and maintenance of a Virtual laboratory. Supports person-to-person (P2P) communication and person-to-equipment (P2E) communication.

Papers and Reports on VIRTUAL LABORATORY

World Web Link	Paper/Report Title
http://dsd.lbl.gov/~johnston/Virtual.Labs.html	The Virtual Laboratory: Using Networks to Enable Widely Distributed Collaboratory Science
http://mitpress.mit.edu/catalog/item/default.asp?tttype=6&tid=727	Human Factors: Engineering of a Virtual Laboratory for Students with Physical Disabilities
http://www.nano-world.org/articles/vexp2003	An Interdisciplinary Virtual Laboratory on Nanoscience
http://ncln.hq.nasa.gov/innovation/innovation56/research.htm	Virtual Laboratory Expands NASA Research
http://fie.engmg.pitt.edu/fie2000/papers/1457.pdf	Resource management strategies for remote virtual laboratory experimentation
http://imej.wfu.edu/articles/2004/2/03/index.asp	Development of a Virtual Laboratory for Science Education
http://dsd.lbl.gov/~johnston/Virtual.Lab/Virtual.Lab1.html_fm.html	The Virtual Laboratory: Application of Multimedia Networks to Enable Collaboratory Science
http://mceer.buffalo.edu/meetings/2004student/Gao.pdf	Java-Powered Virtual Laboratory for Nonlinear Structural Dynamic Analysis
http://csdl2.computer.org/comp/proceedings/ccgrid/2002/1582/00/15820278.pdf	The Virtual Laboratory: A Toolset for Utilising the World-Web Grid to Design Drugs
http://www.bbsrc.ac.uk/media/pressreleases/03-07-03-biodivworld.html	Scientists build a virtual laboratory for modelling biodiversity patterns
http://www.ijee.dit.ie/contents/c190303.html	Several papers on VL
http://istresults.cordis.lu/index.cfm/section/news/Top/article/BrowsingType/Short%20Feature/ID/74535	A virtual laboratory for genetic and medical data
http://www.informatik.uni-trier.de/~meinell/papers/Trier-Emisa04-Hu.pdf	A virtual laboratory for IT Security Education
http://act.ist.go.jp/conten/vh10-material/M09/PageMain_e.html	Development of virtual laboratory system for crystal growth

Contact Information

Readers with questions/comments/suggestions are invited to send them to:

**Acting Director – Technology Centre,
Harare Institute of Technology (HIT)**
PO Box BE277, Belvedere
HARARE-ZIMBABWE
Tel: (+263-4) 741 422-37
Fax: (+263-4) 741408
artehc@yahoo.com

OR

UNESCO Harare Office
8 Kenliworth Road, Highlands
Harare – ZIMBABWE
Tel: (263-4)776775-9
Fax: (263-4)776055
Web: <http://www.harare.unesco.org>
s.bodo@unesco.org