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Using ICT to transform education

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About the journal

The International Journal of Education and Development using Information and Communication Technology (IJEDICT) is an e-journal that provides free and open access to all of its content.

Regional economies and communities are facing increasing economic, social and cultural hardship in many parts of the world as economies adjust to the demands of the new orders of commerce and governance. A part of this is the paradox that regional economies and communities can be either enhanced or disadvantaged by information and communication technologies (ICT) products and services. The potential enhancement comes from the increased social, economic and cultural capital that comes from harnessing ICT products and services in a community sense. The disadvantage comes from the power that ICT products and services have in centralizing commerce, service provision and governance away from the regional community.

Unless we get a greater level of access AND adoption of information and communication technology (ICT) for education and development at community level, we will miss the opportunity to turn the "digital divide into a digital opportunity for all, particularly for those who risk being left behind and being further marginalised" ("Declaration of Principles", WSIS-03/Geneva/Doc/4-E, Principle 10). The International Journal of Education and Development using Information and Communication Technology (IJEDICT) is an e-journal, with free and open access, that seeks to address this issue.

IJEDICT aims to strengthen links between research and practice in ICT in education and development in hitherto less developed parts of the world, e.g., developing countries (especially small states), and rural and remote regions of developed countries. The emphasis is on providing a space for researchers, practitioners and theoreticians to jointly explore ideas using an eclectic mix of research methods and disciplines. It brings together research, action research and case studies in order to assist in the transfer of best practice, the development of policy and the creation of theory. Thus, IJEDICT is of interest to a wide-ranging audience of researchers, policy-makers, practitioners, government officers and other professionals involved in education or development in communities throughout the world.

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IJEDICT has a major emphasis on the use of ICT in education and development in hitherto less developed parts of the world. The journal includes descriptive case studies about ICT projects in developing countries and in rural and remote regions of developed countries, as well research articles evaluating such projects, developing policy or creating theory. Topics covered include, but are not limited to, the following areas:

Community informatics and development in remote, rural and regional areas;
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ICT for micro, small and medium enterprises;
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IJEDICT comprises the following sections: "research articles" (academic, peer-reviewed articles); "studies from the field" (edited but not peer reviewed case studies); “research in progress”; “literature reviews”; "project sheets" (brief descriptions of relevant projects); "notes from the field" (working papers, and other commentaries on relevant topics); "book/media review" (software and other media reviews).

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This section contains the editorial written by the editors for the specific issue.

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This section contains articles that have been reviewed by at least two academic peers in a process that ensures that authors and reviewers remain unknown to one another. To be included in this section, articles must be based on research and scholarship, and contribute "new" and significant knowledge to the field of ICT for education and/or development. Reviewers for research articles are selected from the Editorial Board, the Review Board and the Peer Review Panel.

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This section includes peer-commented and editorially reviewed case studies (2000-5000 words) of the use of ICT in education and/or development.

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This section includes peer-commented and editorially reviewed articles describing research in progress.

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This section includes peer-commented and editorially reviewed articles that review the literature of the use of ICT in education and/or development.

Project Sheets

This section includes brief descriptions (500-1000 words) of education and development projects that utilise ICT.

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This section contains short comments or notes that are useful for practitioners working in the field of ICT in education and/or development.

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This section contains editorially reviewed reviews of books that are relevant to the use of ICT in education and/or development.

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- Submissions are invited for all sections of this journal. Refereed articles should be between 3,500 and 6000 words in length. Project descriptions for the "Project Sheets" section should be between 500-1000 words in length. Submissions for other sections of the journal can be any length.
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- Please use Arial 12-point font for the Title, which should be in bold "title" (upper and lower) case.
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Submitted manuscripts must be written in the Harvard editorial style:

- References should relate only to material cited within the manuscript and be listed in alphabetical order, including the author's name, complete title of the cited work, title of the source, volume, issue, year of publication, and pages cited. See the following examples:

    Marshall, S. (1991), "A genre-based approach to the teaching of report-writing". English for Specific Purposes, vol. 10, no.1, pp. 3-13.

    Taylor, W. & Marshall, S. (2002), "Collaboration: the Key to Establishing Community Networks in Regional Australia", Informing Science, vol. 5, pp. 155-162.

    Marshall, S., Taylor, W., & Yu, X. (eds.) (2003), Closing the Digital Divide: Transforming Regional Economies and Communities with Information Technology, Greenwood Publishing, Westport CT.

- Citations in the text should include the author's name and year of publication where you use the source in the text, as in the following examples:

  In this way, information technology can be seen to effect and influence changes in organisational structure (Orlikowski & Robey 1991).

  Edwards (1995, p.250) views the globalising of distance education as "invested with the uniform cultural messages of modernity".

  Globalisation, especially in relation to open and distance education, will reduce the tolerance of difference and so "how can local issues and contexts be addressed?" (Evans 1995, p.314).

- Further information about the Harvard editorial style can be found at:

  http://lisweb.curtin.edu.au/referencing/harvard.html
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Editorial: Using ICT to transform education

Stewart Marshall
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Wal Taylor
Cape Peninsula University of Technology, Cape Town, South Africa

Welcome to Volume 3 Issue 1 of the International Journal of Education and Development using Information and Communication Technology (IJEDICT). This issue contains articles concerned with using information and communication technologies (ICT) to transform education, especially in developing contexts. It brings articles from and/or about Africa, Australia, Caribbean, Hungary, India, Kenya, Mauritius, Nigeria, Romania and Saudi Arabia.

Female researchers and extensionists are important stakeholders in the development of agriculture in Nigeria because they are required to provide support to the female farmers who ordinarily would be more comfortable with female researchers. The article by E.I. Adebayo and O.M Adesope - "Awareness, access and usage of information and communication technologies between female researchers and extensionists" - examines awareness, access and utilization of ICT among female researchers and female extensionists. Information collected showed that female researchers and female extensionists are aware of ICT and both categories of respondents know how to access Internet on their own. However, respondents do not have adequate access to IT.

In her article "Exploring the use of computer technology in a Caribbean context: Views of pre-service teachers", Pier Junor Clarke presents a qualitative study of five pre-service secondary school mathematics (PSSM) teachers. The major goal of this study was to investigate the experiences and perceptions of the PSSM teachers as they explored the use of computer technology (CT) in their mathematics instructional practices, and to identify factors they consider necessary for successful integration of CT in mathematics instruction.

Gyorgy Katona examines whether applying ICT in teaching Physical Education (PE) increases pedagogical effectiveness in the article "The use of digital materials for instruction in sport topics at the University of West Hungary". A special e-book on sports was made in CD-ROM format, because of the low rate among our correspondence students who have access to the Internet. The CD-ROM contains theoretical and practical general material used in the course of teaching PE, demonstrates specialized vocabulary through videos and charts and provides the possibility for testing and self-testing. The CD-ROM also contains an audio version of the material for the benefit of sight-impaired students. The results indicated that using ICT increases effectiveness in teaching PE.

The incorporation of Information and Communication Technologies (ICT) into the educational curriculum has been promoted as a key step in bridging the digital divide. Despite considerable growth in the numbers of computers acquired by schools in Kenya in recent years and the sacrifices made to finance these, there has been little evaluation of their effectiveness. The article by Pádraig Wims and Mark Lawler – "Investing in ICTs in educational institutions in developing countries: An evaluation of their impact in Kenya" – describes research that seeks to redress this by examining the impact of ICT projects in educational institutions in Kenya. Teaching staff, current students and former students together with parents of current students were surveyed. Key informants were also interviewed to establish the current policies concerning ICT in education in Kenya. The research revealed tangible benefits to students from exposure to ICT. It was also found that exposure to computers in schools influenced the career choices of former students.

In the article "Students' perceptions of prehospital web-based examinations", Brett Williams describes a study that examined the attitudes of prehospital undergraduate students undertaking a web-based examination (WBE) as an adjunct to the traditional paper-based examination (PBE). Students were asked to complete a questionnaire which was designed to obtain information about students' attitudes of WBE. Quantitative results produced high student satisfaction and acceptance of WBE as an appropriate teaching and assessment resource in the BEH degree.

A prototype application for an online coastal zone management module is described in the article "Computer mediated communication for effective teaching-learning of coastal zone management module" by Roshan Ramessur and Mohammad Santally. The prototype consists of three main components - the web-based interface, the mobile access interface and the adaptation mechanism that is used to provide just-in-time tailored content according to students' individual preferences. From a pedagogical perspective, this implies a complete re-engineering of courseware in CZM to meet the constraints imposed by an m-learning environment. Alteration of any of the component would cause an ecological imbalance in the system and the blending of the pedagogical approach in CZM to support mobile learners adds more flexibility to the learning process.

The advancements in ICT are reshaping the architectural design studio teaching and design practices. The digital-imperative to switch from analogue to digital mode has already begun to manifest itself at the schools of design. In "Revitalizing architectural design studio teaching using ICT: Reflections on practical implementations", Rabee Reffat introduces the application of two approaches representing various dimensions of revitalizing architectural design studio teaching using ICT: paperless design studio and collaborative virtual design studio. The paper reflects on the practical implementations of these two approaches including design process, communication and presentation, studio pedagogy, and students' learning. The next step ahead for architectural design studio teaching in which ICT acts as a partner is introduced.

In "Policy networks and the transformation of secondary education through ICTs in Africa: The prospects and challenges of the NEPAD e-schools initiative", Chijioke Evoh examines the prospects and challenges of the New Partnership for Africa's Development (NEPAD) e-schools initiative. Based on qualitative research approach, this study aims to critically evaluate the prospects and challenges facing the e-schools collaborative initiatives under the auspices of the NEPAD. At the organizational level, the study argues that sustained technology intervention is based more on the resolve of the partner members, especially the political will of African governments. Besides, the e-school initiative stands to gain from the experience of developing countries that have successfully integrated ICTs in education through collaborative strategies.

Although an increasing number of faculty are very enthusiastic about adopting technology because of the potential of newer tools for their students, there is still a large number of faculty who seem hesitant or reluctant to adopt technology for their teaching tasks. In their article "Integrating technology into the teaching-learning transaction: Pedagogical and technological perceptions of management faculty" Payal Mehra and Monika Mital describe a study that examined faculty perceptions about technology enabled constructivist pedagogy Vs the didactic pedagogy followed even today in most of the management education institutes.

In "Computer-based testing on physical chemistry topic: A case study", Sorana-Daniela Bolboacă "Iuliu Hațieganu" and Lorentz Jäntschi describe research designed to assess the knowledge on physical chemistry topic of the undergraduate first year students' at the Faculty of Materials

Science and Engineering, the Technical University of Cluj-Napoca, Romania by the use of an auto-calibrated system. The methodology of multiple-choice questions construction and the evaluation methodology are presented. The students performances in terms of number of correct answers and time needed to give a correct answer were collected and analyzed. The future plans of system development are highlighted.

The emphasis in IJEDICT is on providing a space for researchers, practitioners and theoreticians to jointly explore ideas using an eclectic mix of research methods and disciplines, and we welcome feedback and suggestions as to how the journal can better serve this community.

Stewart Marshall and Wal Taylor
Chief Editors, IJEDICT

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 1, pp. 5-22.

Investing in ICTs in educational institutions in developing countries: An evaluation of their impact in Kenya

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ABSTRACT

The incorporation of Information and Communication Technologies (ICT) into the educational curriculum has been promoted as a key step in bridging the digital divide. Despite considerable growth in the numbers of computers acquired by schools in Kenya in recent years and the sacrifices made to finance these, there has been little evaluation of their effectiveness. Consequently, this research seeks to redress this by examining the impact of ICT projects in educational institutions in Kenya. Teaching staff, current students and former students together with parents of current students were surveyed. Key informants were also interviewed to establish the current policies concerning ICT in education in Kenya. An absence of educational software was found, as was the lack of Internet access and use of e-mail. Some 35-40% of secondary school teachers had never used a computer. The research revealed tangible benefits to students from exposure to ICT. It was also found that exposure to computers in schools influenced the career choices of former students. It was concluded that reform of the telecommunications sector is necessary to hasten the rollout of computer technology in educational institutions in Kenya. At school level, the key issues which arose included staff training, mainstreaming of ICT across the curriculum and provision of adequate ICT equipment.

Keywords: *ICTs; Developing Countries; Education*

INTRODUCTION

This paper investigates the use of computers in educational institutions in the Rift Valley province in Kenya. The adoption of Information and Communication Technologies (ICT) has been promoted as a key step in bridging the digital divide. Despite considerable growth in the numbers of computers acquired by schools in Kenya in recent years and the sacrifices made to finance these, there has been little evaluation of their effectiveness. Consequently, this study examines ICT projects in educational institutions in Kenya, in order to establish normal practice and to determine the effects of adopting ICTs at school level.

BACKGROUND TO THE RESEARCH

The country of Kenya experiences many of the problems typical of sub Sahara Africa enumerated by Langmia (2006) in that it is lagging behind in information superhighway technology. In terms of telecommunications infrastructural developments, the growth of the fixed telephone network throughout Kenya has been below expectations; according to the Central Bureau of Statistics (2006), the fixed line tele-density was 1.02% (number of fixed lines per one hundred population) during the year 2003 but this has actually deteriorated since then due to the steady population increase in the absence of infrastructural developments. Most of these fixed line subscribers are concentrated in urban areas which account for 94% of the fixed lines while 6% are in rural areas (ibid). In contrast, cellular services have expanded rapidly from under 15,000 customers in 1999 to over 2.8 million in 2004 (Export Processing Zones Authority, 2005). By April 2004, there were an estimated one million internet users and over one thousand cyber cafes throughout the country (ibid.).

Keiyo District is one of 18 districts of the Rift Valley Province and lies just north of the equator, at its centre approximately 350km north west of Nairobi. The western and southern areas of the district are fertile and support the highest population. Livestock rearing and tillage farming are the main occupations of the community. To the north of Iten, the administrative centre, the land gradually rises through forests of indigenous trees and bleak high merino-sheep country. Lumbering is also carried on in this area. The total population of Keiyo District was estimated at 144,000 in 2004, and the population density was estimated to be 100 persons per square km (CKRC, 2004). Keiyo District is the eighth most densely populated district in the Rift Valley Province and has an average life expectancy of 61 years.

There are 174 primary schools in Keiyo District and the primary school enrolment rate is 98.4%. The total number of pupils who sat the Kenya Certificate of Primary Education (KCPE) in 2004 was 4,922. A total of 2,471 places are available in the 32 secondary schools in Keiyo District, so, at best, only half of primary school leavers in the District can be accommodated locally. The current education system allows for a certain proportion of Keiyo primary school leavers to take up places in neighbouring districts or other provinces but this is offset by students from outside the district who take up places in Keiyo secondary schools. Due to the competitive nature of secondary school enrolment, approximately half of all primary school leavers in Keiyo District will fail to secure a place in secondary schools, which conforms to the national average.

This remainder of this section is presented in two parts: firstly the contribution that ICT can make to development through education is explored and secondly some relevant studies previously conducted on integrating ICT into the educational curriculum in Kenya are critiqued.

Contribution of ICT to Development

Education is a prerequisite for achieving several development goals. Research has shown that education is positively associated with a wide variety of human welfare issues that are seen as development goals. For instance, Lockheed et al. (1980) found that in a modernising environment four years of education improved agricultural productivity by 10 percent. Education is crucial to effective poverty reduction strategies (World Bank, 1995, p.1). Tilak (2002, p.198) argued that there is much research to support the hypothesis that education and poverty are inversely related. Education plays a vital role in improving the health and longevity of populations; even a basic education resulting in literacy and numeracy enables people to gain and employ potentially life-saving knowledge about nutrition, hygiene and sanitation. Health and education are mutually reinforcing; a study by the Global Campaign for Education (2004) suggested that if Universal Primary Education (UPE) is realised then an estimated 700,000 young people could be prevented from contracting HIV/AIDS. Indeed, they posited that education is the most effective weapon to fight the spread of HIV/AIDS.

The World Bank and UN agree that the social benefits alone of female education outweigh the costs without even considering the private benefits or increased productivity and earnings (Todaro and Smith, 2003, p. 377). Educating females has enormous potential to create a virtuous circle, as the children of educated mothers are more likely to receive an education. The benefits of educating mothers are invariably passed on to children. Glewwe (1999) studied health data in Morocco and found that mothers with numeracy and literacy skills attained through school possessed greater health knowledge and consequently had healthier children.

One of the dynamics of the lives of people in the grip of poverty is disempowerment – a lack of control over decisions made both by them and for them. ICT promises to go at least some way towards empowering them by removing barriers to the access to information. Prahalad and Hart (2002, p.9) considered that information poverty may be the single biggest roadblock to sustainable development. Commentators from diverse political persuasions are convinced that ICT offers a potentially valuable tool for development (Annan, 2001; Nulens et al, 2001, p.10 and Ya'u, 2004, p.25). Appropriate use of ICT could enhance many aspects of life in developing countries from health to education to economic growth. Education is one area where ICT deployment and improved access to information promises to deliver tangible benefits. ICT lends itself to adopting a more people or learner-centred approach to education. Freire's liberation theory (1970) stresses the importance of a dialogical approach to education. ICT can facilitate a pedagogical shift entailing an educational interaction between teachers and learners. ICT, if used correctly, can encourage and support a meaningful two-way, informational flow between teachers and learners, moving away from the old "banking" method of teaching where knowledge is simply transferred from teacher to student without any space for critical analysis on the part of the learner. Using ICT in education to produce ICT-literate students and a versatile, adaptable workforce is also consistent with the human capital theory of education. Hawkins (2002, p. 39) states that workers must learn how to learn and quickly acquire new skills. Augmenting the skills of the workforce in this way has the potential to benefit the economy at large and also improve the individual student's earning and employment potential.

In specific terms, there are several ways in which ICT can contribute to solving education problems in Developing Countries; some of the most pertinent of these problems include:

- Shortage of qualified teachers: GeSCI (2004) estimated that as many as 25% of teachers in sub-Sahara Africa are not adequately qualified; ICTs can accelerate teacher training and the Imfundo Report (Unwin, 2004) concluded that ICT in education has most potential in pre- and in-service teacher training.
- Low learning achievement: Introducing ICTs can help to counter some of the negative factors endemic in many schools in Developing Countries, such as high pupil: teacher ratios, shortage of basic instructional materials and poor physical infrastructure. Research on the Digital Education Enhancement Project in the Eastern Cape of South Africa (Leach, 2003) found that ICTs had a positive impact on pupil achievement and classroom practice.
- High drop-out rates: ICT can be used to make the school curriculum more interesting. Studies have verified that children enjoy learning using technology (Hepp et al., 2004; Osin, 1998). This motivation may deter children from dropping out of school; Gómez and Martinez (2001) described how using the internet in education programmes for street children in Colombia enticed a higher than usual number back to learning.
- Lack of opportunities in remote areas: Distance learning can help to overcome the problems associated with geographical isolation and is invaluable for students in remote areas. Distance learning educational software also benefits from economies of scale increasing cost efficiencies. Recruiting teachers for the more remote regions is often difficult in Developing Countries; ICT serves to counteract physical distance as teachers can maintain contact with family and friends through telephone and e-mail.
- Lack of study material and resources: Study and teaching materials are very sparse in many schools in Developing Countries; ICTs can play a significant role in providing teachers and students with access to educational content and up to date resources.

The issues arising from the preceding paragraphs lead toward the conclusion that education is one of the most important elements for achieving development success. However, ICT in turn can contribute towards enhancing education. This relationship was succinctly summarised by Kofi Annan (United Nations, 2003) when he asserted that:

> *"While education unlocks the door to development, increasingly it is information technologies that can unlock the door to education"*

The Government of Kenya sees education as the natural platform for equipping their nation with ICT skills in order to create dynamic and sustainable economic growth (Kenya Government, 2004a, p.67). Apart from the traditional use of ICTs in education "as a vehicle for improving existing school curricula and school management processes" (Makau, 1990, p.3), the Kenya Government holds that the use of ICT in education and training institutions will play a major role in disseminating skills to the wider society and thus create positive impacts in the economy (Kenya Government, 2004a, pp.67-68).

