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Emulating the Best Technology in Teaching and Learning
Mathematics: Challenges Facing Libyan Higher Education

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EMULATING THE BEST TECHNOLOGY IN TEACHING AND LEARNING MATHEMATICS: CHALLENGES FACING LIBYAN HIGHER EDUCATION

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ABSTRACT

The aim of this research is to identify ways to emulate and implement the best of western technology in developing countries given the limited infrastructure, funding and expertise available. Qualitative methodology has involved analysis of the Libyan education system from an experiential and documentary perspective and then to juxtapose this with what is possible in a mathematics department at an Australian University. Three of the most notable differences are: internet access, the use of e-Learning systems and the variety of mathematics and statistical software available. The challenge is to identify the components of these systems which can be made available to support student learning, and in particular mathematics learning, when there is little or no internet access. Possible solutions are identified through an exploration of the components and functionalities of the technologies. These include the use of open source software and of components of the internet, for example html and web browsers, which allow the reshaping of how educational materials are organised and made available to students. It is apparent that professional development will be a key part of the solution.

Keywords: *higher education, pedagogy, e-learning, technology, developing countries.*

INTRODUCTION

This paper was prompted by the bringing together of the technological and educational experiences of a Libyan graduate student studying in a mathematics department in an Australian university with reflection upon the challenges of teaching in Libya.

The impacts of Information and Communication Technologies (ICTs) in the higher education sector have increased the awareness of many staff about the need to improve teaching and learning. This has led to the development of new teaching strategies to accompany new technology. This is particularly pertinent in the discipline of Mathematics which is acknowledged to be a difficult area for students.

Online learning is one outcome of the rapid improvements in ICT. At its most basic it provides students with better access to traditional teaching materials. But online learning offers much more, it can enhance learning processes and teaching experiences by offering new learning strategies. One of the most significant of these technological improvements is e-learning which has expanded opportunities for when and where learning takes place (Benson & Samarawickrema, 2007; Yucel 2006). There are a variety of definitions of e-learning. For Sun, et al. (2008, p. 1183) e-learning is simply "the use of telecommunication technology to deliver information for education and training". Yucel (2006, p. 123) defines e-learning slightly more restrictively as "a web-based educational system on a platform with Internet, Intranet or computer access". Luckin, et al. (2006) emphasise the role of internet technology in allowing interactive and collaborative learning. This style of learning provides students with the resources to become more independent (Khine, 2003). The advantages of enhanced communication between students and between students and lectures are commented upon by Mapuva (2009). Sife et al. (2007, p. 57) suggest the educational possibilities of e-learning by stating that it is "an essential complement to the traditional way of teaching (i.e. face-to-face)".

In developed countries a technological revolution is also reshaping the way that education is organized and delivered, and transforming the ways university services are delivered to students. However, the impact of technologies differs in developed and developing countries. Teachers in developing countries are often unable to access new technologies. Indeed "there are a number of challenges that face universities in developing countries as they seek to implement the e-learning systems" (Sife et al., 2007, p. 57). One of these is the need for research to assist developing countries to take advantage of the western experience.

This paper identifies and examines primary resources available for teaching mathematics and resources used to support students learning at the University Of Wollongong (UOW). It also seeks to explore the possibilities for adopting, adapting or substituting these resources in the Libyan educational system.

THE LIBYAN EDUCATIONAL SYSTEM

Education in Libya is free for citizens up to and including undergraduate university courses. The education system in Libya consists of several stages (Figure 1). All levels of education have two semesters per year.

1. The primary stage begins at age six, continues for six years and is compulsory. Children may be educated in public or private schools or at home. The institution which monitors home education provides free text and course books and also gives financial assistance to parents. There were approximately 10,140 students registered for home education in the academic year 2007-2008 (The General People's Committee of Education, 2008).
2. Preparatory school, or middle school as it is also known, is compulsory. It lasts for three years and is ended by a national examination. Homeschooling is not possible.
3. In the third stage students attend either a high school (general or specialized), or an intermediate vocational centre or a teacher training institute. There are three types of general high school: arts, science and technology. There are also specialized high schools in basic sciences, engineering and industrial sciences,

medical sciences, agricultural sciences, social sciences, economics, fine arts and media. Studies last for three years in general high schools and vocational centres, four years, in specialized high schools, and five years, in teacher training institutions. In all institutions the final year is ended by a national examination. Successful candidates receive either a General High School Certificate or a diploma, depending upon the type of institution attended (Clark, 2004).

4. Students, who pass high school with sufficiently high marks, can advance to higher education.

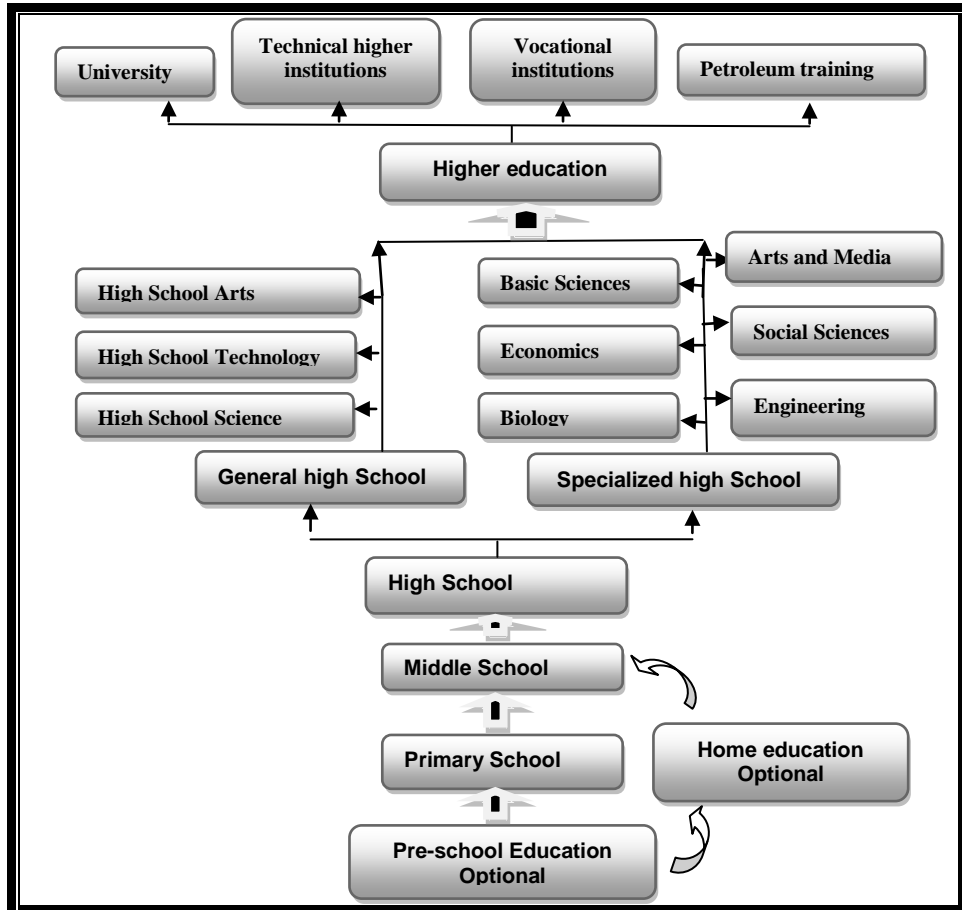


Figure 1: Structure of Education system in Libya

HIGHER EDUCATION IN LIBYA

The higher education system contains a variety of institutions. These include public and private universities, an Open University, technical higher institutions, vocational institutions and also petroleum training and qualifying institutes (Arabsheibani & Manfor, 2001). The undergraduate higher education system is predominantly financed by the state; students only pay tuition fees at the Open University and private universities.

The primary author of this paper is a lecturer at Garyounis University. This is the oldest university in Libya; its antecedents are an art college founded in Benghazi in 1951. The university has grown to include several campuses. Undergraduate courses require four to five years' full-time study. Post-graduate studies are not free but are subsidized. Masters studies are of two to three year duration. A Doctorate requires three years of research following completion of a master's degree. Comparatively few students receive Ph.D.s from Libyan universities; mainly in fields such as Arabic, Islamic studies and the humanities. Libyan universities have not yet started doctoral programs in science,

technology, and engineering. Most academics have Doctorate and Masters' degrees from foreign universities (Clark, 2004).