ICT in Education in Kenya

Although ICT in education in Kenya is a relatively new area of research, some useful publications are available, dating back to an evaluation of one of the earliest computer deployment projects in the country, the Computers in Education Project in Kenya (CEPAK). The latter project was launched as long ago as April 1983 but its evaluation in 1990 is particularly relevant to the present research. At its pilot phase, with funding from the Aga Khan Foundation, a small number of computers were introduced into one secondary school in Nairobi. In the succeeding two years CEPAK was subjected to both in-house and external evaluations. As a consequence, additional funding was obtained from Apple Inc., the International Development Research Centre (IDRC) and the Rockefeller Foundation, and in mid 1986 a three-year Phase II was launched. Five more secondary schools, which included private and public schools distributed throughout Kenya were brought into the project and each received computers, software and teacher training. During the three year period of Phase II, this innovative project was studied and evaluated by an independent research team (Makau, 1990). Three educational researchers carried out this study, using a variety of research methods; these included examination of school records on the use of computers within the six participating schools, observation of classes (91 were observed, 65 of which were computer-assisted), and interviews with students, teachers and non-teaching staff. Two sets of written questionnaires were administered to teachers and students in 1986 (baseline year) and in 1988. In total, 170 teachers responded to these questionnaires in 1986 and 110 in 1988. For the students, 1535 responded in 1986 while 2671 responded in 1988. Thus, this represented a large-scale study of the use of computers in secondary schools in Kenya.

The CEPAK evaluation found that most computer-assisted lessons were observed to be in mathematics and the sciences. However, this evaluation also found that in the majority of computer-assisted lessons teachers tended to be passive, thus leaving students to do whatever they chose. It found that some students regarded both formal and informal sessions on the computer as time for relaxation as opposed to serious learning (Makau, 1990, p.160). This approach to computer-assisted lessons was explained as being a result of the perception of the computer as the object of study, as more exciting and potentially more rewarding than integration of the technology into the existing curriculum (ibid. p.90).

The research also found that computer studies lessons were conducted in the computer laboratory, thus they seemed to have priority over computer-assisted lessons in other subjects. It would appear that, both practically and symbolically, computer science was receiving more emphasis than integration of the technology into the rest of the curriculum (ibid. p.91).

The evaluation also provided some very interesting findings with regard to gender issues in the use of computers. As with the findings of the current research (discussed below), no significant differences in the attitudes of boys and girls to the new technology were unearthed (ibid. p.161). However, with regard to exposure outside the school (i.e. at home, in primary school or elsewhere), female students were more disadvantaged than their male counterparts. The proportion of males that claimed to come from a home which owned a computer was nearly twice that of females, while 21% more boys than girls claimed to have used a computer outside school (ibid. p.161). Even more worryingly, in mixed schools surveyed in the evaluation, female students claimed to have received less in-school exposure than the males (ibid. p.163).

A second research project (Kenya SchoolNet, 2003) conducted in November 2002 was based on the findings of a questionnaire to which 69 secondary schools responded, coming from all provinces and 46 districts. This research reported that only 46.4% of the sampled schools had computers although there did appear to be a high level of awareness of the benefits of computers in schools (ibid. p.11). The research also reported that Internet and fax were rare in the schools (ibid. p.10). It was suggested that E-mail was yet to be recognised as a tool for collaboration among teachers as only one school had a website and only two reported having networked all their computers to the Internet (ibid. p.20). It went on to assert that in those schools, access to the Internet was severely limited and when available, was only for administrative use (ibid., p.20).

The Kenya SchoolNet research found that almost 40% of schools had less than 10 computers, and therefore inadequate numbers for teaching and learning. More than 20% had less than 5 computers, indicating that the computers were largely for administrative purposes (ibid., p.10). Only one third of schools surveyed had dedicated computer laboratories. The research also found that some schools were making use of very old equipment and that heavy reliance on the donation of computers as opposed to sourcing locally reduced the capacity of the school to determine the makes of computer they used (ibid. p.13).

As with the previous research reported from the CEPAK project, the Kenya SchoolNet survey also revealed that there was a significant difference in the quality and use of the computers in schools, depending on the gender of students there (ibid., p.23). Girls' schools were found to have the lowest numbers of computers, almost a third of that of boys' schools (ibid., p23). The survey asked if computers were used for teaching and found that more boys' schools than girls' reported in the affirmative (ibid., p.24). Furthermore, the survey found that fewer of the computers were located in a computer laboratory in girls' schools, indicating their use predominantly in administration in girls' schools. The research concluded that fewer girls were being exposed to computers than boys (ibid., p.24).

Again, mirroring closely the findings of the evaluation of CEPAK, the Kenya SchoolNet survey found that there was a close association between mathematics and computer usage given that many computer teachers were themselves teachers of mathematics. This tendency created a perception that computer courses were closely linked to mathematics, and in turn explains why fewer girls than boys took computer lessons. Consequently, the research concluded that girls would be marginal players in the information society (ibid., p.30).

A third research study (Ndiku, 2003) conducted more recently and based on the experience of managers and computer teachers in eight schools in Uasin Gishu District, western Kenya, focussed on the problems encountered in the implementation of educational ICT projects. The research identified the following as the most important factors in inhibiting the success of computer deployment projects: insufficient numbers of computers and peripheral devices; teachers' lack of knowledge; inadequate software for instruction and inadequate technical assistance (ibid, p.81). Computer teachers themselves were found to have the additional problems of integrating computer usage into the school curriculum and frustrations with out-dated computers which were not relevant to current needs (ibid. p.81).

These studies of ICT in education in Kenya have highlighted some of the issues specific to ICT deployment in schools. The present paper now attempts to contribute to the research in this area with an evaluation of current practice in educational institutions in Kenya with a view to establishing best practice in educational ICT deployment projects.

St. Patrick’s High School, Iten was selected as representative of a typical secondary school in rural Kenya. As is the case with the vast majority of successful secondary schools in Kenya, it is a boarding secondary school, and draws its intake from a wide geographical area. Admission is based on students’ results in the Kenya Certificate of Primary Education (KCPE). The school is designated “Provincial” which places it in a middle ranking in terms of the academic achievement of its Form One intake (above “District and below “National”). The school is based on the outskirts of a small rural village and has electricity, telephone and is covered by both mobile telephone operators. The school is also typical in terms of numbers of staff and students, with approximately thirty full-time equivalent staff and 550 students. It is an all-boys school. However, segregation is the norm in Kenya, but to provide balance and examine any differences in the implementation of ICT programmes that may arise, a “Provincial” boarding school for girls, Singore Girl’s Secondary School, was also selected for the purposes of this analysis. Singore Girls is somewhat smaller in size than St. Patrick’s in terms of staff and student numbers with approximately twenty staff (full-time equivalent) and four hundred students. Form One intake is again based on the results of the KCPE, and in terms of the geographical spread and academic level of Form One intake, is broadly similar to that of St. Patrick’s.

In terms of access, St. Patrick’s High School is located on a good tarmac road, 30km from Eldoret town, which is 320km from the Kenyan capital, Nairobi. Singore Girls’ is a further 6km from St. Patrick’s on the Kapsowar road. This is a mud road and required a four-wheel drive vehicle, as research was carried out between June and August which was the rainy season in this region. Frequent visits to both schools were made, and no problems were encountered. The third educational institution examined was Baraka Agricultural College, Molo. This is also located on a good tarmac road; however the road from Eldoret to Molo is in a bad state of repair.

RESEARCH OBJECTIVES

The overall aim of this research is to evaluate the implementation of ICT projects in selected educational institutions in Kenya with a view to making recommendations on how such projects should best be deployed and supported. The following specific objectives were identified:

1. To describe and critique the current situation in selected educational institutions with regard to ICT usage;
2. To evaluate the ICT learning programmes for students and to assess levels of interest in and attitudes towards ICT among students, teachers and parents;
3. To assess the positive impact of ICT exposure in the lives of students and the improving practices that have resulted; and
4. To issue recommendations on how problems might be overcome and how supports might be enhanced to maximise the learning and benefits that result from an ICT project in a typical Kenyan school or training college.

RESEARCH METHODOLOGY

While the research focussed on three educational institutions (St. Patrick’s High School, Singore Girls’ Secondary School and Baraka Agricultural College), visits to additional institutions were made for the purposes of verification. The research was designed as both a quantitative and qualitative survey using interviews, questionnaires and observation. The research methodology was designed to facilitate a critique of current practice based on the results of these interviews, questionnaires and observations.

In summary, the following sources provided data for the study:

- Management staff from four secondary schools and one agricultural college;
- Teaching staff from two of these secondary schools and the agricultural college;
- Current students from these two secondary schools and the agricultural college;
- Former students from one secondary school;
- Parents of secondary school-going students;
- Key informants from the ICT, education and telecommunications sectors in Kenya.

Specifically, the following research methods were employed:

- In-depth semi-structured interviews were conducted with key members of management staff in four secondary schools in Keiyo District, and Baraka Agricultural College, Molo during July and August, 2005. In St. Patrick's High School, the Principal, the Head of the IT Department and the Computer teacher were interviewed in person. In Singore Girls' Secondary School, the Principal and the Head of the IT Department were interviewed in person. In Kessup Girls' Secondary School, the Principal, Head of IT and one Computer teacher were interviewed in person, while from Kaptagat Girls' Secondary School, the Principal was interviewed by telephone. Four in-depth interviews were personally conducted in Baraka Agricultural College with the Principal, the Deputy Principal, the college IT Coordinator and the Head of the Community Development Department. The purpose of these interviews was to establish background information on the schools concerned and to gather factual information on how ICT was incorporated into the school curriculum. The issues explored ranged from the experiences with deployment of ICT at school level to the attitudes of these staff towards ICT.
- Teachers from three of the institutions mentioned above were interviewed in person during June/July 2005 using a structured questionnaire. Twenty of the thirty teachers from St. Patrick's High School were interviewed, all twenty teachers from Singore Girls' Secondary School were interviewed and eleven teaching staff from Baraka Agricultural College were interviewed. The issues raised focussed on the respondents' teaching responsibilities, their specific experiences of using computers, their attitudes towards integrating computers into the curriculum and using computers to teach their subjects. Details relating to their personal characteristics and academic qualifications were also investigated.
- Samples of current students were randomly selected for interview from both St. Patrick's High School and Singore Girls' Secondary School. A structured questionnaire was personally administered in June/July 2005 by one of the researchers. Twenty students from St. Patrick's (from a population of 550 students) were interviewed; these consisted of ten from lower forms and ten from senior forms while sixteen students from Singore Girls' Secondary School (from a population of 400 students) were interviewed (eleven of whom were from junior forms and five from senior forms, to reflect the population from which the sample was drawn). All students in Baraka Agricultural College (90 students) were surveyed using a questionnaire administered by the Head of the Community Development Department when the students joined the college in July 2004. The questionnaires explored the students' experiences with using computers both at primary and secondary schools, investigated in depth the students' exposure to computers and determined their attitudes towards computers in the school curriculum. Personal questions were also asked in order to examine the characteristics that were associated with these experiences and attitudes.
- Twenty-nine former students (all graduates from the class of 2005) of St. Patrick's High School were invited to participate in the research. These consisted of nineteen who lived locally and an additional ten from further away. All nineteen former students who were

identified as living locally were invited to participate in the study. They were asked in person to complete a structured questionnaire by one of the researchers in June/July 2005. Among the former students who did not live locally, ten were selected at random and invited by post to complete the questionnaire and return by post. All ten responded, thus resulting in 29 completed questionnaires. The questionnaires administered to former students sought details about their experiences with computer classes during their primary and secondary schooling and asked the respondents to evaluate their familiarity and current levels of competence with a range of computer applications. In addition, these former students were asked to comment on their current access to computers and to report on the purposes to which they were using computers since leaving school. They were also asked about their career aspirations and if they were using computers to realise these.

- Ten parents of secondary school-going students from the Iten area were randomly identified and invited to participate in the research. All ten agreed and were personally interviewed using a structured questionnaire during June and July 2005. Their questionnaire focussed on their personal and family circumstances, their own experiences with computers and the importance that they attached to their children being able to use computers.
- Four key informants were interviewed in person to provide additional information on the ICT, education and telecommunications sectors in Kenya: these consisted of the District Education Officer, Keiyo (Kenya Government), the National IT Co-ordinator from the Kenyan Ministry of Education, a Manager from ICT Trust Fund, Nairobi and a Technician from Telkom Kenya.

The data collected to evaluate the teaching and learning programmes at these educational institutions were presented and analysed using the logic of Bennett's Hierarchy (after Bennett, 1975). First used in the 1970s to guide the evaluation of Extension programmes, this hierarchy continues to be updated and used for planning and evaluation of broad-based development programmes (see, for instance, Fisher et al, (2001), and is ideal for evaluating educational programmes.

The seven stages of Bennett's Hierarchy of Evidence may be summarised as follows:

7. Impact–Social, economic, environmental conditions intended as end results, impacts or benefits of the programme.

6. Actions–Patterns of behaviour, such as decisions taken, practices implemented, actions taken, technologies used etc.

5. Learning–Knowledge (awareness, understanding, and/or problem solving ability); Attitudes (outlooks, perspectives, viewpoints); Skills acquired; Aspirations (ambitions, hopes).

4. Reactions–Degree of interest; feelings towards the programme.

3. Participation–Numbers of students reached; characteristics of students; extent and intensity of exposure to programme.

2. Activities–Educational methods used; subject matter taught.

1. Resources–Staff time; salaries; resources used: computer equipment etc.

This seven-stage hierarchy is based on a logical progression of evidence required to conduct an evaluation. The lower stages of Bennett's Hierarchy represent the resources (1) involved in implementing the programme of activities (2) intended to achieve the participation (3) of the students. As the hierarchy is ascended participants' reactions (4) to programme activities are measured to determine how these activities affect their learning (5). This fifth stage of the hierarchy looks at changes in what Bennett calls 'KASA' i.e. students' knowledge, attitudes, skills and aspirations. After learning, people take action (6) which will have a social, economic or environmental impact (7). Bennett's thesis is that evaluations are strengthened by collecting data at several stages of the hierarchy.

The data collection phase of the study involved visits to the institutions under examination and observations of their ICT programmes. Information on resources, activities and participation was collected through the semi-structured interviews with the Computer teachers and ICT Co-ordinators and school or college management. For the higher levels of Bennett's Hierarchy – impact, reactions, learning and actions – evidence was garnered from both structured in-depth interviews with current and former students and the series of questionnaires designed for parents and teachers.

Quantitative data (results of questionnaires) were entered into the Statistical Package for the Social Sciences (SPSS 11.0® for Windows) software and analysed using this data manipulation programme. Descriptive statistics (Frequency distribution, percentages, measures of central tendency and variability) were used to describe the data. Crosstabulations were used to examine relationships between variables while Pearson Chi-Square (with a 0.05 level of significance) was used to test significant differences. This methodology is typical in evaluation research (see, for instance, Kistler and Briers (2003),

The quantitative data were supplemented with qualitative information. The key informant interviews provided very valuable insights into the levels of awareness among interviewees. Civil servants, even those charged specifically with a role in education and the provision of ICT resources and information to schools, seemed poorly informed as to the kinds of educational ICT resources available, the funding options available to schools and colleges and the very potential itself of ICT in education. By contrast, at school and classroom level, the response was much more encouraging. It almost seemed as if schools and colleges rolled out their own ICT projects in spite of the official infrastructure in place rather than because of it. The key informant interviews also proved to be a very useful tool for gathering information on the ICT, education and telecommunications sectors in Kenya. It gave the freedom to the interviewees to include a wide range of information in the discussion and share any personal views held about the current situation and possible future developments.

RESEARCH FINDINGS

The findings below are presented according to the objectives of this research paper. Findings from field research conducted are analysed in order to understand current practice in the three institutions surveyed. Programmes of teaching and learning with ICT are scrutinised using data from personal observations, documentary analysis and key informant interviews.

Current ICT Usage in Education Institutions

Half of Keiyo District's 32 secondary schools had at least some computer equipment installed (information made available by the Education Office, Keiyo District). Just over half of those (28% of all schools) offered computer lessons to students. The average number of machines at the disposal of students in those schools that offered lessons was 15, the highest recorded was 21, and the lowest was 10. The ratios of students to computers in the institutions surveyed were as follows: St. Patrick's, 25:1, Singore, 32:1 and Baraka, 4:1. No institution, however, had more than two students per machine during lessons.

In St. Patrick's, the computer laboratory had 16 working machines, with an average of 1.5 students per machine. Singore Girls' had a laboratory with 10 machines, and an average class size of around 15, or a ratio also of 1.5 students per computer. In Baraka Agricultural College, students had access to a computer laboratory with 12 PCs. Only 12 students attended classes at any given time, allowing for a ratio of 1:1.

The software installed on these PCs for use by students came exclusively from the Microsoft Office® suite of programmes (Word, Excel, etc). In addition, Operating Systems in use were exclusively versions of Windows®. The cost of licences for these software packages was prohibitive for most educational institutions. No educational software in any subject was found. In school management, use was made mostly of Microsoft Excel® for book-keeping and Word® for letters and reports. No secondary school in the Keiyo District exploited the resource of the Internet for educational purposes, though Baraka Agricultural College had recently installed an "always-on" connection, and enjoyed access albeit at a very slow speed.

Some 40% of secondary schools in the district were served by fixed wire telephone, although all parts of the district were found to be covered adequately by at least one of the two mobile telephone service providers. Of the three institutions surveyed in this research, only Singore did not have a fixed line. Two of the secondary schools in the district claimed to have e-mail addresses on their official notepaper, though only one had an active e-mail account. In no secondary school was either e-mail or Internet accessible to students, and in the one school where e-mail was used it appeared to be as much for the personal use of the school Principal as for official school business. Baraka Agricultural College did, however, have a leased line from the national phone company, Telkom Kenya, and an 'always on' connection to their ISP. Students there were able to access the Internet for both personal and research purposes.

Only one secondary school in the district (one of the secondary schools which was the subject of this research) had an active website, i.e. www.itensaints.com. It is managed and maintained in the USA by a group of former students from St. Patrick' High School. There is no up-to-date news from the school on the site, but there are several articles and many pictures of interest pertaining to the history of the school. In 2002, the Principal agreed that the site would be the school's official website, however since then, neither he nor the computer teacher in St. Patrick's have had any contact with the individual who manages the site. In contrast, Baraka Agricultural College had an active and regularly-updated website which was managed internally.

An impressive 88% of the secondary schools in the district (and all three of the education institutions surveyed) had electricity from the national power company, Kenya Power and Lighting (KPLC). Penetration of the electricity network was well above the national average in Keiyo District which had benefited from powerful political representation over the years.

Funding for ICT deployment was found to have been raised locally in the case of the two secondary schools examined. This was confirmed as the norm through visits to other schools. However, considerable donor funding has been made available to Baraka Agricultural College. Two of the 32 schools in the district involved private companies in the provision of equipment. One of these was Singore Girls' Secondary School: it acquired PCs through an arrangement with a Nairobi-based private firm, Regio-Tech Ltd. (RT), which is involved in the deployment of computers to primary and secondary schools throughout Kenya. A ten-year contract was signed in September 1998. The firm supplied the hardware, software and the teacher for the duration of the contract, by the end of which the equipment will be fully owned by the school. Prior to the end of the contract, however, the equipment remains the property of RT, and when used by the computer teacher for income generating purposes such as providing lessons for local people or typesetting and printing for commercial purposes, the proceeds are submitted to the company.

The obvious attraction of this arrangement was the immediate provision of ten computers, together with a qualified instructor and a guarantee of servicing and maintenance over the period of the contract. The Headmistress at the time admitted to having no expertise in the area of ICT, although she was under considerable pressure from parents to introduce computers. A glance through the newspaper archives reveals a very similar story in other schools assisted by RT. One Primary School Head-teacher in Nyanza Province described his delight at the arrangement and his relief that the firm “will protect us from dubious experts now all over” (Daily Nation, 9^{th} August 1999).

Funding for the students’ Computer Laboratory in Baraka Agricultural College came from a donor agency, and several machines in the administration were also donations. Approximately 15 reconditioned laptops and 4 desktop computers were recently donated. The IT Co-ordinator explained that, while warmly welcoming this equipment, there had been some problems on occasion, such as the requirement to pay excise duty, the out-dated software loaded on some reconditioned machines, and their incompatibility with the network and software already in use.

Experiences of Teaching & Learning Programmes in Education Institutions

The experiences of students, teachers and parents are presented below. The problems that arose and successes experienced in these educational ICT deployment projects laid the foundations for the recommendations on best practice presented in the final section of the paper.

Students’ Experiences

In regard to the students surveyed, it was found that half of all boys interviewed in St. Patrick’s (n=20) had used a computer before joining the school, however for the girls (n=16), the figure was just over 30%. A direct relationship was found between choosing Computer Studies as an optional subject for the Kenya Certificate of Secondary Education (KCSE) and having had experience with computers before joining secondary school. This may go some way to explaining the lower number of girls than boys who chose to take Computer Studies to KCSE level. Of the group interviewed in St. Patrick’s who had chosen to take Computer Studies to examination level in Form Three and Form Four (n=10), 90% had used a computer before joining secondary school.

A teacher-led approach was evident with considerable emphasis on the textbook and theory in the upper Forms in St. Patrick’s. This is confirmed by the high percentage (87.5%) of lower Form students who said they worked in groups *often*, *mostly* or *always* compared to only 40% of Form 3 and 4 students who said the same. Singore Girls’ School seemed to follow the more active participation and student-centred model in evidence in the lower forms in St. Patrick’s.

A very high level of interest among students was found in computer lessons, particularly in the lower Forms. Some 90-94% said that they found computer lessons *more interesting* or *much more interesting* than other subjects. This is very encouraging, and indicates success in the implementation of the ICT projects examined in this research.

Students were also asked to rate their levels of satisfaction with the quality of computer equipment, textbooks, handouts or additional written resources given by the computer teacher, computer assignments and assessment tests in computer lessons. These constituted a subjective measure of quality based on students’ own assessments and the purpose was not to rate computer equipment, textbooks, handouts, assignments and assessment tests but rather to give an indication of the students’ level of satisfaction with them.

More than 40% of students interviewed (N=36) rated the computer equipment in their schools as *very good* (44% in St. Patrick’s and 42% in Singore). The remaining students rated it as *good* for the most part (39% in St. Patrick’s and 58% in Singore) but there was a significant number (17%) in St. Patrick’s who gave only a *moderate* rating. None of the interviewees from either school gave a *poor* or *very poor* rating, indicating that overall satisfaction with computer equipment was high (85%-88%).

Almost 40% of students in St. Patrick's rated their computer studies textbooks as either *poor* or *moderate*. The girls in Singore were less critical but 17% rated the textbooks as only *moderate*. The most common rating in both schools for textbooks was *good*, so, although satisfaction levels were lower than for the computer equipment, overall satisfaction with textbooks was still high (74%-82%).

Handouts and additional written resources related to computer lessons were rated the lowest among all aspects of the computer courses undertaken by students in both schools (these had satisfaction levels of 65%-77%). Some 28% of students interviewed in St. Patrick's rated handouts as *poor* and only one in three students felt the quality of computer-lesson handouts was either *good* or *very good*. Again, the students interviewed in Singore girls' were not as critical as the boys, but satisfaction among the girls was at its lowest in this category at 77%. One in three girls ranked handouts as *moderate*, however a large number (over 60%) maintained there were too few (or no) additional written resources handed out to rank, especially girls from the lower Forms. This was a significant finding, especially given that the dynamic nature of the subject demands up-to-date additional resources are used for successful teaching and learning to take place.

The results from the two schools in the national examination from the previous year (2004) indicated that boys performed better than girls in Computer Studies. The mean score in St. Patrick's was 8.33, while that of Singore was 6.81 [Subject 'mean score' is a numerical scale from 0 to 12 used in Kenya to present examination results. 12 (the maximum) is an A, 11 is an A-, 10 is B+ etc.]. This could be explained by any number of factors including the fact that more boys attended primary schools with computers (25% compared with 12% of girls) and more boys had exposure to computers outside secondary school (50% of boys compared with 30% of girls). It was also observed, while visiting these schools, that boys were more interested than girls in computers and were performing more challenging tasks on the computers. Informal discussions with these children also suggested that boys appeared to be more aware of the possibilities of the Internet, for instance in relation to career options in ICT.

Teachers' Experiences

The research found that there were no computers in the two secondary schools surveyed set aside for use by teachers. This was a concern raised by the teaching staff. One teacher complained about having to share the facility with students, especially given the confidential nature of some of the work that teachers need to prepare on computer. It was also felt that learning to master the new technology in the company of students was inappropriate and at times embarrassing. In Baraka Agricultural College, where the deployment of computers in administration was most impressive, every office had at least one computer, a printer and a connection to the Internet. In contrast with the secondary schools, these facilities at Baraka greatly facilitated teachers in improving their computer skills.

The findings revealed a clear trend between the year of graduation of teachers and whether or not they ever used computers outside the workplace, with the older graduates less likely to have used one (see Table 1). Some 35-40% of secondary school teachers admitted never having used a computer at all, either in school or outside of it.

Table 1: *The relationship between the year of graduation of teacher respondents and whether or not they used a computer outside the workplace (n=51).*

			Graduation Year (categorised)			**Total**
			1980-1990	**1991-1996**	**1997-2005**	
Have you ever used a computer outside the workplace?	Yes	N.	*7*	*11*	*14*	*32*
		%	*36.8%*	*64.7%*	*93.3%*	*62.7%*
	No	N.	*12*	*6*	*1*	*19*
		%	*63.2%*	*35.3%*	*6.7%*	*37.3%*
Total		N.	*19*	*17*	*15*	*51*
		%	*100%*	*100%*	*100%*	*100%*

Pearson Chi-Square 11.486(a), DF=2, Sig.=0.003

It was found that a high proportion of teachers of the Humanities subjects did not use computers while a high proportion of teachers of the Mathematics and Science subjects did use computers. The example of the findings from Singore is typical and is presented in Table 2.

Table 2: *The relationship between Singore teachers' subject areas and whether or not they have used a computer (n=20).*

			Teaching Subject(s)						**Total**
			Modern Languages	Human-ities	Business Studies	Maths/ Maths and Physics or Chemistry	Biology/ Biology and Agriculture	Tech-nical	
Have you ever used a computer?	Yes	N.	*2*	*1*	*2*	*5*	*2*	*1*	*13*
		%	*50%*	*33.3%*	*66.7%*	*83.3%*	*66.7%*	*100%*	*65%*
	No	N.	*2*	*2*	*1*	*1*	*1*	*0*	*7*
		%	*50%*	*66.7%*	*33.3%*	*16.7%*	*33.3%*	*0%*	*35%*
Total		N.	*4*	*3*	*3*	*6*	*3*	*1*	*20*
		%	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*

Pearson Chi-Square 3.15(a), DF=5, Sig.=0.677

Only two (10%) of the staff interviewed in St Patrick's said they had an e-mail address, and only three (15%) had ever used the Internet. The figures were better for Singore where 30% of the staff said they had e-mail addresses and 50% had used the Internet (in public Internet Cafés). Teachers appeared not to use the Internet to search for information related to their teaching subject areas although around half in both schools indicated awareness of this possibility.

Parents' Perspectives

Of the sample of parents of secondary school students interviewed (n=10), only one had ever used a computer. Despite this, seven out of ten felt that computers were *extremely important* in the lives of their children, while the remainder said they were *very important*. This reflects the significant levels of enthusiasm among parents for ICT. Parents, however, were, for the most part, unable to respond to the question as to the ways in which computers could help their children. Two parents mentioned improved career opportunities, but most admitted they did not know enough about computers to be able to say exactly what benefits they might herald for their children.

Impact of Exposure to ICT in Schools

As an indicator of improving their practices as a result of exposure to ICT in schools, students were asked if they had ever used a computer to assist them with studies in another subject area. The results ranged from only one third of Form One students in Singore (n=6) who claimed ever to have used a computer to assist them in another subject to 80% in Form Two (n=5) and 100% of the Form Three students (n=3). However, a broadly similar trend was found in St. Patrick's where only 10% of the Form Ones and Twos (n=10) claimed ever to have used a computer to work on another subject, rising to 80% of students in Form Three and Four (n=10).

These figures relate to improving practices among students as they demonstrate increasing evidence of the practical application of ICT skills learned as students' years of exposure increase. They are particularly encouraging when one considers that only 5% of current students surveyed in St. Patrick's said that any other teacher (apart from the Computer teacher) had ever used computers to teach their subject. Although this figure was considerably higher for Singore (at 21%), the figures show that, on the whole, teachers did not give students a good example as to how computer technology may have a practical application in diverse subject areas.

The research shed light on some of the tangible benefits to students of exposure to ICT in secondary schools. Some were able to secure short-term work in the area of IT, while all past pupils claimed to have needed a computer for some work, study or leisure-related activity since leaving school. It was clear that exposure to computers in schools had a considerable impact on the career choices of former students, with many opting for further studies in the area of IT. Some 38% of respondents listed Computer Engineer as one of their three most preferred jobs. What was surprising was the number of students who opted specifically for "Computer Engineer". This seems to illustrate a rather poor foundation in secondary school in the area of career opportunities in ICT. The Computer Studies syllabus recommends four lessons in Form Four to deal with descriptions of careers in ICT e.g. Computer Operators, Programmers, Software Engineers, Database Administrators, Computer Technicians, Web Designers, Systems Analysts, etc. (KIE 2002, p.42). The responses from the students in this survey, while certainly suggesting a high level of interest in careers in ICT, also suggest low levels of awareness of the various career options in the field.

CONCLUSIONS

This research highlighted the complete dependency on licensed software and standard Microsoft® applications such as MS Word® and MS Excel®, and the absence of any educational software. This is in spite of the commitment of the government of Kenya that the development and deployment of Open Source software for public and private sector would be encouraged (Kenya Government, 2004b, p.14).

Computers set aside for the exclusive use of teachers were not found in any secondary school surveyed, highlighting the low priority given to this by school managers, confirmed in the findings of previous research that “the first computer sits in the Principal’s office, the second at the secretary’s desk or the bursar’s and the third goes to the computer laboratory” (Aguyo, 2004, p.155). This could go some way towards accounting for another significant finding in this research, namely that many teachers were found not to be making use of the ICT facilities in their schools.

Some schools had acquired such facilities over ten years ago, yet 35-40% of teachers, representing, in particular, those longest in the profession, and those teaching humanities and language subjects, were found not to be exploiting the potential of computer technology to enhance teaching and learning in their subject areas.

The involvement of private companies in the provision of computer equipment, software and/or personnel to schools was concluded, from the findings of this study, to be poor value for money. The contract entered into by Singore required the school to pay 60% of the total cost of the hardware up front, and then continue to pay approximately 20% of the total value of the hardware on an annual basis. The school was locked into this arrangement for five years and prohibited from utilising the facility for its own income-generating activities such as printing and computer training. Clearly, any arrangement by which a private company recoups its full costs potentially within less than two years and then begins to turn a profit at the school’s expense should be discouraged.

It was found elsewhere that the expenditure incurred associated with the donation of computers could sometimes be equivalent to the purchase of new machines. The case was presented of the donation of laptops which attracted importation duty, the loading of licensed software and, in some cases reconditioning and the replacement of spare parts.

This research exposed the failure of former students fully to exploit the resource of the Internet as a source of information on careers, job opportunities and college and training courses. This is an obvious consequence of the lack of Internet access in schools, and the absence of any meaningful introduction to the potential of the Internet in the course of computer training. Only one respondent said he had used the Internet to find out about a college course abroad, and seemed determined to pursue the lead. While information on courses within Kenya on the Internet is not up to the standard of foreign universities and colleges, relevant information is nevertheless available, especially on careers.

Immediate reform in the telecommunications sector is necessary to hasten the rollout of computer technology in educational institutions in Kenya. In the areas of Internet connectivity, importation duties, rural electrification, software provision and financial support, much work remains to be done by Government, the private sector and development partners in order to create an enabling environment for ICT in education. At school level, some of the burning issues which arose were: the need for staff training, mainstreaming of ICT across the curriculum, additional computer equipment for staff and students and the development of relevant software and Internet access. Among the recommendations made specifically for development partners include a commitment to local ownership, emphasis on ICT in girls' schools, staff training, Internet access and the provision of equipment and software.

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Exploring the use of computer technology in a Caribbean context: Views of pre-service teachers

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ABSTRACT

This article presents a qualitative study of five pre-service secondary school mathematics (PSSM) teachers in an English-speaking Caribbean context. The major goal of this study was to investigate the experiences and perceptions of the PSSM teachers as they explored the use of computer technology (CT) in their mathematics instructional practices, and to identify factors they consider necessary for successful integration of CT in mathematics instruction. These teachers faced similar challenges of developed and other developing countries in their exploration. They suggested that CT use in secondary schools is needed because of its benefits for both students and teachers and to stimulate interest, motivation and improvement in their students' performance.

Keywords: *Caribbean; preservice teachers; mathematics; computer technology; graphing calculator; computer software*

INTRODUCTION

As part of the mathematics reforms of the National Council of Teachers of Mathematics (NCTM) of North America and the Advisory Task Force of the Caribbean Community (Caricom), it is required that students be able to learn and use CT as an integral part of the learning of mathematics (Carrington, 1993; NCTM, 2000). Some countries or islands in the Caribbean have been providing their teachers with computer literacy skills and integrating CT in various subject areas (Carrington, 1993; Miller, 1996). However, this innovation is not common in mathematics classrooms. Yet, researchers have seen CT as a tool with capabilities to support an exploratory and experimental environment aimed at improving the teaching and learning of mathematics (Barron & Goldman, 1994; Carrington, 1993; Cousins & Ross, 1993; Hazari, 1992; Larson, 1995; Oliveira, 1989).

Norvak & Berger (1991), in their study, concluded that teacher education did not prepare preservice teacher educators to use technology in their teaching and provided little support on hardware, software or inservice training. As a result, preservice teachers could not deal with the demands from school districts, parents and students to use CT in their classrooms. Larson (1995) suggested that preservice teachers needed to understand the potential of these essential tools, have opportunities to apply the tools, be supported in their explorations, and have time to experiment with them. The implications of this approach meant that preservice teachers are not only expected to select and create new instructional materials, but to learn how to use the technologies with a learner-centered approach in their pedagogy (Carrington, 1993; Graham, 1998; Larson, 1995). A learner-centered approach to teaching is demonstrated when students are allowed the opportunity to explore the meaning of new knowledge using prior knowledge on which to build. The teacher using this approach facilitates and does not dominate or prohibit personal discovery of new meaning from the learner's own style or pace for learning (Huerta-Macias, A., 1993). For many pre-service teachers it is challenging to make the change from a teacher-centered approach, which is traditional, to a learner-centered or student-centered approach.

According to Hope (1997) teachers are engaged in a psychological tug-o-war because school leaders and change facilitators pay little or no attention to their perceptions and the challenges they confront while integrating CT in their classrooms. As educators in developing countries move forward with the integration of CT in mathematics classrooms, it is imperative that the stakeholders take into account the challenges that preservice secondary school mathematics teachers face in bringing about positive changes when exploring CT in mathematics instruction. A lack of detail in the literature regarding the integration of CT in mathematics instruction in the Caribbean and the move toward CT integration in mathematics classrooms, were instrumental in the investigation of:

> "*What are preservice secondary school mathematics teachers' experiences within the junior high school classrooms as they explore the use of CT in their instructional practices in an English-speaking Caribbean country?"*

Past Experiences in Developed Countries

The following sections describe the lessons learned in developed countries when preservice and inservice teachers were integrating CT in mathematics instruction: teachers' attitudes, concerns, and motivation in CT integration, role of the teacher, classroom management, support systems, and computer coping strategies.

Teachers' Attitudes

Research has shown that teachers who had a spectrum of attitudes such as fear of possible failure because of a lack of knowledge of the technology, and skepticism toward technology, gradually changed toward an appreciation through classroom experience that convinced them of the positive benefits technology has to offer as a problem-solving tool (Tharp, Fitzsimmons, & Ayers, 1997; Abramovich & Brown, 1996). It is important for teachers to have positive attitudes about an innovation, so they can encourage those attitudes in their students. Their students, in turn, will develop positive attitudes that will reinforce the knowledge gained. The students will then achieve an understanding of the process and benefits of CT (Senge, 1990); at the same time, any negative ideas of CT will disappear or be minimized.

Teachers' Concerns

In teacher education programs where training was provided for preservice educators, there were concerns about not having up-to-date equipment or faculty with technological expertise; preservice training was about computers and not learning with computers (Willis, 1997). One earlier study concluded that teacher education did not prepare preservice teacher educators to use technology in their teaching and provided little support on hardware, software or inservice training (Norvak & Berger, 1991). As a result, those preservice teachers realized that they could not deal with the demands from school districts, parents and students to use CT in their classrooms. Teachers' Motivation

Motivation is a key factor that contributes to change in attitudes and at the same time results in effectual continuation of an innovation. Teachers need support in integrating CT in their classrooms. The technology is rapidly escalating in sophistication, and educators and teachers are finding it hard to keep up with the changes. Teachers need to be educated with the appropriate skills so they can function and facilitate learning in the most suitable manner promoting high-quality education. Mentoring has been demonstrated as an effective model for teachers' change (Erickson, 1995). This model has posited factors involved in genuine change, which includes having a goal, addressing conflict, having a vision, being committed, translating knowledge into activities, and reflection on the learning. Erickson (1995) found that it was important to have support and executive control as an integral part of the change process to maintain a constructive direction. Success of mentoring is directly related to support from administration and peers. This approach would definitely add to the development of teachers' professional growth by the use of innovative tools and the constant reflections on classroom events (Guzdial et al., 1996).

Role of the Teacher

According to Dexter, Anderson, and Beck, (1999), teachers' instructional styles are determined by the way they learn. The experiences and knowledge bases developed in that learning process influence their decisions about the best course of action to take in their instructional practices. With the introduction of CT in the education systems, the role of the teacher has been reconsidered. The teacher's past role of being an information giver has changed to one of facilitator and mentor in the classroom. The teacher has the responsibility for (1) planning and providing careful organization of activities, and (2) helping students to access information, process it and communicate their understanding. This role will allow students to become less dependent on their teachers as experts (Dexter et al., 1999; Noss, Hoyles, & Sutherland, 1990). The teacher in adapting this role must perceive a vision of the benefits, be motivated, committed, and an active learner in the process.

Classroom Management

Computers in classrooms not only influenced instruction but also classroom management. Yet unexpected problems were also present; these frustrating experiences were some of the discouraging conditions that were encountered in integrating CT in the classrooms (Sandholtz, Ringstaff, & Dwyer, 1992.). Effective implementation was hindered by teachers' lack of confidence in their computer skills and lack of motivation (Scheffler & Logan, 1999). Students, in turn, recognized these behaviors of their teachers, and could quickly turn the classroom into chaos. In the mathematics classroom, it would be advantageous for the teachers to be prepared to meet the challenges in the learning process.

The flexibility of using various strategies to solve many problems is an advantage in mathematics, and should be used in the classroom to motivate students. Educational change takes time, and it is worth noting that the skill of classroom management in a technological environment cannot simply be mastered once and for all (Sandholtz et al., 1992); the zeal to achieve and maintain this skill must be present. In order to cope with classroom management, teachers with computer skills must be prepared to demonstrate patience, flexibility and persistence with a great passion for teaching and learning in the process of trying different things.

Support Systems

A critical barrier to continuing computer usage has been the lack of support from other members of staff (peer support), heads of departments and heads of schools (Noss et al., 1990). Support from the other preservice mathematics teachers, peer support, could be influential and therefore needs immediate and continued attention while in training and during implementation. The lack of appropriate technical support for equipment has been reported to be discouraging in the educational setting (Cooper & Bull, 1997; Noss et al., 1990).

Computer Coping Strategies

Ropp (1999) reported that research on reducing stress caused by anxiety about computer use (computer anxiety) in ways other than increased experience with and instruction in computers is less common. Several measures of coping with stress have been developed. In using individual characteristics as pedagogical tools for learning to integrate CT into teaching, Ropp (1999) developed the Computer Coping Strategies scale to emphasize adaptive coping strategies. Adaptive coping strategies are the ones students might use when they encounter difficulties in getting the computer to do what they want.

The coping strategies, among other individual characteristics such as attitude toward computers, technology proficiency, computer anxiety, and computer self-efficacy[1] have shaped the computing experiences of all individuals including preservice teachers (Ropp, 1999). The individual characteristics were identified as being associated with learning to use computers. Consideration of these characteristics has been valuable to teacher educators who are charged with helping preservice teachers learn to teach with technology (Ropp, 1999). Educators being aware of the diverse experiences and expertise that students bring to the learning setting will be better able to integrate this diversity into CT tools for positive growth.

Computer Technology Tools Employed in the Mathematics Instruction

Integration of CT in the Caribbean context had to be strategic and practical because of its economical situation. Mathematics computer software programs, the graphing calculator (GC) and the internet are becoming more commonly used among different Caribbean contexts. In some Caribbean contexts, however, these tools are not frequently used or are not always accessible to teachers and students in mathematics classrooms. Based on economical concerns, availability, and recommendation for their positive effects, the choice of mathematics computer software, Math Trek; the graphing calculator, TI-83Plus; and the Internet were chosen as the tools utilized in the study. For purposes of this paper, the CT tools used in the mathematics classrooms will be described in the next sections.