The Open University was established in 1990 in Tripoli and now has 16 campuses around the country. It awards Bachelor's level degrees, depending heavily on printed materials (Clark, 2004).

Higher technical and vocational institutions were established in 1980. These include: higher teacher training institutes; higher vocational centers; and, specialized higher institutes for technical, industrial and agricultural sciences. Higher institutes offer programs in fields such as electricity, mechanical engineering, finance, computer studies, industrial technology, social work, medical technology and civil aviation. After three years study at vocational institutes and centers a Higher Technician Diploma is awarded or else, after four to five years study, the Bachelor's degree is awarded (Clark, 2004).

At the petroleum training and qualifying institutes trainees and employees within the oil and gas sector take courses leading to City and Guilds qualifications of the London Institute (Clark, 2004).

Challenges in the higher education sector

The Libyan higher education sector currently faces the challenge of significant reform (Sawahel, 2009). Under a five-year national strategic plan costing US\$9 billion universities are engaging in structural reforms to become more efficient and effective in providing learning and support for students. The strategy includes the establishment of a National Authority for Scientific Research (NASR) to help build scientific capacity and a Centre for Quality Assurance and Accreditation (CQAA) to evaluate the academic performance of the education system according to international performance standards (Sawahel, 2009). Libyan universities face challenges to improve the quality of education services, the efficiency of education expenditure and to introduce new teaching and learning methods. These challenges include the provision of better teacher training and qualifications, finding mechanisms for adopting e-technologies, providing professional development and technological infrastructure and overcoming culture influences.

Teacher training and qualification

Teachers are at the core of education reform and it is important to provide them with opportunities for professional development in the use of educational technology (Danwa & Wenbin, 2010). Teaching staff play a significant role in the effective delivery of e-learning, as it is the lecturer not the technology that facilitates the student learning experience (Mapuva (2009). Danwa and Wenbin (2010) suggest that in a diverse information technology environment, the development of students requires teachers not only to teach them how to use information technology, but also to guide them in the information technology environment. Thus one challenge facing the education sector in Libya is providing teachers with an opportunity to gain the required expertise.

The lack of training results in teachers using traditional "chalk and talk" methods which do not help students learn how to think. Instead, there is a tendency for students to learn by memorisation rather than by reasoning and meaningful learning (The General People's Committee of Education, 2008). Mapuva (2009) points out that in developing countries the intensely established traditional pedagogical experiences based on the talk-and-chalk teaching methods and shortage of resources has lead to difficulties accepting and adopting e-learning. This is particularly problematic in teaching areas such as mathematics which requires the use of many technologies.

Despite the increase in expenditure by the Libyan National Education Department there are limitations to what can be achieved. For instance, teachers have little experience of

modern educational methods which implement strategies to build skills and engage students in thinking and analysis or even in using technology. Jamil and Som (2007) argue that to fill and correct such gaps appropriate training needs to be identified through research, delivered in stages and the outcomes evaluated to ensure that training needs have been met.

Teachers should be helped to understand how educational technology can inform and improve pedagogy and, as a result, contribute to improved student performance (UNESCO, 2005a). Academic staff and students in Libya are generally not conscious of the potential of the resources and the support that can they obtain via an e-learning or web environment. Rhema and Miliszewska (2010) have expressed the view that the lack of adequate awareness of instructive technology is common between educators and students in Libyan higher education institutions. Techniques that can be used to raise awareness and change attitudes include “formally organized awareness programs, visits to similar institution where success has occurred, and short training” (Sife et al., 2007, p. 63).

With respect to the integration of technology into teaching there are several issues for Libya. The first is that the level of educational technology knowledge and basic computer skills among lecturers in the higher education sector is low and this leads to confrontation in adopting ICT for teaching (Rhema & Miliszewska, 2010). The lack of training in both technology and instructional methods leads to concerns about teaching in unfamiliar teaching environments (Wright et al, 2009). Where ICT has been used it has been seen as a set of efficiency tools, rather than as an integration of these technologies into teaching (UNESCO, 2005a). Libyan academic staff need to be trained in both the use of new technology, so that they become familiar with it, and in the effective use of it in teaching.