Computer Mathematics Software

Selecting computer mathematics software such as Math Trek was important in that it had to be interactive and motivating towards learning mathematics. Pokay and Tayeh (1997) have suggested that students' positive reports on one computer mathematics software, such as the Geometer's Sketchpad are likely to become negative when they are frustrated by the program. This phenomenon is common for all software programs within learning environments. This tends to happen when learners fail to make progress in communicating with the computer, and when they do not find answers as in their textbooks. For this reason, researchers have recommended that teachers need to communicate to students that exploratory programs are to provide environments for inquiry and reassure them that these environments and interactions are a normal part of learning (Pokay & Tayeh, 1997). The researcher had found Math Trek for grades 7, 8, & 9 (MT789) to be useful in motivating and engaging students in classrooms. Students' interaction has been empowering for each other and the teachers had opportunities to facilitate active learning and inquiry.

Graphing Calculator

The graphing calculator (GC), a commonly used tool in secondary school mathematics, has been found to have potential benefits for students' understanding of functions (Wilson & Krapfl, 1994). It is further stated that the GC has the potential for influencing the way mathematics is taught and learned, which in turn would affect the students' achievement, their mathematical disposition, and the classroom environment. Berger (1998), drawing on the Vygotskian[2] paradigm, described two effects of the GC, i.e., the amplification effects and the cognitive re-organization effects on the learning of mathematics. In the amplification effect of technology, the GC is seen to amplify the zone of proximal development (ZPD) by removing cumbersome and time-consuming tasks from this zone. The learner then has more space in this zone to perform conceptually demanding tasks with greater effectiveness and ease. The effect of using mathematical conceptions meaningfully or differently as a result of using the technology is known as cognitive re-organization.

These effects of the GC have enabled students to simultaneously view several related graphs or change algebraic parameters and note the corresponding graphical changes. This has led many mathematics educators to believe that students' achievement was affected as they could more easily understand conceptual features of functions. Wilson and Krapfl, (1994) claimed that some students were impressed with the utility and power of the GC, and others found it made mathematics more enjoyable. They also reported that feedback from a GC reduced anxiety and increased confidence, which improved the students' mathematical performance and feelings about their mathematical capabilities. The GC has also definitely influenced classroom environment. As Demana, Schoen and Waits (1993) have reported that the use of GC in precalculus classes enabled and induced teachers to use more group problem solving and less lecturing in the classes. This tool has also created a change in the way teachers plan for their classes, and the way in which they view mathematics and their role as a teacher.

CONCEPTUAL FRAMEWORK

According to Barron and Goldman (1994), beginning teachers having learned models of instruction in their subject areas in an invariably lecture-based mode tend to teach the same way they were taught. They replicate that teacher-centered approach. The expectation that such teachers should somehow change to teaching with a learner-centered approach is not very realistic. However, Wetzel (1997) noted that when learning opportunities are provided for teachers to use CT in their instruction, they used the opportunity to effectively implement the technology in their instructional practices. He found that providing a learner–centered approach and a focus on learning rather than teaching had addressed some of the central issues of implementation and effectiveness on teachers' minds during their training. That is, addressing the question of how they could help their students learn mathematics using these technological tools.

In preparing mathematics teachers to use CT, Blume (1991) has specifically recommended a three-phase model. The first phase is to provide mathematics teachers with opportunities to learn with the use of technology. In the second phase, opportunities are provided for mathematics teachers to reflect on their learning in the technological environment. Finally, in the third phase, they have the opportunity to translate their own encounters, which were facilitated by their instructor in a technology-rich environment, into similar encounters for their students.

Senge's (1990) model, which consists of five learning disciplines known as personal mastery[3], mental models[4], shared vision[5], team learning[6], and system thinking[7], is also part of the framework. These compatible theories of Blume's model, Senge (1990) model and the learner-centered approach formed the conceptual framework that guided this study.

CONTEXT OF THE STUDY

The study was conducted in an English-speaking Caribbean country where the use of CT in the subject areas had been initiated. In the English-speaking Caribbean countries, mathematics is a compulsory subject through elementary and the earlier grades 9 and 10 of secondary school education. In the final year(s), students' programs may be more focused in other subject areas. Preservice mathematics teachers were selected for the teacher education program based on their interest in the teaching profession and high scores in mathematics on their first attempt at the Caribbean Examination Council (CXC)[8]. The participants of this study were selected from the third year students of a teacher education program for preservice secondary school mathematics teachers who were screened by this process.

Background of the PSSM Teachers

In this research study, the participants were five PSSM teachers whose ages were in the range of 20-30years. Using their pseudonyms, Abiola, Levoli and Yvon were females who were new to the profession, while Sean and Wayne were males who had one-year previous experience as mathematics teachers. These PSSM teachers had experience working with computers for a period of five years and accumulated skills in using Microsoft Word, Excel, Publisher, and PowerPoint. In the teacher education program, along with their methods courses, they gained additional training in programming, networking, and system analysis, but there were no opportunities for hands-on experiences integrating CT in the teaching and learning of mathematics.

Classroom Contexts

The participants, being in the computer option of the teacher education program, were sent to schools within the urban area since each of these schools had a computer laboratory. At these secondary schools, the participants were given Grade 7, Grade 8 and Grade 9 classes to teach as is customary for new teachers to be assigned to the lower secondary grade levels. The students in these classes were heterogeneously grouped by ability and performance. For three sessions, Abiola conducted her grade 7 activities with the TI-83Plus GC in a classroom that was large but the furniture was uncomfortable and at times students had to share seats because chairs were broken. Levoli conducted two of the three sessions in the classroom and in the third session shared the computer laboratory that had 15 working computers and a multimedia projector. Her grade seven classroom was large and airy where she conducted her TI-83Plus GC activities.

In the large computer laboratory that Levoli used, there were technical problems when downloading Math Trek software. Subsequently, the researcher's laptop was used with the multimedia projector. Sean conducted his teaching practice with MT789 and the TI-83Plus GC in computer laboratory and classroom that were large and had their computers and furniture loosely arranged. Seating arrangements were appropriate and this allowed for interaction between teacher and students and among students to optimize teaching and learning. This was a comfortable and welcoming learning environment.

Wayne and Yvon had access to computer labs that had 20 and 30 working computers for all three sessions with his grade 8 students and her grade 7 students respectively. Math Trek software was downloaded on the computers individually since the network was not working at the time. Computers were tightly arranged in these two computer laboratories. Wayne and his students had limited mobility in the lab while Yvon and her students could move around more comfortably. The attendance rates in the classes of the participants ranged from 95 to 100 percent. However, the classrooms that were observed had a teacher-to-student ratio ranging from 1: 35 to 1: 45, which is normal in this context.

Teachers' Choices in the Use of CT Tools

The tools made available in the classrooms were at the request of the preservice teachers. Despite the desire to have both CT tools, Abiola was unable to have access to the computer lab to use Math Trek software, and Yvon had scheduling difficulties to use the TI-83Plus GCs during the limited loan period. Levoli and Sean wanted to have the experience of exploring both CT tools. While Sean received support from his principal and cooperating teacher in his venture, Levoli had limited opportunity for exploring with MT789 due to the challenge of availability of lab time. Wayne had specifically concentrated on MT789 based on his research interest for his final project in the teacher education program.

METHODOLOGY

Based on the study's context of a natural setting, and its sensitivity to the local needs and conditions of a developing country (Bogdan & Biklen, 1998; Crossley & Vulliamy, 1997), qualitative methodology was employed to gain an in-depth understanding of the PSSM teachers perceptions of the integration of CT in their classrooms. In particular, a case study approach was taken (Yin, 1994), which was identified with the following research question,

> "*What are preservice secondary school mathematics teachers' experiences within the junior high school classrooms as they explore the use of CT in their instructional practices in an English-speaking Caribbean country?"*

Abiola, Levoli, Sean, Wayne and Yvon volunteered to participate in the study. They were among other student teachers who attended a technology application course, taken in their third and final year of their program - a hands-on experience of CT integration in a learner-centered environment. Having a specialization in computers within the program, the participants were purposefully sent to schools with computer laboratories as part of their student teaching placement requirement.

During the technology application course, the PSSM teachers worked individually and in groups on mathematics problems using the TI-83Plus graphing calculator and MT789 software. On the database of Web Knowledge Forum (WebKF), the PSSM teachers communicated and reflected on (1) the National Council of Teachers of Mathematics (NCTM) Principles and Standards, (2) the integration of CT in mathematics, and (3) their experiences of the use of TI-83Plus and MT789. This was ongoing through their practicum assignment. At the end of the course, they were given their student teaching assignments to different schools where they had access to a computer laboratory. Each PSSM teacher provided a lesson plan that incorporated the use of CT for each observed session. During student teaching, each PSSM teacher was observed three times. Each observation was for 30 minutes of a full class session range from 40 through 80 minutes. In each of these observations, the researcher examined the PSSM teachers' use of technology, rationale for its use, teaching strategies implemented, interactions among students, teachers, and computer technology tool, the teachers' role in the classroom and their perception of the exploration. As part of the data collection, each teacher kept a journal of activities and reflections of each lesson. Towards the end of student teaching, 90-minutes interviews were scheduled with each participant. Data collected from observations, journals, lesson plans, field notes, and interviews were transcribed, coded and categorized using Microsoft word and NUD*IST, a qualitative data analysis software.

FINDINGS

In the interviews, the PSSM teachers were reflective on the way they were taught in secondary schools. This provided the opportunity to determine their view of any changes in their teaching methods with respect to the learner-centered approach. In the next sections are their views:

PSSM Teachers' View of the Learner-centered Approach

Abiola recalled when she was attending secondary school:

> *Teaching was done in the traditional way, where the teacher gave examples on the chalkboard and the students answered the questions by applying the examples. The questions were chosen from a textbook, and students were asked to answer those questions for homework assignments. The teacher was the one who wrote on the chalkboard and students copied what was on the chalkboard.*

Levoli stated that

> *……….. I would definitely appreciate such [NCTM] standards in the Caribbean because teachers in the past have used only "chalk and talk," which I thought of as torture.*

Here, it is evident that Levoli has relinquished herself from the traditional method of "chalk and talk."

When Sean was an elementary student, he learned mathematics by practicing math exercises and by taking money and giving change in a shop. In secondary school he was taught higher-level skills through rote learning and much practice. The more he practiced, the better he did in mathematics. He claimed that, if he did not know a concept immediately, he would practice it repeatedly until he grasped it. The majority of his teachers in secondary school used the traditional "the chalk and talk" method in which they demonstrated how to do a particular problem on the chalkboard. Sean did not experience much "discovery" in that method; e.g., formulas were given and the students were required to memorize them. He often wondered, "How did teachers come up with these formulas?" He learned the answer to this question in college.

Changing the instructional tools and method of approach in the mathematics classroom was a revelation for Sean in his training; the change affected him in many ways. Moving away from the traditional teaching style, he realized the effectiveness of the discovery method in mathematics. Sean saw mathematics as a practical subject and in using MT789 and the TI-83Plus GC; he was able to utilize the discovery approach having students explored on their own. He did not see any disadvantage to using CT and felt that his teaching improved due to the strategies he used.

At secondary school, Wayne learned mathematics mostly by trial and error and constant practice. He was taught by the lecture method exclusively, also known as the "chalk and talk" method. Wayne claimed that the classroom environment in which he did his teaching practice was quite different from his experience as a student in secondary school. He remembered that teachers put work on the chalkboard, checked, and marked students' notebooks. These activities were expected to be completed by the end of class. Comparing that time to now, Wayne said that the teacher played a more active role in the classroom today.

Yvon learned mathematics in secondary school using a variety of strategies. When a problem was given she was expected to solve it on her own, and guidance was given when the teacher recognized help was needed:

> *If a student did not understand a problem, normally in school a teacher would come over and say "where did I lose you?" and the student would say, "Well, Miss, I started out here and then I...." And the teacher would guide the student step by step through the problem. The student would then be able to analyze and say, "oh! I made a mistake." The student*

> *would be able to see the mistakes. It is better than telling them the answer. It is a form of the teacher helping the students to see or realize that they have made a mistake and be able to correct it.*

The "chalk and talk" method was used most often and occasionally a manipulative tool such as a protractor, ruler, or geo-board was used. Yvon identified that she needed to learn more to be able to use CT in the mathematics classroom and would take courses in professional development to upgrade her skills.

Based on these PSSM teachers' reflections of the teaching and learning styles in their secondary schools as students, it is evident that they were taught mainly with the "chalk and talk" method and became more aware of the learner-centered approach in their teacher education program. In observation sessions, the PSSM teachers were using group activities and facilitating learning in the use of CT in their mathematics instruction. Through these observations, and their reflections, the study provided evidence that the PSSM teachers have the tendency to become teachers who will use the learner-centered approach in their classrooms. Abiola in her interview expressed the learner-centered approach as non-traditional and compared it to the teacher-centered approach as blue versus black and she explained what she meant by "blue and black":

The blue represents all the colors but the black is dead drag. In my days, it was black but in their days now is blue because you have that different teacher (one who teaches with a non-traditional approach) and technology has gone a far way from when I was in school so the students have what they need to go on further.

PSSM Teachers' Perceptions of CT Experience

The PSSM teachers did not have attitudes of skepticism or fear toward CT integration in their mathematics classrooms unlike the experiences of Abramovich & Brown (1996) and Noss et al (1990). Being students with a computer option in their development was a positive attitude towards technology. However, they did have concerns about the continued availability of the technology for teachers and students. Abiola stated that if the resources of CT were available, she would use them perhaps 90 percent of the time, because information would be processed easily. Instead of doing manual calculations, the students would do the critical thinking part rather than the knowledgeable part of it. She had the students use the TI-83Plus GC, and instead of constructing graphs, the data were entered and the scales were prepared for the graphic output. The students then analyzed the graphs in groups and proceeded to a class discussion.

The students using the TI-83Plus GC also developed a higher level of understanding of the basics and they constructed ideas to apply knowledge gained from the study of particular models. CT had a positive impact on the students; this technology enabled them to derive the same benefits as Abiola herself (Noss et al, 1990). She felt her students could reap increased benefits because they were introduced to technology [electronic toys] at a younger age. Students were curious about knowing how to use GC's and were eager to measure accurately.

Levoli was enthusiastic because it was a new task for her as well as her students:

> *I did not know much about MT789 or TI-83Plus GC before the technology application course. They were new to me, so the activities that we explored in the classroom were a learning experience for the students and me. ……..Hopefully, the school at which I will be teaching will have computers for every student. …I would not mind having a copy of the Math Trek software and at least one TI-83Plus GC so I can utilize it in my class because I really enjoy using CT in my mathematics instruction. … It would be good if I had at least one TI-83Plus GC for myself with the view screen panel and I could utilize the overhead projector with it where students can actually visualize some concepts until I can get a class set.*

The students' positive reaction to the technology had motivated and inspired her. She saw the benefits of the TI-83Plus GC when her students subsequently became aware, explored and analyzed geometric relationships and made conjectures from patterns.

Supporting CT in the Mathematics Classroom

The schools where the practice sessions were conducted had limited resources for the integration of CT. Four of the five principals accepted and showed interest in engaging their practicing teachers with CT integration in mathematics. They gave their verbal support and followed through, giving specific permissions and instructions to guide a smooth process. Levoli's principal granted her permission for the study, but he did not show much interest, which subsequently was responsible for greater challenges in arranging access and availability of computers at that school. The PSSM teachers' supervisors from the teacher education institution verified their lesson plans and teaching strategies used, while the researcher provided the MT789 software and the TI-83Plus GCs.

Generally, in the schools where permission was granted, challenges were often encountered along the chain of administrative command. For example, at the school where Abiola taught, the computer coordinator was a bit cautious about the usage of the computers because of previous students' misuse that damaged a few computers. Therefore, he did not allow her to use the computer laboratory. As a result, Abiola had the only other choice of using the TI-83Plus GC in her teaching practice sessions. At Levoli's teaching practice school it was challenging to gain support in using the computer laboratory. Scheduling was then a problem, and the whole notion of not getting much support from the Principal made it a difficult situation to resolve. The computer coordinators at Sean, Wayne and Yvon's teaching practice schools gave their support in allowing the software to be installed on the working computers, maintained the computers, and were willing to assist with technical issues.

The cooperating teachers did not place any restrictions on the mode of delivery, but cautioned the teachers to ensure the material was valid, and would not lead the students astray. The cooperating teachers were instrumental in the behavior of the students by periodically checking on them in class and cautioning them to be attentive to the teachers. However, Yvon had the support of the cooperating teacher at all times in the classroom because he was curious to learn how to use CT along with the students. Sean's cooperating teacher also provided motivational support.

Technical support was also a concern for Levoli, Sean, Wayne and Yvon. The technician could not get the network connected, and these PSSM teachers had to utilize their expertise in downloading the software on each computer. The constant lack of provision of such expertise to the classroom teachers as Cooper and Bull (1997) and Noss, Hoyles, and Sutherland (1990) reported, could be discouraging in the [general] educational setting. However, these teachers, because of their training and focus in computer studies, had the opportunity to put theory into practice in assisting with such technical issues.

Availability and Accessibility

In many instances, laboratories of 25 computers had to be shared among 35 to 40 students, which meant that at least two students had to share one computer. The multimedia projector was also a limited resource: only two of the five schools had one. Abiola's school had a regular projector that she used with the screen of the TI-83Plus GC.

Yvon realized that the use of one computer with a multimedia projector could accommodate a class of 30 to 40 students. However, having such large schools with arbitrary scheduling made it very difficult to access the facility. Due to unavailability of an adequate number of computers for each school, accessibility to the computers became restrictive, and the personnel in charge of these tools were seen as controllers who perpetuated distance between the CT tools and the students.

The PSSM teachers made changes in their teaching strategies to facilitate the integration of CT in their instruction. For example, they accommodated the students in cooperative groups to use the limited number of computers or GCs available to them. Abiola had a sad feeling of the temporary availability and accessibility of GCs to the students during student teaching. The five teachers had indicated their willingness to use CT tools as students in the mathematics methods workshop and as facilitators in student teaching.

Concept of Time

The PSSM teachers experienced the management of time as a hindrance to complete class activities, so they had to develop strategies to cope with it. Abiola found that time was consumed quickly because of the students' unfamiliarity of the technology and the time she spent imparting instructions verbally. She opted to give instruction sheets in future lessons. Sean found that preparation of the laboratory or classroom ahead of class time was important to save time in the class sessions. He also realized that time limits had to be set and followed.

Levoli's greatest challenge was the time taken away from her sessions because previous classes did not finish on time; thus she was unable to use the entire class period on the computers. The school based assessment (SBA) assignment was also a common preference for students using the computer lab for other academic work. Wayne and Yvon found it quite challenging to set up schedules for their teaching practice sessions because they had to negotiate with other teachers to use their laboratory time. Yvon's challenge of not getting the GCs was due to their inappropriateness for use in class activities at the time when they were available.

Classroom Management

Another challenge that occurred, though not often, was inattention to instructions. Sean found that the students were being inattentive to instructions and exploring on their own, before it was time to do so; this made it difficult for them to draw the graphs on the TI-83Plus GC. He had to spend some time with them discussing the different icons and demonstrating their functions. Sean applied the strategy of "demerit" points for not being attentive, and it worked because students did not want to accumulate such points.

The PSSM teachers formed cooperative groups in their sessions to address the lack of experience with computers, the limited number of computers available, and the varying reading capabilities. Continuing to experience the situation of limited financial support in the school system would be frustrating to teachers in future attempts to implement CT. It would not be motivating to teachers who have a vision for school change, and want to be mediators in such innovations.

PSSM Teachers' Suggestions Based on CT Experience

Based on the PSSM teachers' experience, their common recommendations for effective integration of CT in secondary school mathematics were (1) CT use in secondary schools is needed because of the learning and teaching benefits for both students and teachers; (2) teachers need to know how to choose CT tools that are appropriate, current, interactive and user-friendly in mathematics; (3) teachers need training in the use of these CT tools; (4) teachers need professional development for upgrading their content, technological and pedagogical skills; and

(5) teachers need to be motivated first with their use of CT in the classroom, so they would be able to stimulate interest, motivation and improvement in their students' performance.

Wayne's advice to the Minister of Education [rather a leading reformer in the context] about investigating the availability and accessibility of CT tools for secondary school students came from his observations and research project in his teacher education program. From his observations, cooperative learning was a workable application to CT integration in mathematics. He also observed that the students' enthusiasm to learn was increased in the setting with CT use. In his research project, Wayne concluded that his observations were contributors to the increased students' performance in his project. Based on his experience, he recognized the need for CT implementation in secondary school mathematics. Wayne advocated that there is need for an adequate number of computers and other CT tools to be available and accessible in schools for effective implementation to occur in the education system.

CONCLUDING REMARKS

This study being one of few that explored a Caribbean perspective has provided evidence that a Caribbean setting has faced many similar challenges of developed and developing countries when new qualified teachers attempted to apply new technologies. The motivation developed in teacher education programs, and the risks new teachers are willing to take in exploring new ideas, teaching and learning strategies, and new technologies are expressed as in the cases of Abiola, Levoli, Sean, Wayne and Yvon. However, the lack of resources, principal, other faculty and technical support, and environments that are conducive for teaching and learning during teacher preparation are seen to be prohibitive to the appropriate integration of CT. To encourage our new teachers to continue the path to an effective teaching career in the reform of mathematics education in the Caribbean, policy makers need to review the availability, accessibility and pedagogy of computer technology in the mathematics curriculum.
Students' academic acquisition in the world of advanced technologies is not only shown by excellent academic record and aptitude, but it is also indicative of the knowledge they gained about the use and efficiency of computer technology. It is therefore evident that the teachers' conscious effort to move away from the traditional "chalk and talk" approach to a learner-centered approach did lend itself to genuine positive progress in using computer technology. Hence this new approach made the teachers aware that reading and group skills along with computer literacy are factors to be considered in their planning when introducing CT use.

The current mathematics reform of the NCTM-Principles and Standards (2000) and the Advisory Task Force of Caricom (Carrington, 1993) advocated the restructuring of the mathematics classroom and an increased focus on teachers' accountability. There should also be an increased recognition that teachers do play important roles in structural reform in order to respond to students' needs in the classroom. Integrating CT tools in the classroom structure was strongly recommended in the reform because these tools when used appropriately have the power to foster understandings and intuitions in mathematics. In this study, the PSSM teachers had the opportunity to learn with CT tools; they were motivated to continue in this learning mode and gained zeal to remain committed to their personal growth.

According to the PSSM teachers, when they assumed alternative roles like facilitators in the classroom, the nature of interactions significantly changed from what they remembered in their secondary schools. Reflecting on their experiences in the classroom, they provided their perceptions of the challenges encountered and demonstrated their motivation to continue using CT in mathematics instruction. Recognizing the roles that the teachers undertook in the change process, it is vital to provide opportunities in which continuous growth and development can transpire. Furthermore, providing necessary CT resources and support for both teachers and students will be key factors in any reform efforts.

FUTURE ADJUSTMENTS FOR CHANGE

Based on the findings of this study, the following suggestions are made to the stakeholders in the Caribbean and countries of similar economic status:

- PSSM teachers' professional development must increase focus on having teachers' practice teaching strategies to enhance the implementation process of CT integration.
- Class size must be lowered to allow PSSM teachers to conduct meaningful exploration and assessment of students' achievement.
- Technical and human supports are necessary to successfully implement CT integration in mathematics.

For most education systems in the Caribbean, the big question is: Where can we get the financial support for these resources? Community education development programs, such as fund-raising and donations, and foreign agency funding for education are some viable ways to get support. To gain access to these supports entail getting to know the agencies and their requirements, and writing winning proposals that will provide the support needed. However, using CT tools, such as the graphing calculators, which are becoming more affordable, are provisions of a portable mathematics laboratory, which can also be a realistic implementation in developing countries. There are also current developments of computer software for local use. There is a need to get more advocates at the administrative level of the education system who would champion the integration of CT. Teacher educators, teachers, principals, and heads of departments in the Caribbean and countries of similar economic status need to consider the pertinent factors and CT tools that are necessary for implementation to improve their curriculum for a global community.

Endnotes

Individuals' judgments of their capabilities to organize and execute courses of action applied to computer learning.

[2] Vygotskian paradigm indicates that education is both a theory of development and a process of enculturation in which mediated action links the external social world to internal mental processes.

[3] Developing competence with CT use.

[4] Managing deeply held internal images that affect change process.

[5] Sharing their goals and expectations to develop a common vision for CT use.

[6] Builds on developing shared vision and personal mastery through dialogue and discussion.

[7] A loop process where there is an interrelatedness of forces when learners reflect and reinforce changes in the overall process of integration.

[8] CXC provides examinations and certification at the secondary and post-secondary levels.

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Revitalizing architectural design studio teaching using ICT: Reflections on practical implementations

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ABSTRACT

The advancements in ICT are reshaping the architectural design studio teaching and design practices. The digital-imperative to switch from analogue to digital mode has already begun to manifest itself at the schools of design. This paper introduces the application of two approaches representing various dimensions of revitalizing architectural design studio teaching using ICT: paperless design studio and collaborative virtual design studio. The paper reflects on the practical implementations of these two approaches including design process, communication and presentation, studio pedagogy, and students' learning. The next step ahead for architectural design studio teaching in which ICT acts as a partner is introduced.

Keywords: *Architectural design studio teaching; paperless design studio; virtual design studio; digital design education.*

INTRODUCTION

The digital-imperative to switch from analogue to digital mode has already begun to manifest itself at the schools of design and architecture. Design and architecture students routinely use the best of new technologies that provide information-rich and fully networked multimedia environments (Muir & O'Neill, 1994). The developments in design computing and digital media in the last decades have been phenomenal and what the next decade will bring can only be imagined. However the advancements in digital design and communications are already reshaping architectural design studio teaching and design practice. On the other hand, some of the design and architecture schools are still using manual techniques similar to those used at the beginning of the last century. For long time, design studio activities have been carried out using manual sketching, drawings and physical modeling. Since the late 1980s architecture and architectural education have witnessed an important transformation with the introduction of computers and information and communication technology (ICT) in which they have become pervasive in all aspects of practice and education. The pervasiveness of information and communication technology in architectural education and practice has been manifested in the growing proportion and importance of IT related courses in the curricula of architectural schools. Many schools have increased IT content in their curriculum and are investing to acquire computing resources to ensure that they provide their students with the necessary skills and competitive advantage. Modern information and communication technology and digital tools have been adapted in the architectural education and practice since the 1990's. Computer Aided Design (CAD) has been adapted into architecture and became the major working environment. CAD and digital media have also been adapted by many architectural schools around the world. The rapid developments in information and communication technology and its applications in architecture have introduced a new opportunity to design studio teaching. There have been various ways to integrate computation and digital media into design teaching that led to alternative models for digital design studio including computer augmented design studio, CAD-plus studio, virtual and web design studio, cyberspace design studio, intelligent building studio, and toys and tools studio (Do & Gross, 1999).

This paper introduces the application of two approaches implemented by the author representing various dimensions of revitalizing architectural design studio teaching using information and communication technology. These approaches for architectural design studio teaching using the advancement of information and communication technology in design computing and digital media include (a) paperless design studio; and (b) collaborative virtual design studio. Such approaches are inspired by: Resnick's (1996) view to new paradigms of computing as new paradigms for thinking; Schmitt's (1997) perspective of the computer as a design medium that is more than a tool and it is an interactive counterpart through its capabilities and what it offers; and Madrazo's (1999) assumption that designing with computers is based on establishing a fruitful dialogue between the designer and the tool. The thrust of this paper is not about the software, hardware, networking configurations, or even on the approaches themselves but rather on addressing the models used in the practical implementation of these approaches including strategies that are most suitable in both stand-alone paperless design studio and collaborative virtual design studio. Furthermore, this paper reflects on the effects of utilizing such strategies while implementing the proposed models including design ideas and artifacts created by students while designing with computers. The implementation of these two approaches of paperless design studio and collaborative virtual design studio was conducted at two consecutive design studios (Semester 1 & Semester) respectively for the first year students of Design Computing at the Faculty of Architecture, University of Sydney, Australia. The next step ahead for architectural design studio teaching in which information and communication technology acts as a partner is addressed in this paper.

THE PAPERLESS DESIGN STUDIO

The approach of paperless design studio was emerged initially in the early 1990s and was characterized by eliminating, as much as possible, hand drawn designs, and developing strong dependencies upon the usage of high-end software such as Alias/Wavefront, Softimage, and Maya. Software ability to create fluid diagrams, character animations, and other special effects, (first thought to be un-useful in architectural design), has proved to be extraordinary tools to test unproved architectural speculations. Circulation and mobility studies, building program variations, and quick diagrammatic ideas allowed paperless studio students to explain and experience in a totally new way for their design formulations. The software soon proved to be more useful than a mere rendering tool; it started to inform and transform the design process (Andia, 2001; 2002).

Designing with Computers: Why Paperless?

The infusion of digital media into the practice of design and architecture is changing how the design process is carried out, what is designed (i.e. artifacts), and the culture of design education. There is a transition from a completely analogue system of representation to one of computer immersion or the "paperless studio". Design and architecture schools have already begun to struggle with the physical issues of either integration of new media or going completely digital (infrastructure and economics). However, the pedagogical integration should be of a greater concern. New media and its forms of representation are challenging traditional skills of communication and representation. Changes in practice as well as design education should look to new media with the opportunity for further exploration of design ideas, creation of new forms, and new design vocabularies. The creation of new forms comes with a responsibility of seeking new forms of representation (Norman, 2001).

It may be asked why is it necessary to provide digital immersion environment in which traditional models for design exploration such as physical models and manual drawings would be excluded? An attempt to answer this question is with posing another question that is "why does it seem satisfactory to exclude digital media when exploring with traditional methods?". The validity of a paperless design studio lies in the notion that digital media can change the process of design, the forms of design, and how design ideas are communicated. A comparison could be made between a paperless design studio and another traditional studio that has casting as the only medium for exploration. A casting studio would force changes in ones process, forms and experience (Norman, 2001). To draw a parallel to the paperless design studio, one needs to become aware of the unique capabilities of what digital media offers and how it can be used to explore the design process. Digital models and web-based project sites are becoming normal practices within the real world of building construction. As the world becomes a more global society, the ability and means to transfer, communicate, and collaborate design ideas in more efficient ways and timely manner is ever increasing.

Design Tools in a Paperless Design Studio (PDS)

Design tools in a PDS should be primarily employed at the conceptual stage of designing and at an early level of design education to provide the opportunity for the students to comprehend the use of computers as design medium instead of a tool solely for drafting. As design tools are incorporated into the design process the student's ability to test and investigate design ideas is becoming more thorough. Using design tools that are object and time-based at the conceptual stage of designing is quite important. Utilizing objects in a design tool is simple to conceive and to simulate reality. For instance, time-based animation allows one to approach, test and investigate a simulated reality. Lynn (1999) describes animation as "evolution of a form and its shaping forces". The use of time-based media in the PDS allows understanding objects in space, their relationships, and influences over other objects. The indiscriminate application of computer design tools at the conceptual stage might allow the student (designer) to be removed from the design process and the software to be in control of the design outcome, however designers must be in control of the design tool (software) and design outcome. The ability to utilize the computer as a design tool comes with a responsibility of understanding its roles and limits as a tool for inquiry.

Pedagogical Concerns with Paperless Design Studio

Pedagogy is any conscious activity carried out by one person designed to enhance the learning of another (Mortimer, 1999). While pedagogy can be a personal matter it is more often conceived of as the art or science of teaching; a set of principles and practices to improve learning. Educational technology, as a subset of pedagogy, is the sound use of any technology to support and improve learning. Information technology, on the other hand, focuses more on the digital delivery of information. Technical issues tend to take precedence. Christie & Ferdos (2004) argued that educational and information technologies cannot be separated. For better or for worse they impact upon one another. When one seeks to improve learning using digital media pedagogical considerations are always an issue. The same fundamental questions that are asked of traditional university pedagogy need to be asked of ICT-based curriculum but, in addition, the potential for a radically different, more innovative pedagogy has to be explored. Good pedagogy can inform and be supported by good ICT. Poor pedagogy can subvert the very point of using good information technology and communication. A combination of bad pedagogy and bad ICT is a disaster for the future of students' learning in general and architecture in particular.

While moving to a PDS design studio instructors need to be concerned with the pedagogical issues of integration and how to infuse the computers into the design process. This is a larger educational issue of concern compared to how to afford and place computers into a design studio that is a financial or an organizational dilemma on the part of institution or the student. The success of a PDS relies on the ability of its students and instructors to implement these new digital tools and to change the culture of the design studio environment. If students are not adequately taught the digital skills of concern in advance, the digital media will not become part of a process of design and will be degraded to instructional labs for software training. To avoid weakening the pedagogical endeavor in a PDS, the students need to learn the related digital media tools in advance and then use the computers as a design tool for inquiry and exploration (Norman, 2001).

Experience Designing with Computers in the Paperless Design Studio

The first year design computing students in their first semester have been given a brief to design a café on a vacant land next to the Faculty of Architecture's Tin Shed Gallery at the University of Sydney and were asked to design this café using ArchiCAD as a platform. ArchiCAD is very effective software that can be utilized as a design tool at the early stages of the design process and it satisfies the criteria outlined in the above Section of Design Tools in a PDS. Other digital media tools such as Adobe Photoshop, Microsoft PowerPoint, Macromedia Flash and Dreamweaver were used in the PDS as image processing and presentation tools. The typography and surroundings of this land were modeled by the students in ArchiCAD. The climatic changes and effects on the site from surroundings were calculated and presented using ArchiCAD at specific hours of the four seasons as shown in Figure 1, e.g. 3pm. This had a primary effect on where the proposed building might be located on site to avoid the overshadowed areas. The students have produced a QTVR (Quick Time Virtual Reality) animation showing the analysis of shadow studies. This simulation of reality was of a great importance to the students and facilitated their understanding of the climatic effects on design.

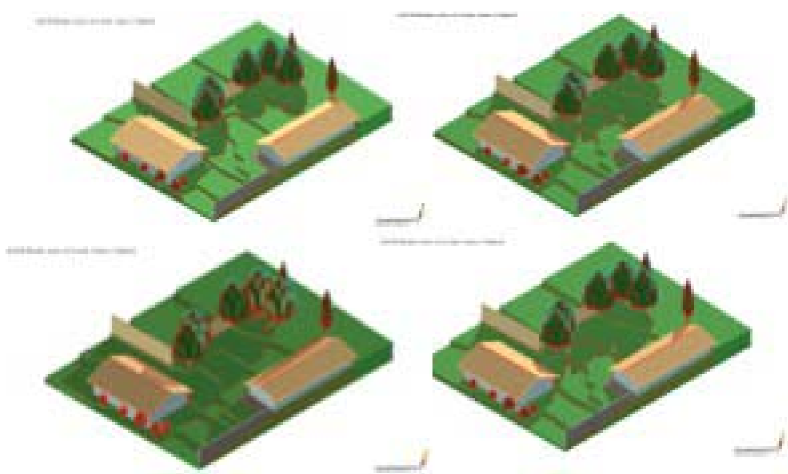

Figure 1: *Land topography and shadow analysis of the proposed site to design a café developed in the paperless design studio*

A major teaching and designing strategy that has been elaborated in the PDS is that the limitations of ArchiCAD as the platform should not be considered as constraints in creating design ideas but rather utilize its capabilities as primitives in developing various design ideas. Instead of viewing the platform as a shell to generate typical and routine designs, it is rather to facilitate the features of this platform as a starting point to explore design ideas. This approach had a great impact on how the students interpreted the brief depending on where and how they started to explore their designs and which features of the platform were selected as design primitives to create and compose their design ideas. Some examples of students' diverse design ideas are shown in Figure 2. Students have also found that the experience of designing with computers within this approach has opened up an enormous amount of new design ideas and imaginations for them that may have not crossed their minds if they were designing on paper or constructing physical models. Not only are their ideas become richer and innovative, but also they were able to test the behavior of their designs, such as climatic changes to achieve thermal comfort, color and texture scheme to achieve aesthetics and harmony with the surrounding environment, etc.

Figure 2: *Some examples of first year design computing students' designing a café project produced in the paperless design studio*

THE VIRTUAL DESIGN STUDIO

The Virtual Design Studios (VDS) explores the asynchronous and synchronous techniques in remote design collaboration. By using technologies, such as video conferencing, Internet publishing, e-mail, Web3D, and digital modeling, students gain an increasing understanding of the new modes of collaboration and media integration in design practices. The VDS also enriches the architectural experience by exposing studios to different design cultures and to a larger context of design feedback. The first Virtual Design Studio was attempted at the University British Columbia, during the early 1990s, in collaboration with other schools of architecture such as Harvard, MIT, Washington University, Cornell University, and Hong Kong University (Wojtowicz, 1994). These early experiences relied heavily on asynchronous communication technologies that supported e-mail, bulletin boards, FTP, and Internet publishing. As collaboration technologies evolved and became available to the masses, virtual studios began to foster more international experiences that lasted a complete semester. Most studies report that cross-cultural and global nature of the VDS experience usually motivates students. Also several interdisciplinary experiences emerged in the mid-1990 as students from architecture, engineering, and building construction from institutions such as U.C. Berkeley and CIFE at Stanford University, have collaborated in virtual studio experiments (Kalay, 1995).

Teaching Architectural Design in Virtual Environments

The concept of virtual environments has emerged from advances in computer networking, image processing, modeling, simulation, and multimedia representation (Simoff & Maher, 1997). Virtual environments that mimic the spatial arrangements of the physical world have changed the role of 3D CAD systems from drafting to producing blocks of the new 3D virtual environments. Virtual Environments (VEs) are attractive platforms for learning in which they provide opportunities for new kinds of experience that enable users to interact with objects and navigate in 3D space in ways not possible in the physical world. Claims have been made about the added-value that can be gained from interacting with these kinds of virtual representations including easier learning, better understanding and training, more engagement, and pleasure (Psotka, 1995). These benefits are manifested on the key properties of VEs in their ability to captivate. For instance, Byrne (1996) suggests that immersion in 3D environments is highly motivating, inducing users to spend more time on a given activity. Pedagogically, Wickens (1992) argued that virtual environments encourage people to be more active in the way they interact with external representations, through having to continuously choose their position and viewing perspective when moving through the virtual environment. It has been suggested that learning and retention of information can be increased. Kvan (2001) asserts that the advent of virtual design studio appears to raise promising opportunities for reconsidering the way we teach design. Utilizing virtual environments in architectural design teaching advances the concept of designing with computers (e.g. in a paperless design studio), to a multi user real-time 3D virtual environment for achieving collaborative designing and learning (Reffat 2003, and 2005).

Virtual Environments have proliferated and a large number of architecture and design schools are currently engaged in them as virtual architectural design studios. Virtual Environments can either support teaching in a single studio within an institution or bring together students from several institutions. There are various motivations for engaging architecture students in VDS including instinctive feelings that Virtual Environments present an essential learning for practice of the future, exploiting technology in design teaching, researching the nature of design communication and processes, and searching for ways to improve the educational experience of a student (Kvan, 2000). Virtual Environments provide powerful communication and navigation environments wherein users can collaboratively design in centralized or distributed environments. Some examples in this field include “Phase X” (Schmitt, 1997) that is a design course at ETH, Zurich which starts using the computer as a medium but in a passive approach. Another example is a collaborative virtual studio in an immersive environment that allows experiencing design ideas differently in which the interaction of idea and creation was direct (Schnabel et al, 2001). Collaboration was possible and teams engaged in intense discussions about design, concepts and forms.

An Alternative Teaching Model for Collaborative Learning in a Virtual Architectural Design Studio

In collaborative learning, students work together as members of a learning community by questioning each others, discussing, and sharing information. Flexibility and interactive communication are key features in collaborative learning. In order to achieve collaborative learning, the author has developed an alternative teaching model that includes four major phases as shown in Figure 3: Inhabiting, Designing, Constructing and Evaluating (IDCE). These phases are carried out in a multi-user real-time 3D virtual environment platform (Activeworlds), wherein activities do not occur sequentially but rather in a constructive loop that maps in part to the activities in the conventional face-to-face design process. The new activities in this model are inhabiting and constructing. Inhabiting requires users to virtually familiarize themselves with: (a) nature of the design problem to be solved, (b) electronic interaction with their colleagues and studio instructor, and (c) design environment within which they will design, construct and evaluate their ideas. All of these are happening virtually (students and studio instructor do not have to be physically collocated), within one sitting, that is the multi-user real-time 3D virtual environment.