To adopt and implement e-pedagogy it is necessary to continuously provide lecturers with confidence and skills via training and update courses (Mapuva, 2009). Teachers should be encouraged to continuously build up their experience and innovate in the process of the development of technological capabilities (Danwa & Wenbin, 2010).

Adopting E-technologies

In developed economies e-learning and the web have become a significant medium for providing distance learning and support for student learning with students attracted to the use of diverse media, such as audio, graphics, text, and video (Ali, 2003; Khine 2003). These technological developments add pressure to educators to integrate ICT, such as e-learning and Web-based instruction, into the education system (Ali, 2003).

International cooperation can positively impact on the adoption of e-learning and education reform. Through the support of UNESCO and the curricula provided by developed countries Libya is currently moving to integrate ICT educational systems. This includes the trial of e-learning with Blackboard, provided by an international company, in six schools in Tripoli for Mathematics and English subjects (The General People’s Committee of Education, 2008). The eventual aim of this project is to expand the course management system to all subjects and all levels of education. There is other evidence of progress in adopting e-learning for use in higher education to support and engage student learning (The General People’s Committee of Education, 2008).

The adaptation of technology on its own can not improve the learning experience of students. Even in developed countries teachers are faced with a continuing challenge to review their teaching practices; to develop and adopt learning design for teaching with technology (Agostinho, 2006). One of the difficulties for higher education institutions is to develop an understanding of how to balance the demands of technology against the need for strong pedagogy (Harper et al., 2001).

Libya has begun to address the issue of national development and has developed an information technology infrastructure plan which seeks to support the rapidly developing information technology market and enhance education. There is a need to design new curricula specifically for an e-learning setting (Andersson & Grönlund, 2009) which combines interesting learning interactions with attractive designs to improve learning and motivation. Libyan educational developers lack the experience necessary to develop curricula and pedagogies for e-learning. These developments require the contribution of academic expertise and support from educational developers experienced in e-learning (Rhema & Miliszewska, 2010).

Technological infrastructure

The technological infrastructure in Libya is not currently at the same level of provision as in developed countries. Although computer laboratories are accessible for students in the majority of Libyan higher institutions, they lack sufficient network facilities for Internet access for all students (Rhema & Miliszewska, 2010). This has implications for adopting e-learning into teaching practices. The educational program also suffers from limited resources and insufficient tools, such as, electronic libraries, up-to-date technological books, computer hardware and software. These restrictions pose a barrier to academic staff enhancing the quality of education through the use of ICT. Thus Libya needs to further develop its education system and interact with regional and international communities.

Cultural influences

In a society as tradition-bound as Libya's cultural influences present another challenge to the education sector. Chen, et al. (1999, p. 219) argue that "An appreciation of the role of culture in education is essential as it leads researchers and teachers to a deeper and more valid understanding of the nature of student learning". Rhema and Miliszewska (2010) argue that, due to Libyan customs and traditions, most Libyan families have concerns about the rapid growth of technology and its impact on their children. This leads to concerns about the adoption of new technology, such as e-learning in teaching and learning. Both Andersson and Grönlund (2009) and Wright, et al. (2009) consider that the home environment is the most important factor upon student use of e-learning. Families that are opposed to the acquisition of technological skills obstruct the use of e-learning (Mapuva, 2009).

In Libya people enjoy frequent social contact. It may be for this reason that parents are concerned about e-learning as it is perceived to lead to a distance between the teacher and student which are not found in the traditional classroom. Mapuva (2009) argues that the introduction of ICT into higher education will require institutions to support students in adapting to unfamiliar learning contexts. The use of e-learning may therefore be problematic in its early stages as students are discomforted when new learning approaches based upon ICT replace the traditional instructor-led classroom (Andersson & Grönlund, 2009)

Research development: scientific research and publishing

Although publication of scientific research is necessary to support the economic and social development of developing nations there is limited scientific productivity in most developing countries as they have little tradition of scientific research. China, India and Iran (Meyer, 2008) are exceptions to this, Libya is not. Abdelrahim (2004) points out that "while developing countries comprise 80 per cent of the world's population, only 2 per cent of indexed scientific publications come from these parts of the world". The research

production of Libyan universities' academic staff is very small. For example, the average annual production rate at the Al-Fateh Medical University is 1.4 article/100 academic staff (Tashani 2009). One reason for this is that universities do not always follow their strategic priorities to make scientific research paramount. Further they do not have development plans for technical support staff (Tashani 2009). Andersson and Grönlund (2009) argue that the level of support offered for staff makes a difference. Lecturers are usually more motivated and committed when they feel supported by their institutions. Wright et al (2009) and (Sife et al. 2007) explain that ICT support is often lacking in developing countries, as the few individuals with technical expertise focus on network infrastructure installation, operation, maintenance, network administration and security. Addressing this issue would help the creation of a rich research community. Evaluation of the academic performance of the Libyan education sector according to international standards is required in order to strengthen and improve its quality.

THE FUTURE OF ICT AND EDUCATION IN LIBYA

A range of embargos and restrictions were imposed upon Libya starting in 1986. Following their lifting in 2004 the stage has been set for stable sustainable development. One consequence has been the return of international relationships with the United States, Europe, and other countries. Services expected to follow from these relationships include: the supply of technical support, including education consulting, research, software production, and distance learning. There is now a national policy and international cooperation regarding ICT in education to enhance the future of ICT and education in Libya.

The administration of national policy for ICT in education

The national policy for ICT in education commenced in 2005. In 2005 UNESCO signed an agreement with Libya to cooperate in a "National ICT Project for Capacity Building" (UNESCO, 2005b). This project includes the organization of Local Area Networks within all 149 faculties belonging to diverse university campuses and institutes, and of Wide Area Network forming the "Libyan Higher Education & Research Network". It also foresees the creation of digital libraries/portals of educational resources, the development of ICT-enhanced learning solutions such as e-learning and tele-education (UNESCO, 2005b). This organization plays an essential role in laying the groundwork for the ICT policy implementation which opens the door to encourage investment in Libya.

The implementation of national policy for ICT in education

The Libyan government is determined to provide tools and ICT skills to all sectors of the country, particularly in the education sector. By June 2008 all 1.2 million Libyan school children had received a laptop. Despite the government's efforts to supply computers to primary and secondary schools considerable challenges remain, including restricted internet access and a shortage of teachers who know how to integrate computers into learning. There is now a program for training teachers and higher education staff in ICT use. The policy seeks to improve the quality of learning in higher education and open and distance learning by adopting modern techniques and methods in education and also to encourage the scientific community in research. The strategy includes a \$US72 million project to use information and communication technologies to reform the higher education and scientific research system by integrating ICTs in education and science (Sawahel, 2009). The project foresees the creation of a national ICT resource centre for educators and the automation of university management systems through ICTs such as student information systems, university procedures, financial operations (Hamdy, 2007). The process of implementing the national ICT policy is still at an early stage.

EMULATING THE BEST TECHNOLOGIES FOR A DEVELOPING COUNTRY

One solution to address the challenges confronting developing countries is to learn from the experiences of other countries by identifying the components and functionalities of the best technologies and to emulate these, skipping over many development stages. For instance, developing countries can utilize wireless technology rather than cable (Wright, et al, 2009). Sife et al. (2007) suggested that higher learning institutions should adopt freeware and open source software for teaching and learning activities. Freeware does not necessarily imply an inferior product as support documentation is often available and sometimes there is online user support with questions answered via blogs.

We have identified the components and functionalities of the software available in a mathematics computer laboratory at UOW. Simultaneously we identified freeware or open source software that could be used as an alternative. This process generated questions as to what functionality is available in the original and the alternative software. A description of these packages and functionalities is provided in Table 1.