This is an alternative to the various settings of the traditional face-to-face, paperless design studio, and previous VDS that included disjunction among lecture sessions, discussion groups, studio sessions, individual drawing boards or individual and a single user CAD platform. The real difference here is that all previous activities are now taking place within one sitting in a multi-user real-time 3D virtual environment wherein students' actions, communications, and designs are viewable to all participants from a single computer interface. Within this interface each user selects his/her view point and location in the 3D virtual environment, interacts with objects and navigates in 3D space. Students build their designs in the VDS in a similar fashion to the construction process in real world. Therefore, they evaluate their designs and modify them as they build or construct them. This is an unparallel experience for each student to realize the design as it evolves without mental transformation efforts and shift of focus between various design representations. It also allows studio instructor, teaching assistants and each student to view each design from his/her computer interface (as s/he moves "teleports" to its virtual location), interacts and communicates with the designer and provides alternative solutions in one to one or one to many collaboration settings since many users can be at the same virtual location simultaneously.

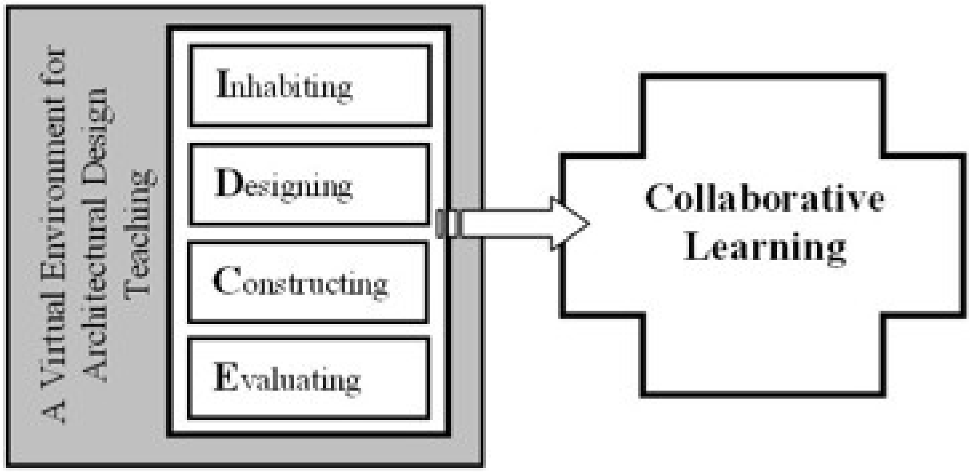

Figure 3: *The IDCE teaching model for collaborative digital architectural design learning within a multi-user real-time 3D virtual environment (Reffat, 2006a)*

The IDCE teaching model has been applied by the author in teaching the first year design studio (Semester 2) at the University of Sydney within a multi-user real-time 3D virtual design platform (Activeworlds). Students can access the VDS through client software (Activeworlds client) that is required to be installed on their local computers that can connect to the server (via local area network, or DSL, or dialup) in which the VDS platform (Activeworlds galaxy server) is installed. Therefore, students can access and work on their designs at any time day or night. All designs and actions are saved on the server and can be viewed and modified from anywhere. Objects created by each user are owned by him or her. Hence, these objects that constitute the design can not be modified except by their owner or the studio instructor who has full access to the whole environment. Students have constructed their design ideas of 3D virtual café taking into considerations that design objects are modeled in real size (1:1 scale), achieving a sense of presence, directedness and engagement in the design of their virtual cafés, and designing objects to be interactive with user's actions. Students' designs are constructed from objects that were either imported from the Activeworlds object library or were designed and modeled using 3D CAD modeling tools (AutoCAD, ArchiCAD, 3D Studio and FormZ), converted, exported to augment the Activeworlds object library at the server, and used to construct the proposed designs. Examples of students' designs in the VDS are shown in Figure 4.

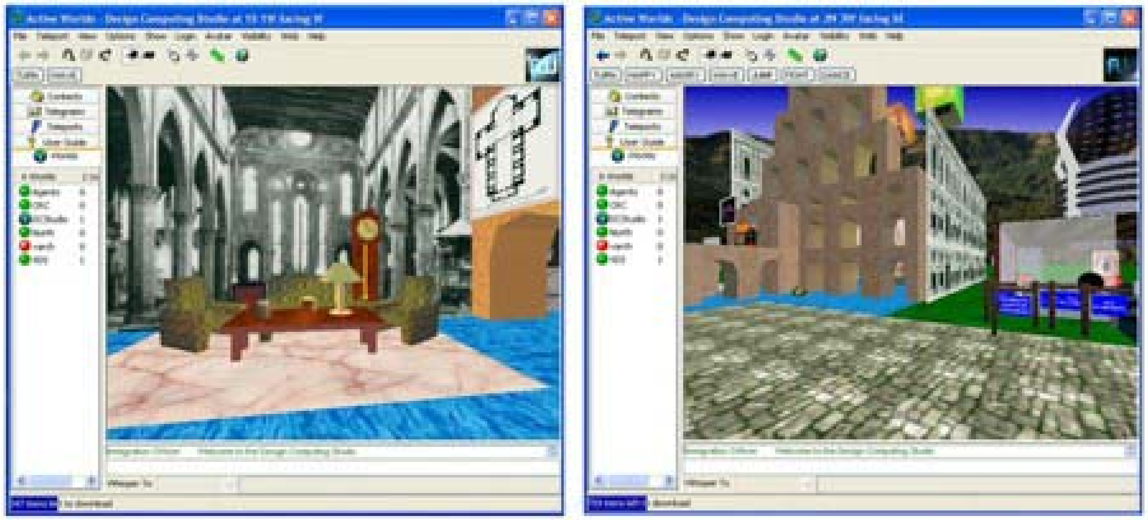

Figure 4: *Examples of students' designs developed in the collaborative virtual design studio*

REFLECTIONS ON STUDIO EXPERIENCES IN THE PAPERLESS & VIRTUAL DESIGN STUDIOS

Reflections on Studio Experience in the Paperless Design Studio

Design Process in the Paperless Design Studio

In the conventional design studio the design process is carried out through the use of sketching, physical modeling and orthographic drawings. A unique characteristic of the conventional design studio is that sketching, tracing and recording ideas are left visible. This provides richness to the exploration through revisiting and revising previous ideas. The ability to see where a design idea is at present and where it came from seems to be of benefit while working in a physical or tangible medium. All of this and more can be offered using digital media in the paperless design studio (Norman, 2001). The history of a project and process of design must be evident in the educational techniques employed in the paperless design studio. Editing a digital file might cause the history or part of the design process to be lost. This was simply resolved by using the design tool to benefit the design process in the paperless design studio. Whenever a design idea was revised then a new file was saved providing a record of the past. This strategy was not applied by our students at every change in the design process but rather at times of conceptual changes. Another alternative to document the design process is with taking frequent captures and snapshots of the computer's screen state, well prior to final presentation. This allowed the students to see the evolution of their designs from various concepts to design developments. The documentation of the design process in the form of a digital sketchbook "digital portfolio" has broaden the students' design universe to utilize the design tool to digitally merge design ideas created at different time intervals of the design process.

Communication and Representations in a Paperless Design Studio

The newcomer to a paperless design studio might expect instant efficiency as a result of the move to digital design studio. Yet, even after developing a basic fluency with a given program, this efficiency is not likely to be immediate. Initially, a significant amount of time must be devoted to mastering computing in the design context. It is important to anticipate a “time sink” at the early stages of the digital engagement and to allow for it (Lewis & Wojtowicz, 2001). The forms of representation in the traditional design studio include the use of physical models, manual drawings, and even to some extent two and three-dimensional CAD drawings. In a paperless design, design tools are used as tools for inquiry. Furthermore, various types of representation forms are produced by students including, real-time modeling, web-based presentation, dynamic presentation incorporated with sound, QTVR animations and walk-through. A promising aspect of the digital model lies in its inherent ability to be used as data for the production of design and to serve as data in CAD-CAM (computer aided manufacturing), or the quick prototyping process using rapid prototype machine that was made available to students to produce physical models of their designs from their digital 3D models. This has created a new relationship between designer, project and design objects; perhaps turning the designer into the digital artisan-craftsman. The nature of the digital design medium has permitted designers to think more naturally in three dimensions and to a greater degree than previously imagined.

Paperless Design Studio and its implications on Studio Pedagogy

The nature of design with its uncertainty and irregularities are congruent with the epistemology and ontology of the constructivist pedagogy. The inclusion of constructivist ideology within the paperless design studio helps to increase learning and advance constructions of knowledge (Powers, 2001). Similar to a traditional design studio the responsibility in the learning process is shared and negotiated amongst teachers and learners. Utilizing digital media in a paperless design studio enriches the design studio environment with a multiplicity of informational sources and representations that help students and teachers to reflect upon design ideas at different time intervals at the early conceptual stage of the design process. The paperless design studio is an excellent place for the outgrowth of exploring, investigating and constructing design ideas.

Reflections on Studio Experience in the Collaborative Virtual Design Studio

Multi-user 3D virtual learning environments provide the capacity to merge the institutional infrastructure for academic subjects with the educational principles of constructivist pedagogy. The educational aims of higher education form a constructivist pedagogy may be divided into the categories of: (a) Knowledge and skills acquisition, including competence with tools and techniques; (b) Socialization, particularly induction into the canons of particular communities, disciplines or professions; and (c) Development of intentional learning, a form of learning in which learning itself is the goal and the individual becomes a self-organized learner, capable of critical thinking, reflective practice and active open-ended inquiry. The multi-user 3D virtual collaborative learning environments provide immersive, learner centered educational environments that are based on the constructivist pedagogy (Lombardi & McCahill, 2004). In the VDS students bring multiple perspectives, diverse backgrounds, learning styles, experiences and aspirations. In order to foster collaborative learning there should be a structure that encourages student conversation and communication (Kvan & Yunyan, 2005). The utilization of the IDCE teaching model in the VDS has permitted a range of communication media and engaged students, studio instructor, and teaching assistants over a relatively long duration allowing more freedom in learning approaches. From a studio instructor's perspective, it has been witnessed that students have been captivated by the opportunities provided by the activities of inhabiting, designing, constructing and evaluating their design ideas in the VDS in which they have been fully immersed, engaged and enjoyed the experience of design process within a more social sitting. Furthermore, from students' perspective, the advantages of applying the IDCE teaching model in a VDS compared to using a single user CAD software in a traditional face-to-face studio include:

- Improving students' motivation for active, creative and explorative learning.

- Fostering learning electronic communication, collaboration techniques and etiquette in addition to design technology.
- Online archiving of design information and keeping track of previous design actions, approaches and critique helped students to improve design reflection and moving into new directions.
- Synchronous communication within the current design as it is developed at the VDS across all stages of the IDCE model has stimulated the sense of presence and collaboration between students themselves and between students and studio instructor and teaching assistants.
- The process of designing has become more exciting and natural in a social sitting for learning and design development.
- Extending collaboration time due to the availability of access to the VDS at all times and from anywhere.
- Enriching collaborative learning experience wherein students realized exploring and learning together without ego, embarrassment or domination.
- Strengthening the social bonds between studio participants since they occasionally had chance to talk about other issues during their collaboration or just surfing or walking through the VDS to observe what others are doing in their designs.

On the other hand, there are some drawbacks that have been realized and faced during the processes of applying the IDCE teaching studio in VDS. The capacity of bandwidth (via networking, DSL, or dialup) and firewalls are limiting factors governing the speed of mobility, access, resolution of visual and sonic objects, and quantity of data transferred in (near-) real-time in a multi-user online environment. Modeling objects and modifying their geometries are other important limitations that should be taken into account while adopting Virtual Environments (basically Activeworlds), in virtual architectural design studios. The above limitations were the most important constraints that interrupted all participants during this experiment. However, these are technological limitations that are expected to be overcome in the near future with the fast and advanced rate of development in IT and communications.

The Next Step Ahead in Architectural Design Studio Teaching: ICT as a Partner

When information and communication technology was introduced in architectural education, the reflection on building practice was seen very clearly. The use of ICT tools within architectural offices came much later than any other engineering disciplines. In the historical developments of ICT utilization in the education of architectural students, the computer was used as information processing tool, communication tool, and visualization tool during the design process. It was mainly used in processes such as animation, simulation and the whole spectrum of visualization. By the developments of advanced 3D visualization tools including Virtual Environments platforms such as Activeworlds, Adobe Atmosphere, Second Life, etc., one may expect enormous improvements in the approaches of digital architectural design studio teaching. Therefore, ICT is not any more used only as a tool for architects but are becoming a new medium besides the other existing ones within the architectural design process (Sariyildiz et al, 1998). ICT is becoming a valuable media for designers and architects in relation to the use of conventional medium. The widening of Internet opened the horizon for computers to become more and more an open medium and speed up ongoing processes. Hence, there is a growing need for advanced ICT supportive tools that enables architects to cope with the increasing complexity in design and with the increasing need of efficient communication with many partners in the building process.

The ICT is expected in the near future to play a more important role than being a medium; it will potentially play the role of a reliable partner in the design process as depicted in Figure 5. How can they become a partner and what will be the role of this partner in the design process?. ICT will be used as partner when its advancements and supportive tools successfully function as: knowledge integration tools, decision support tools, and design assistant tools (Sariyilidz & Van der Veer, 1998). Therefore, viewing information and communication technology as a partner in architectural education requires developing new methodologies and techniques to realize the goal that computers can be put into the education process and act as a reliable partner. The need for such methods and techniques presents challenging tasks to architectural educators with expertise in information and communication technology to carry out and provide creative directions. An approach that envisages the new generations of supportive collaborative medium architectural designing and studio teaching has been developed which carried out synchronously within smart and real-time 3D virtual environments within which architects are designing with intelligent agents based on the view of situated digital architectural design (Reffat, 2006b).

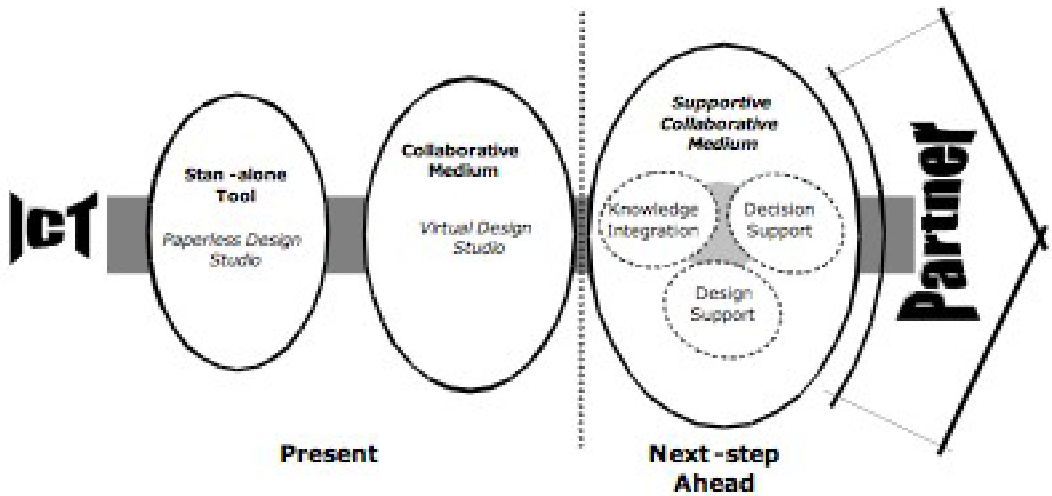

Figure 5: *The Next Step Ahead in Architectural Design Studio Teaching: ICT as a Partner*

DISCUSSION

In the paperless design studio there were different types of interactions that took place between the students and the design tools, between the students themselves and between the students and their design instructors and teachers. The focus on the interaction between the student and design tools in the paperless design studio distinguishes the approach presented in this Paper rather than using computers as generative systems. The generation of shapes using generative systems is very different with the creation of design ideas within a form of fruitful dialogue between the student and the design tool where designing is viewed as an activity that occurs with active participation. Designing with computers is not a systematic process by which a set of rules would generate design solutions (Madrazo, 1999). Designing with computers is rather a situated process wherein the result of design artifacts is based on the design situation that each student encounters, the state of interaction with the design tool, and which objects primitives of the design tool the student is utilizing. A designer, through analysis, investigation, research and interaction begins to synthesize an idea for a possible solution to respond to the situation at hand. The process is then to chase this idea down to see if it works, to test it, to modify it, and to branch out in a different direction, or to reject it back all together.

On the other hand, the application of the IDCE model in the collaborative virtual design studio has offered a rewarding opportunity with challenges and dilemmas. The implementation of this model has facilitated active exchange of ideas, increased the interest among participants, promoted creative exploration, and made the learning more natural. The utilization of IDCE model in VDS made the design studio not to be any longer solo teacher and leave individual students with their own designs. It became more of an interdependent community with all joys, tensions and difficulties that attend to all communities. The assumption that studio instructors act as keepers and dispensers of knowledge is no longer valid. It fostered the VDS to be a collaborative learning environment with shared responsibility, persistence and sensitivity. In order to succeed in the future of digital architectural design studio teaching, one needs to know more about how the digital world is likely to change. We live in a universe of continuous change; a world in which most the unchanging things in the past keeps on changing based on discoveries and interpretations. Information and communication technology and digital media are real indicators of a changing world. Such a world requires responsive design studio teachers and instructors to make the best use of latest developments including information and communication technology. This will help design studio instructors to improve the quality of design studio processes and products in addition to enhancing student's learning and design skills to better prepare them for an ever changing world of everything wherein architecture is not an exception.

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Students' perceptions of prehospital web-based examinations

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ABSTRACT

This study examined the attitudes of prehospital undergraduate students undertaking a web-based examination (WBE) as an adjunct to the traditional paper-based examination (PBE). Following the completion of the WBE second year Bachelor of Emergency Health (BEH) undergraduate students at Monash University (n = 94) were asked to complete a questionnaire which was designed to obtain information about students' attitudes of WBE. Quantitative results produced high student satisfaction and acceptance of WBE as an appropriate teaching and assessment resource in the BEH degree. Generally, students found the WBE experience to be very positive and preferred WBE to PBE.

Keywords: *Prehospital education; higher education; web-based examinations; paper-based examinations*

INTRODUCTION

With financial constraints now being placed on higher education sector, this has forced staff and administrators to develop more cost-effective programs, which can be delivered in a more flexible environment without reducing the sophistication of educational pedagogical approaches. Other areas that have emerged have been programs that involve collegial merging of partnerships and more efficient ways of conducting non-teaching activities such as written examinations.

One teaching and learning solution postulated has been the online teaching and learning paradigm. Many institutions now offer many or part thereof in both undergraduate and postgraduate studies. This paradigmatic shift however, has not been without pedagogical obstacles or resistance by teaching staff, with terms such as 'Digital Hemlock' and 'Sophisticated Obstacle' being associated with online teaching, learning and assessment.

Aims

This study was undertaken in two phases comparing attitudes of second year BEH prehospital undergraduate students. The BEH degree is pre-employment or pre-registration professionally oriented undergraduate degree, offered full-time on campus by Monash University. The goal of the study was to assess BEH students' attitudes and perceptions of WBE and comparing WBE to PBE.

Literature Review

A literature review was undertaken using several databases: MEDLINE, EMBASE and Cochrane Library. The following MeSH terms were used in the search: web-based examination, web-based testing, computer-assisted instruction, computer testing, online testing, internet testing, EMS, paramedic, prehospital and out-of-hospital.

No papers were obtained under designated prehospital filters in MEDLINE, EMBASE or ERIC. A second tiered search response was undertaken with an improved outcome using an un-filtered search approach. WBE literature does exist in other health science disciplines, however this is the first study of its kind relating to prehospital undergraduate students.

BEH DEGREE

The BEH degree is a full-time on-campus degree completed over two years (accelerated entry) or three years (standard entry). Students receive education relating to prehospital practice, clinical epidemiology, public and population health and professionalism issues with a strong emphasis towards a more general community-based health approach.

The BEH program is a newly formed thematic degree offered at Monash University Department of Community Emergency Health and Paramedic Practice (DCEH&PP). The degree offers students the opportunity to develop skills, knowledge and an understanding of the attributes required of a prehospital practitioner. Many students undertake this degree in anticipation of becoming an ambulance paramedic; however the unique nature of this degree allows students to consider other community-based occupations with the program offering five themes as highlighted below.

- *Theme 1.* Science, knowledge and evidence
- *Theme 2.* Population health and illness in society
- *Theme 3.* Foundations of the paramedic clinician
- *Theme 4.* Community-based Emergency health in integrated health and emergency systems
- *Theme 5.* Personal and professional development

These themes 'intersect' both vertically and horizontally throughout the curricula and shape the teaching and learning under the founding paradigm of community-based emergency health. DCEH&PP staff has responded to Monash University's Graduate Attributes which include development of information technology (IT) skills and thus have included not only online teaching and learning but also WBE to improve their skills with computers and health informatics.

Traditionally, Australian prehospital education with vocational or on-the-job training historical origins have generally measured students' theoretical competency by way of the traditional PBE. Often this traditional PBE would consist of multiple choice questions (MCQ), short answers, case studies, long answers and word matching. With the transition of prehospital education moving to the higher education sector, it is important that further exploration of other pedagogical and assessment options are evaluated. One such option is the move from the traditional PBE to one of innovative, flexible and state-of-the-art way of assessing students' competency and cognitive ability.

WBE PROCESS

The unit used in the study utilises the educational paradigm of case-based learning (CBL) via a blending mode of face-to-face (F2F) and online teaching and learning. The learning management system used during the study was WebCT (CE) ™ / WebCT (Vista) ™ and required significant student participation in the online classroom forum. All online testing facilities were undertaken in WebCT™.

The initial phase of this project was to formally assess the students in an online capacity during the semester 1, 2005 and 2006 in a prehospital clinical unit of study. Students were advised on the first day of class and also in their unit booklets that such a testing procedure was taking place during week 5. Advice was provided to students who were not “IT-savvy” to seek student assistance on campus. The test was worth 15% of the overall grade.

The testing procedure was conducted in designated computer laboratory; each laboratory contained 20 personal computers with full network capabilities. The allocated test time was 1 hour and consisted of 55 questions. Multiple attempts were not allowed. The computer laboratory was structured in a designated space, thus no computers or chairs were altered to increase proximity or distance during the examination process. Questions were generated from the first 4 weeks of lectures and consisted of MCQ’s, diagram MCQ’s, true or false questions and word matching.

Authentication was ensured by standard login and passwords via the normal WebCT™ URL. Given the blended teaching mode lecture; notes and material were available in WebCT™, nevertheless security was maintained by selectively blocking students to their lecture notes during the 1-hour examination. This type of security is discussed by Peterson et al. (2004) who also discusses the capacity for students to view electronic text books and resources via the Internet during the exam. No notes or paper material were allowed on desktops and security was maintained with 2 invigilators present during the examination. These general security measures are repeatedly identified in the literature (Gilmer et al. 2003).

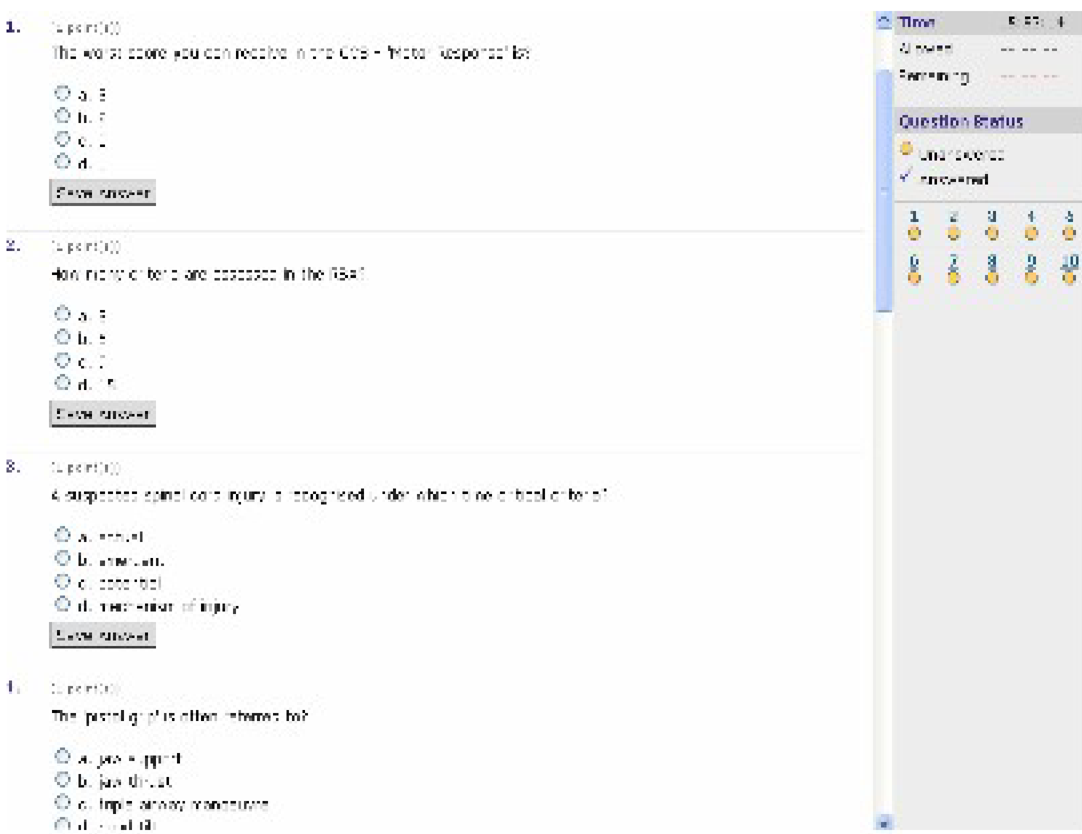

Figure 1: *This is a representative screen from the WebCT™ examination questioning area highlighting the multiple-choice questioning layout. Please note the timer in the top right hand corner.*

A timing clock was clearly highlighted in the testing screen advising the students of the remaining time (Figure 1). Once the 1 hour time interval had lapsed the exam automatically closed and any unanswered questions could not be attempted. Printing of the exam was not permitted and students could change their answers (if required) during the exam. This point is important as other studies have shown increased student distress when some uncertainty exists with clicking the wrong answer (DeAngelis 2000).

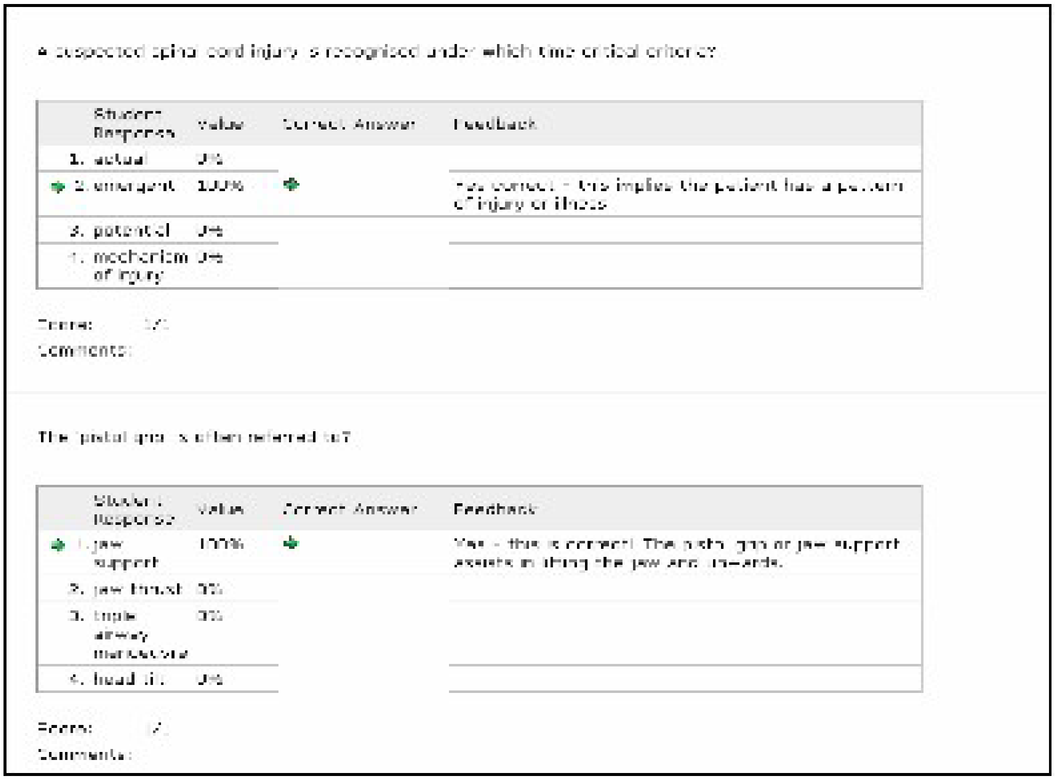

Figure 2: *This is a representative screen from the WebCT™ examination questioning area highlighting the capacity to provide feedback with correct answers.*

METHOD

The convenience sample consisted of (n = 94) BEH undergraduate students. Second year students enrolled in the BEH degree in semester 1, in 2005 and 2006 were selected in this project. The study population consisted of 100 students enrolled in one of the clinical units from the degree, 94 (94%) students participated in the study.

There were 37 second year [2005] and 57 second year [2006] students at the time of the study. A cross-sectional survey design using a paper-based questionnaire was adopted in this study. The questionnaire contained 10 multiple-choice questions. The survey attempted to elicit students' attitudes towards WBE's and its key features and attitudinal comparison between WBE's and PBE's. Students were asked to report their attitudes and opinions on a 4-point Likert Scale (1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree).

Data Analysis

Analytical statistics were used to report the students' perceptions and their attitudes towards WBE using a 2-tailed unpaired *t* test. The results are considered statistically significant if the P value is < 0.05. The Likert scale responses were analysed using SPSS (Statistical Package for the Social Sciences, Version 14.0, SPSS Inc., Chicago, Illinois, U.S.A.).

Ethics

Ethics approval for the study was granted by the Monash University Standing Committee on Ethical Research in Humans.

RESULTS

The following data are a concise description of the student's responses to each question of survey collected and calculated from both second year cohorts.

Table 1: *Combined data second year students 2005-2006 (n=94)*

	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
The web-based examination was a positive experience.	40.4	54.3	5.3	-
The web-based examination was confusing.	-	2.1	52.1	45.7
The web-based examination was efficient.	51.1	48.9	-	-
Did you feel threatened by the web-based examination compared to the paper-based examination?	-	11.7	38.3	50.0
The web-based examination was undertaken in a conducive environment for student testing.	35.1	57.4	6.4	1.1
The web-based examination was tedious.	-	2.1	56.4	41.5
The web-based examination was better than the paper-based examination.	40.4	44.7	9.6	5.3
Would you prefer web-based examinations compared with paper-based examinations?	43.6	37.2	14.9	4.3
Do you think student fairness and equity is ensured with web-based examinations?	28.7	55.3	13.8	2.1
Do you prefer receiving your test results automatically using the web-based system?	63.8	24.5	6.4	5.3

WBE a learning experience

The vast majority of students (94%) strongly agreed or agreed that the WBE was a positive experience. In contrast, only (5%) of respondents disagreed this statement. In terms of the WBE itself, (97%) of students either strongly agreed or agreed that the WBE was not confusing and (100%) students stated they either strongly agreed or agreed that the WBE was efficient. Interestingly, almost 100% (97%) of respondents felt the WBE was not tedious.

WBE testing environment

Just over (90%) of students felt the WBE was undertaken in a conducive testing environment, (6%) of respondents disagreed and only (1%) of students strongly disagreed with this statement. Almost 85% (83%) of students believed the WBE ensured fairness and equity. One in ten (13%) students disagreed with this and only (2%) of respondents strongly disagreed with this statement.

WBE versus PBE

Just over 80% (84%) of students either strongly agreed or agreed that the WBE was better than PBE's. Less than one in ten (9%) disagreed and only (5%) of respondents strongly agreed with this statement. The far majority of students (80%) strongly agreed or agreed that they would prefer WBE's compared to PBE's. Less than 15% (14.9%) disagreed and less than one in twenty (4.3%) strongly disagreed with this. Almost one in nine (87%) strongly agreed or agreed that they would prefer to receive their test results automatically using WBE's. Just over 5% (6.4%) and (5.3%) disagreed and strongly disagreed with this respectively.

Statistical Analysis of Group Differences

The statistical analysis aimed to identify whether any statistical significance existed with the second year students and the efficacy of WBE as an assessment tool in undergraduate prehospital education. Analysis of the Likert responses showed that the second year cohort had an overall mean satisfaction of 1.74 (SD 0.58) [95% CI 1.52-1.77], P = <0.0685.

Overall analysis of the two groups combined shows that the students generally liked WBE as an appropriate assessment tool. A t-test revealed that there was no significant difference (t=-1.84 P = 0.0685) in students' perceptions and attitudes towards WBE.

DISCUSSION

Whilst internet-based education has increased dramatically, the actual testing and assessment via the World Wide Web is not often reported in the health care literature. Several articles have examined students' perceptions or attitudes toward WBE. The results highlight evidence that prehospital students generally prefer and enjoy the opportunity to participate in WBE's. Notably, similar satisfaction levels have been identified in the literature by Butzin et al. 1984; Legler & Realini 1994; Bloom & Trice 1997; Bocij & Greasley 1999; Ogilvie et al. 1999; Cotugna & Vickery 2001; Hong et al. 2002; Gilmer et al. 2003).

Over 80% of students stated they strongly agreed or agree that they would prefer WBE over PBE. Other studies (Griffiths 1994; Zandvliet & Farragher 1997; Hong et al. 2002; Schultze-Mosgau et al. 2004) also found similar results. These findings are significant in the context of prehospital education and shows great promise in general prehospital higher education. Some of the advantages of WBE's are found below. One benefit WBE's have over PBE's not directly identified in the literature is the capacity for faculty members to support individual or group learning problems that may have not been possible in the past given the time constraints of traditional PBE's. A high proportion of students would prefer undertaking a WBE compared to the traditional PBE. These results are substantially higher than other reports in the literature (Butzin et al. 1984; Bocij & Greasley 1999; DeAngelis 2000). This raises the question whether WBE's are just another sophisticated piece of technology in reducing the teachers making time or do WBE's produce better exam scores?

- Timely feedback
- Flexible scheduling
- Cost effective
- Reliable
- Student/teaching flexibility of time and location
- Reduction in teacher marking time
- Instant scoring
- Enhanced security
- Inclusion of multimedia
- Immediate student grade storage
- Allows greater student progress to be monitored
- Unbiased marking
- Easy identification of 'common' question errors
- Standardisation of examination environment
  (Griffiths 1994; Stephens 1994; Bloom & Trice 1997; Ogilvie et al. 1999; Bartlett et al. 2000; DeAngelis 2000; Lynch et al. 2000; Cotugna & Vickery 2001; Hong et al. 2002; Gilmer et al. 2003; Doty & Lucchesi 2004; Peterson et al. 2004; Schultze-Mosgau et al. 2004; Vrabel 2004).

High student satisfaction results were gained in instructional design, presentation and efficiency with almost 100% of the participants claiming the WBE was not confusing and all students claiming the WBE was efficient. Similar results were found in the studies by (Butzin et al. 1984; Ogilvie et al. 1999; Bartlett et al. 2000; DeAngelis 2000). Comparable student satisfaction was also highlighted with almost 100% of students stating that the WBE was not tedious. Bocij & Greasley (1999) and DeAngelis (2000) also state parallel conclusions in their studies.

Whilst the majority of students felt the test was undertaken in a conducive environment several aspects should be taken into consideration for WBE's. Consideration should be sought for computer-to-computer proximity, although question randomisation would remedy this. Also, 'quiet signs' should be posted on doors and hallways to reduce external noise and potential student traffic (Gilmer et al. 2003). Faculty staff should pay particular attention to reducing external noise and the room temperature. In this particular study, given the multiple computers being used simultaneously this increased the ambient temperature dramatically. Network printers should also be considered if they are placed in computer laboratories. In Gilmer et al. (2003) study a network printer was identified as a distracter that unfortunately had to be subsequently removed during the exam.

Over 80% of students felt adequate fairness and equity was maintained for the WBE. These data are substantially higher than other studies found in the literature (Bartlett et al. 2000; Gilmer et al. 2003). This could be attributed to that the fact that students were given the opportunity to undertake a 'mock' test in an informal environment allowing them to familiarise themselves with the testing environment and type of questions. These 'mock' tests during each study module has been identified by several authors to provide students with a non-threatening and fair means of undertaking a WBE, perhaps for the first time (Danielsen et al. 1998; Bocij & Greasley 1999).

Only one in ten of participants felt threatened by the WBE, further analysis is required to determine the cause of this feeling. Was it due to the proximity of computers, first exposure at WBE or simply the subject matter being assessed? This is reinforced by other studies who also found similar findings (Bocij & Greasley 1999; Gilmer et al. 2003). Other potential or perceived disadvantages (see below) that may affect student fairness and equity might include generational learners, experience with WBEs, level of expertise with computers and associated anxieties. Notably, several studies have shown that computer anxieties have little effect on student's performance or academic results when undertaking WBE's (Powers & O'Neill 1992; Lynch et al. 2000; Cotugna & Vickery 2001).

- Increased cost
- Student apprehension
- Need for new test-taking skills
- Non-conducive testing environment
- Potentially reliant on information-savvy students

The literature highlights that for exams to provide the most useful learning experience then feedback should be timely or automatic. Almost 90% of students preferred their test results automatically using the web-based system. So what are the advantages of this? The WebCT™ online exam function allows not only automatic scoring results but also the ability of the instructor to place descriptors in correct and incorrect answers. The capacity for faculty to include descriptors in the answer section has been identified as a positive teaching method by several authors in their studies. This provides the student with timely feedback but also feedback that is meaningful and assists in clearing misconceptions with particular questions. In DeAngelis' (2000) randomisation study she identified several benefits of automatic and descriptive scoring. Firstly, this led to a reduction of actual testing time, and secondly, further reduction in marking time with no need to review test results.

Further research

Further research into students' capacity and equity with computer use could be undertaken via an experimental control group study. One aspect could be to compare and contrast similar educational content with other universities – WBE's could be used simultaneously across the country or globe (Schultze-Mosgau et al. 2004). Additional analysis into whether WBE's can be determined to be more valid, reliable and cost effective in terms of financial costs but also in terms of students assessment requirements than traditional examination methods. Also, comparison of different learner generations should be undertaken, for example, Generation Y versus X Generation and how this may impact on user-friendliness of WBE's.

Limitations of study

Several elements were not identified in the survey including gender, English language proficiency and participant's previous experience with WBE's; these specific backgrounds and exposure may have affected some of the results. Moreover, since no control groups were used who did not use the WBE; the author cannot be sure the testing system itself was responsible for academic performance.

CONCLUSION

Prehospital education in many facets is undergoing significant change in pedagogical approaches, principles and assessment methods. As identified a small number of articles have examined students' perceptions or attitudes toward WBE. In this study undergraduate prehospital students found the WBE experience to be very positive, preferred WBE to PBE and preferred to receive their test results automatically. Providing students with more exposure with WBE's and other contemporary assessment technology should become an integral component of prehospital higher education.

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Policy networks and the transformation of secondary education through ICTs in Africa: The prospects and challenges of the NEPAD e-schools initiative

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ABSTRACT

Using the policy network theoretical framework, this paper examines the prospects and challenges of the New Partnership for Africa's Development (NEPAD) e-schools initiative. Based on qualitative research approach, this study aims to critically evaluate the prospects and challenges facing the e-schools collaborative initiatives under the auspices of the NEPAD. Secondary education system is the most strategic education sector and unfortunately the least developed and the least available in Africa. With the vision of changing teaching and learning paradigms in Africa, the e-schools initiative aims to tackle the problems of secondary education in the region through the application of information and communication technologies (ICTs). However, a successful exploitation of the potential of ICTs for the enhancement of secondary education depends more on pedagogical and inter-organizational strategies than ICT issues. While secondary education is the domain of interest, e-school projects are premised on collaborative partnerships, alliances and consortia of corporate and governmental bodies. The projects have many prospects and challenges that must be resolved to ensure its sustainability. It is argued that a responsive ICT in education policy in each country is key to the success of e-school projects across Africa. At the organizational level, the study argues that sustained technology intervention is based more on the resolve of the partner members, especially the political will of African governments. Besides, the e-school initiative stands to gain from the experience of developing countries that have successfully integrated ICTs in education through collaborative strategies.

Keywords: *Information and communication technologies; e-school; secondary education; policy network; collaborative partnerships; Africa*

INTRODUCTION

Improved secondary education is fundamental to the creation of effective human capital in any country. In an effort to eradicate poverty and ensure sustainable socio-economic development in Africa, the newly formed New Partnership for Africa's Development (NEPAD) recognizes that a key issue is the development of human resources in the region. The crisis facing human resource development in Africa is clearly manifested in the secondary education sub-sector in forms of limited access and poor quality. The World Bank (2005) describes secondary education as the crucial link between primary schooling, tertiary education, and the labor market. As the World Bank (2005) notes, the task confronting education policymakers in Africa is to transform secondary education institutions and current schooling practices to align them with the fast growing demands of globalization and the technology-driven world. Thus, the main focus of the education policy process in Africa is to address the twin challenges of increasing access to, and improving quality and relevance of secondary education for all young people in the region. This underscores the imperative to transform teaching and leaning in primary and secondary schools in African countries. This is what the NEPAD e-school projects wants to accomplish with a new paradigm of educational curriculum delivery. This new and integrated strategy for socio-economic development in Africa paves a new way for the improvement in quality and expansion of access to public education in the region. The NEPAD e-school projects aims to equip secondary schools (and later primary schools) in Africa with information and communication technologies (ICTs) to enable educational transformation to meet the demands of the 21st Century. In the long-run, modern communication technologies are expected to be widely deployed for teaching and learning in primary and secondary schools across Africa. This broad-based technology- enhanced education will be implemented through a collaborative partnership system in African countries.