Functionality of Software packages	Software packages	Possible Libyan alternatives freeware/open source
Maths typesetting To help lecturers & students to manage tasks related with mathematics.	LaTex MikTex Mathtype	Freeware.
Maths packages: assist lecturers & students to understanding of mathematical Concepts and procedures. It yields high precision numeric results and can plot functions and data in two and three dimensions	Maple 10 MATHLAB 2007b Magma	Sage Sage Sage Mathematica Demonstrations Scilab/ Euler GNU Octave Maxima Yacas
Word process or Publisher: to write, edit & format Spreadsheet: processing information numerical or textual in tabular form Presentation: generate the presentation content PDF creator : create PDF files from any Windows application Majinea draw : create graphic images, create animations Camtasia: create videos Parallels desktop: running Windows applications Database is a collection of information E-Mail Client	Microsoft office 2007	common software Free MyPaint CamStudio Wubi Requires Internet
Statistical packages To assist lecturers & students to understanding of Statistical concepts and procedures such as statistical analysis, data manipulation, and graphing.	SAS 9.1 SPSS 17 JMP 7 S R 2.10.1 Ghostgum 4.9 Scilab 5.2.0 ML Win STATA	PSPP(some procedures) Can be replaced with R Freeware ROOT
Bibliographic database: to facilities lectures & students' organize to information on mathematics	Endnote	Zotero

Table 1 some Functionality of Software packages

The description of functionality in table 1 is not sufficient to highlight either the similarities or differences between the packages, nor the diverse utility that is provided. Additional guidance to such questions is provided at internet sites such as, for SAGE, (<http://www.sagemath.org/>) or the open source site (<http://www.opensourcemat.org/>). There are also sites providing comparisons of security, file systems, networking capabilities for open source operating systems (http://en.wikipedia.org/wiki/Comparison_of_open_source_operating_systems).

Two aspects of technology that are greatly different between the west and Libya are the use of e-learning systems and the internet. e-learning systems can be used to both deliver learning content, including the facilitation of learner interaction, and for administrative purposes. Blackboard is used at UOW. Alternative freeware E-Earning software includes LAMS (<http://lamsfoundation.org/>), eFront (<http://www.efrontlearning.net/>) and Moodle (<http://moodle.org/>). Although at UOW students typically access Blackboard over the internet it is possible to access e-learning systems from an intranet server. Intranets are available in computer laboratories at Garyounis University. Other functions at UOW such as linking of student databases to the e-learning system for automatic enrolment of students are not generally freely available, instead requiring specialist programming.

In the UOW mathematics department all staff and postgraduate students have access, not unlimited, to the internet, as do all mathematics undergraduate students, via the computer laboratory. These students also have access to centrally controlled laboratories for both in-class and out of class work. This is in stark contrast to the Libyan mathematics department at Garyounis University. In 2008 only staff and some postgraduate students had internet access; it was not available for undergraduate use in laboratories although students could pay to have access on campus.

An examination of the functions provided by e-learning systems reveals that there are several steps that can be taken to improve Libyan mathematics education. Even without good internet access many enhancements can be made to teaching by use of facilities usually associated with the internet. Figure (2) shows an extract from a subject taught at UOW. On the e-learning site the subject is divided into modules, within each module students may access lecture material. However most of the features used do not require either internet access or an e-learning system. For example, page viewing only requires a web browser not an internet connection. Web browsers are readily available, for example Mozilla/Firefox, Oprah, or Internet Explorer. The language used to construct the page is html, and there are many freely available html editors for creating html code, (See for example <http://www.thefreecountry.com/webmaster/htmleditors.shtml>). Web pages can also be created by languages such as Javascript and XML. An attractive feature of web documents is the ability to hyperlink to other images, files or documents. In this example the icon "ff" links to a video clip created on a Tablet PC with Camtasia Studio V6, a freeware alternative is CamStudio. The video clip could have been an animation created using a mathematics package such as Maple.

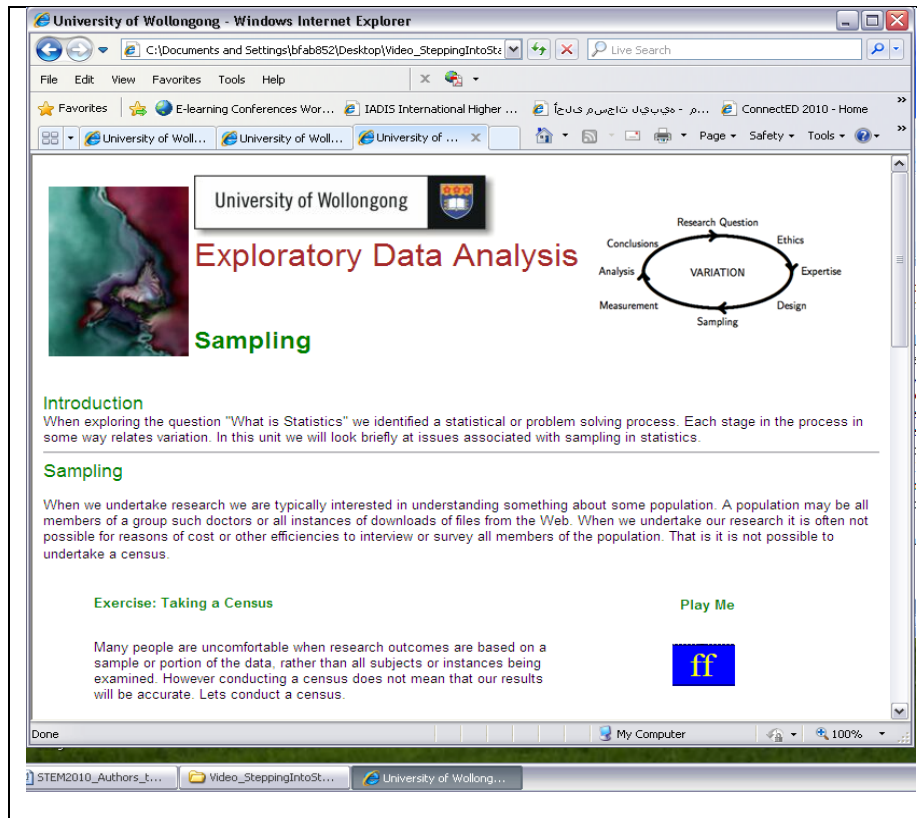


Figure 2: Web Page

Web pages such as this can be demonstrated by a teacher in a classroom using a data projector and computer. Under circumstances of restricted internet access the web pages, including accompanying features, can be made accessible to students by supplying them on a DVD or alternative storage system.

Over the last decade Information and Communication Technologies, such as the Internet, video conferencing and computer-mediated communication, have become powerful tools in the tertiary education sector (Armatas, at al., 2003). Technological development has forced academia to integrate technology into education to support all forms of learning (Ali, 2003). O'Sullivan and Samarawickrema (2008) highlighted that teaching and learning experiences are successful when ICT is used to develop interactive learning environments. The spread and rapid change in ICT has resulted in many university staff changing the way they teach. Not everything is available in Libya. The internet will be required for communication with the world.

At first it seems that there is so much available to universities in developed nations and so little available for universities in developing countries. While internet infrastructure is being introduced in Libya there is an opportunity to develop staff in readiness and at the same time to develop and improve the teaching and learning mathematics environment. The natural extension of our current work is the development of an in-service awareness learning program. The next step along this trajectory is to identify which technologies are most effective in supporting student learning. Part of this prioritisation involves examining which technologies are used most often, for what purpose and with what level students.

CONCLUSION

This paper provides insights into the Libyan higher education sector and outlines several challenges that must be overcome before technology such as e-learning can be

introduced. These include teacher training, overcoming both cultural perspectives and poor infrastructure and a lack of research, development and publication. However examining what is available in Garyounis University has allowed progress to be made towards understanding how the restrictions of limited infrastructure can be overcome.

Training of academics is required to increase their awareness of what can be achieved. For instance, limited or no internet access does not mean that applications such as web browsers and linked documents cannot be used. Alternative pedagogical approaches can be provided from internet applications accessed in an offline capacity. In mathematics there are freeware alternatives to many software applications. For example, LAMS is a freeware e-learning environment that can be used over an intranet when full internet capability is unavailable. The challenge is to incrementally introduce and trial these possibilities in Libya, increasing awareness of the educational possibilities that will eventually arrive with full internet capability.

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