The pilot phase of this e-learning initiative is currently being implemented in selected African countries. The NEPAD e-Schools Project is under the auspices of the NEPAD e-Africa Commission, the NEPAD ICT task team responsible for developing the NEPAD ICT program and implementing related projects. The e-schools initiative is on a multi-collaborative partnership strategy between the NEPAD, major ICT companies and ministries/departments of education in different participating African countries. The objective of this study is to examine the prospects and challenges of effectively implementing a large scale technological intervention in education within the context of developing countries in Africa. Due to high costs and shrinking educational resources in Africa and the increasing demand for secondary education in the regions, technology intervention has become one of the most feasible choices for education transformation. Following this background, this study examines the question: to what extent can the NEPAD e-school initiative use the policy network approach to bridge gaps in secondary education in Africa through the application of ICTs? To address this question, I will employ the policy network theoretical framework for analysis which is fully described below.

RESEARCH METHOD

This research uses qualitative methodology. Qualitative studies involve multiple data collection strategies for purposes of deriving rich descriptions within as natural a setting as possible (Merriam, 1998; Patton, 1990). Unlike the quantitative approach, qualitative research method promises to provide in-depth information and description about the basic dynamics of collaborative partnership in the NEPAD e-schools initiative in Africa. Data for the article was collected from primary and secondary sources using a triangulation of methods. The field research for the study was conducted in the summer of 2005. Interviews were conducted with key informants at the NEPAD e-Africa commission in Pretoria, South Africa. A large set of information used in the study comes from internet materials, particularly those produced by civic groups responding to issues of ICT in education in the developing countries.

CHALLENGES FACING SECONDARY EDUCATION IN AFRICA

The NEPAD e-schools project is motivated in part by the sordid state of the secondary education system in Africa, and by the conviction that the potential of modern ICTs can be utilized to meet educational challenges in the region. One may ask, to what extent is the introduction of ICTs necessary for the transformation of secondary education in Africa for national development? Is an initiative like the NEPAD e-school project vendor-driven or a mere effort to ensure that African schools conform to the global trend of applying modern ICTs in education? In essence, are ICTs a luxury or a necessity for secondary education in Africa? These are genuine questions that can be answered by looking into the current state of post-primary education Africa using the policy network theoretical framework for analysis.

Secondary education is of strategic importance to Africa’s development and capacity building, particularly because students of secondary school age and young people in general make up more than 60 percent of the population of Africa (Bregman, & Stallmeister, 2002; Lewin, 2004; Akoojee & McGrath, 2005). Unfortunately, many African countries are unable to meet the increasing demand for secondary education due to their inability to build on the successes of the universal primary education system. African countries are expected to double or triple the number of primary school graduates in the next couple of years. This massive turn-around is due to the success of the universal primary education system under the Education for All (EFA) programs. For instance, in the 2004 school year, the number of primary school graduates in Uganda was expected to increase from 400,000 to over 1million; in Tanzania, this figure increased from 540,000 to 1.2 million; while the expected growth in Malawi grew from 200,000 to 500,000 (Bregman, & Stallmeister, 2002;Lewin, 2004). Unfortunately, existing secondary schools in Africa do not have the capacity to absorb the increase in aggregate primary school graduation.

For decades, the sub-sector of secondary education has been neglected in Africa both by the governments and donor agencies. This view is in line with Colin Power's statement: "We in UNESCO have put much emphasis into basic and higher education, and have neglected the young people in the middle" (Chavez *et al*, 1996, cited in UNESCO, 1999). This neglect of the secondary education sub-sector in Africa is further confirmed by Nsubuga's (2003) view that, "whereas primary education has been targeted during the past decades and higher education always had strong interest groups behind it …Secondary [education] has been conspicuously relegated to the behind scene" (p. 1). The apparent neglect of this sub-sector has resulted in limited access, especially for young women and rural communities, poor quality of curriculum and lack of qualified teachers and essentials infrastructure. This has created inequity in access to secondary education. Out of an estimated 86 million children of secondary school age in sub-Saharan Africa (SSA), only 23 million are in enrolled in schools (ibid). Lewin (2004) reports that the secondary Gross Enrolment Rate (GER2)[1] is below 20 percent in fifteen countries in SSA and below 50 percent in thirty-seven others countries in the region. In general, SSA has an average GER2 of about 26 percent but when other variables such as over-aged students and repetition are factored in, the net GER2 in Africa may be below 20 percent (*ibid)*. African countries have the lowest GER2 value when compared with other developing countries around the world[2]. The widening gap in secondary education development between SSA and the rest of the world cannot be reversed simply by exploring new finance and planning strategies, the mode of delivering secondary education needs to be reexamined in order to expand access.

Historically, secondary education is more accessible to urban areas than to rural communities in Africa (Boaduo, 2005). Additionally, there are some significant gender disparities in the distribution of secondary education in Africa. Socio-cultural, religious, and economic factors have contributed to this disparity that has placed young women at a serious disadvantage (Bregman & Bryner, 2003). In African countries, more boys (28 percent) benefit from secondary education than girls (22 percent) (The World Bank, 2005), yet secondary education plays a vital role in the political and socio-economic development of Africa. As Psachraopoulos (1986) notes, knowledge and human capital are vital aspects of growth and development. With high social and economic return on investment, education in general and secondary education in particular brings about productivity improvements that drive economic growth (Hanushek and Kim, 1995). This is because the social and economic returns to investment in secondary education outweigh the cost. Among other things, such returns include reduction of endemic poverty, increased democratic culture, social inclusion, health awareness and gender equality (Bregman & Bryner, 2003; Lewin, 2004). These are empirical evidences to demonstrate the direct correlation between secondary schooling and socio-economic development of Africa.

The above problems are commonly associated with educational failures and setbacks, which make the realization of the EFA (Education for ALL) goals in Africa a daunting challenge. Considering the high private and social return to investment in secondary education (Psacharopoulos and Patrinos, 2002), innovative policy interventions are urgently needed to improve the quality of secondary education and meet the increasing demand for secondary education in many African communities. Without disregarding the basic needs of secondary education in Africa, such as building more classrooms, there is growing evidence that ICTs may be the only feasible and economically sound means of expanding access to and improving the quality of secondary education, both in Africa and the rest of SSA (Isaacs, 2002). The NEPAD e-school initiative is designed to accomplish this goal through public-private partnership approach.

THE RATIONALE FOR ICT IN SECONDARY EDUCATION IN AFRICA

There is a general consensus that modern information and communication technologies are transforming various aspects of human activity, particularly the arts of teaching and learning. While various terms have been coined for this technology-enhanced education, such as information society, e-learning, and e-school, many countries have acknowledged the fact that investment in ICTs is an investment in human capital development. Such investments are essential in order to meet the demands for new meanings of "school" and "learning," within the larger process of education reform.

Considering the level of poverty in SSA, it is ideal to ask whether it is reasonable to invest huge amount of money in ICTs for the educational development, instead of using such resources to meet other needs of the secondary education system in the region. Such resources, one may argue, can be used to construct more classrooms, provide updated textbooks for students, or better still used to provide electricity and good access roads to secondary schools in rural and remote communities in Africa. In response to the above concern, this study agrees with Luis Osin (1998) that ICTs in education and basic needs in the developing countries are not contradictory or conflicting interests. As he further argued, "The only way to reach a long-term solution for the economic problems of the population is to raise the educational level, particularly for the low socio-economic groups" (Osin, ibid, p.2). In addition, the objectives of ICT in education cannot be realized without basic infrastructures and educational resources. Suffice it to say that the objective of integrating ICT in secondary education cannot be pursued in isolation rather it should be seen as an integral part of the overall strategy for knowledge creation and the improvement of educational system in Africa.

The rationale for integrating ICTs in education was substantiated in a report issued by the Organization for Economic Co-operation and Development (Organization for Economic Co-operation and Development [OECD], 2001) on the impact of ICT in schools. In addition, the report identified other rationale for integrating ICT in education and these include:

- Economic rationale which has a focus on the perceived needs of the economy and the requirements to meet the skill and learning needs of the information economy;
- Social rationale which focuses on facility with ICT becoming a prerequisite for participation in society and employment, so that ICT competence is seen as an essential life skill and a basis for maintaining employability throughout life;
- Pedagogical rationale which concentrates on the role of ICT in teaching and learning and the ways in which ICT can increase the breadth and richness of learning, foster motivation for learning, and support the development of higher-order thinking skills (OECD, 2001)

Generally, the expected advantages of integrating ICTs in secondary education in Africa are: Effective curriculum delivery by teachers as facilitators; Improved learning by raising curiosity; Technological Literacy among students; expanding educational access to remote communities that were formerly deprived of education due to distance, culture, economic needs or gender disparities; and to prepare students for the world of work.

Despite the recognized roles of Information and Communication Technologies (ICTs) in improving the quality and quantity of education, ICTs remain a low policy or financial priority in most educational systems in Africa. Obviously, most countries in the region lack the local capacity and financial wherewithal essential for a sustainable integration of ICTs in education. Understandably, African countries face numerous competing development priorities ranging from budgetary constraints, management challenges, and shortage of teachers and other educational resources, to the dreadful impacts of HIV/AIDS on education. These are issues that vie for the attention of local policy makers. While all countries in the region acknowledge the strategic role of ICTs in development, only a couple of countries in Africa have established a comprehensive policy for the integration of ICT in education. Where such policies exist, they tend to remain vague and make little reference to implementation (James, 2001). As Tina James (ibid) aptly opined, ICT in education policy needs to establish itself within the set of competing priorities. However, given the urgency of educational needs in the region, particularly at the secondary school level, the establishment of such policy domain is overdue. It is against this background that one sees the NEPAD e-school initiated as an innovative approach.

Countries in Africa share few domains driven by harmonized policy initiatives and standards. Such few regional policies are under the sponsorship of regional bodies and groupings like the South African Development Cooperation (SADC) and the Economic Community of West African States (ECOWAS). These regional organizations, modeled along the European Union (EU), have contributed more in recent history to the areas of regional peace-keeping, peace-enforcement and reconciliation/reconstruction of member countries destabilized by civil wars. Hence, the decision to implement a harmonized ICT in education policy through the NEPAD e-school initiative is an unprecedented accomplishment of collective governance, which this study sees as policy network from a regional perspective. The need for the integration of ICT in secondary education in Africa is underscored by two main factors, namely: expanding secondary education access to marginalized communities; and to improve the quality and value of secondary education in Africa.

The NEPAD – A Background

The New Partnership for Africa's Development (NEPAD) is the newest experiment in regional cooperation and economic development of the African Union (AU). The strategic framework document that formed NEPAD was the product of a mandate given to the five initiating Heads of State (Algeria, Egypt, Nigeria, Senegal, and South Africa) by the African Union to develop an integrated socio-economic development framework for Africa. The 37th Summit of the AU in July 2001 formally adopted the strategic framework document (New Partnership for Africa's Development [NEPAD], 2005). With focus on education, health, regional infrastructure, agriculture, market access and preservation of the environment, NEPAD operates within the larger framework of the African Union. The framework has been described as a holistic, comprehensive integrated strategic approach for the socio-economic development of Africa. NEPAD is more or less a fresh collective commitment to move Africa forward. To a large extent, the NEPAD venture is driven by the implications of globalization for African countries. The NEPAD document provides the vision for Africa, a statement of the problems facing the continent and a program of action to resolve these problems in order to reach the goal. According to the document, the objective of NEPAD is "to consolidate democracy and sound economic management on the continent" (NEPAD, 2001. p.59). The NEPAD e-Schools project was publicly launched in Durban, South Africa during the Africa Summit of the World Economic Forum on June 12, 2003. The aim of the project is to impart ICT skills to young Africans in primary and secondary schools and utilize the potential of ICTs to improve, enrich and expand education in African countries (e-Africa Commission, 2006). As the architects of NEPAD argue, public-private partnership is "…a promising vehicle for attracting private investors, and focus public funding on the pressing needs of the poor …" (NEPAD, 2001. p.23) such as improved literacy and high quality education. Hence, the activities of the NEPAD and its various commissions adopt the policy network strategy in pursuit of their development objectives in Africa.

NEPAD e-Schools Initiative as Policy Network

Policy network is a perspective which shows that the activities of the society, represented in formal policy process, are no longer centralized and dictated by the formal institutional arrangements of the state; instead, it is controlled and influenced by dispersed intelligence and activities of independent actors. The objective is to mobilize both public and private sector resources in order to produce methods and activities that can promote sustainable development in the society. Kenis and Volker (1991, p. 27) observe that "contemporary policy processes (i.e., problem identification and agenda setting; policy formulation; policy implementation; and Policy monitoring and evaluation) emerge from a complex actor constellation and resource interdependencies." It is important to stress that policymaking is not linear process. Therefore, policy network is seen as a linkage between broad social structures of the state and other elements of social coalitions in the state, such as the private sector and other civil society organizations.

The strength of the policy network theory is the fact that almost all of its definitions involve a number of similar components, which serve as the points of theoretical and conceptual consensus upon which this study builds. These components are: multiple actors or agencies; multiple sectors (at times); multiple levels (at times) and, a recognition that everybody is participating for their own reasons. As Lawrence O'Toole aptly puts it, "[t]he image of the 'policy implementation network' can be used to convey the idea of a highly differentiated and complex array of public and private organizations that are involved in the translation of the policy intentions … into appropriate measures or actions for the realization of these objectives at the 'level of the consumer' (1988, p.139)." Policy network is therefore composed of the linkages between interdependent organizational actors.

In the past, African countries have had a series of externally driven and unsuccessful technological interventions in education. [3] The NEPAD e-school initiative marks the first time that African governments, the private sector, foundations, development agencies and civil society organizations have come together for a common ICT project in education, developed and driven by Africans and for Africa (Chasia, 2004). Thus, the NEPAD e-school initiative represents a policy network model, which involves a multi-actor, multi-sector and semi-closed system operating on interwoven activities of entities aimed at maximizing influence and resources for the common goal of secondary education transformation in Africa. The ten-year NEPAD flagship e-schools initiative involves establishment of an Africa-wide satellite network that will connect schools to the internet, as well as to points within each country from which, educational content will be fed to the schools on a continuous basis (NEPAD Dialog, 2004). Additionally, in order to utilize ICT educational development it is crucial to train teachers and students, develop content and curriculum, and facilitate community involvement and participation in the implementation process.

The formulation and implementation structure of the NEPAD e-school project in Africa is a policy network in action. Though it requires national execution with continental coordination, the e-school initiative conveys the idea of a highly differentiated and complex array of public and private organizations, including the civil society that are involved in the translation of the policy intentions for the realization of secondary education objectives in rural and urban Africa. All the actors in the e-school implementation structures operate in both markets and hierarchies. This is a multi-actor model of ICT in education policy process where no single organization or agency commands all the needed resources. None of these actors, both at national and continental levels, have the power to autonomously determine the strategies of all the other actors or unilaterally determine the outcome of the e-school initiative. Thus, the e-school policy processes are not the implementation of *ex ante* formulated goals, rather they are more or less processes of interaction in which actors exchange information on ICTs, preferences and means of implementation, and trade-off goals and resources essential for the accomplishment of the e-school objectives in Africa. In this model, while African governments are no longer envisioned as holding superior, hegemonic positions, they are, nonetheless, viewed as being on, at least equal footing with other stakeholders in secondary education in Africa.

The NEPAD e-Schools System

The NEPAD e-schools initiative is a collective response to the challenges of secondary education in Africa by leveraging the potential of ICTs. Generally, the development and application of ICT infrastructure to educational development is considered essential to the achievement of long-term sustainable socio-economic development on the African continent. Kinyanjui (2003, p.5) defined an e-school as "a school connected to the ICT network and with a minimum set of ICT tools and teaching capabilities necessary to impart ICT skills and improve the provision of education in Africa." The objectives of the NEPAD e-schools initiative are to:

- Provide ICT skills to young Africans in primary and secondary schools to enable them function effectively in the emerging information society and knowledge economy;
- Make African students health literate;
- Provide teachers with ICT skills in order to enhance teaching and learning;
- Provide school managers in Africa with ICTs skills to facilitate efficient management and administration in schools; and
- Establish "health points" in each school in order to provide health information to students, parents, healthcare workers and the broader community (The NEPAD e-School Initiative, 2005).

The Health Point aspect of the e-school system is not necessarily part of the on-going demonstration projects hence it is given less attention in this paper. This technological intervention in education was announced on June 12 2003 at the Africa Summit of the World Economic Forum in Durban, South Africa (The NEPAD Dialog, 2004). The NEPAD's e-schools policy implementation is under the aegis of the e-Africa Commission. This is the department responsible for driving NEPAD's ICT Programs. The implementation structure of the e-school project has two broad levels: the core tasks of supervising the installation and operation of the hardware and software in the schools, deploying teachers and curriculum delivery will be managed at the national level; while the tasks of formulation, co-ordination, monitoring and evaluation of the project will be performed as a continental collaboration through the NEPAD e-Africa Commission (NEPAD, 2004).

A major aspect of the e-school system is the NEPAD e-school Satellite Network. This project is expected to provide a central and harmonized Internet connectivity for all schools in the NEPAD e-School system in Africa. In addition to connecting African schools to the Internet, the satellite network is expected to facilitate the distribution of educational contents in Africa. The satellite will be linked to major distribution content centers in each country from which educational contents will be distributed to schools (Malapile, 2006). This mechanism is expected to enrich the quality of secondary education contents in Africa, especially among those countries that are still using outdated and ineffective educational curriculum.

Delivery targets have been set to turn all African secondary schools into NEPAD e-schools within five years of the implementation start date and all African primary schools into NEPAD e-schools within 10 years of the start date. It is estimated that the 600,000 schools in rural and urban Africa (about 10 percent secondary schools) will benefit from this collaborative and technological intervention in education (Kinyanjui, 2003). The project aims to establish a steady and sustainable process in which Africans graduate from secondary schools equipped with basic and vital skills that will enable them to function effectively in the emerging information society and to contribute meaningfully to the development of their immediate society. The implementation of this technological intervention in secondary education includes the following processes:

- Installation of ICT equipment, software and infrastructure in schools;
- The training of pre-service and in-service teachers to use this technology to impart ICT skills to the students, as well as facilitate preparation and delivery of course materials in all other subjects;
- The use of ICT to develop appropriate course materials and make them available to schools and teachers;
- The establishment of an African-wide satellite network that will connect schools to the internet, as well as to points within each country from which educational content will be fed to the schools on a continuous basis (NEPAD Dialog, 2004. p. 8).

According to the outline of the e-school agenda, within five years (by the end of 2008), each youth graduating from an African high school will be ICT-literate, and within ten years (by the end of 2013), each child graduating from an African primary school will be ICT-literate (NEPAD, 2004). By these dates, it is expected that each one of these schools in the respective category would have been converted into a NEPAD e-school. The image of a NEPAD e-school is one which is connected to the NEPAD e-schools network via satellite and equipped with the necessary ICT infrastructure (computers, TV sets, radio-sets, telephones and telephone lines, fax machines, digital cameras, VCR's, scanners, photocopiers, communication terminals etc). School management and administration will also benefit from this ICT-induced system of reform in education.

The e-schools initiative is a unique project geared towards using regional and sub-regional cooperation to realize economies of scale to reduce unit cost in the acquisition of ICT capabilities for secondary education improvement in Africa. As the World Bank (2001) points out, expanding educational access through educational technology can reduce unit cost through economies of scale that require large target audiences. This is rarely available within national boundaries of sub-Saharan African countries. The implication is that using ICTs to effectively change the landscape of educational provision and access in SSA is beyond the unilateral effort of national governments. This underscores the imperative of collaborative partnerships in this untested water of socio-economic development. This is one way of ensuring ownership and financial sustainability of such projects.

The e-School Pilot Projects

The implementation of ICT in education policy under NEPAD is organized in phases, starting with pilot or demonstration projects. The e-schools demonstration (e-schools demo) projects are critical initial steps for the implementation of the e-Schools Project. Phased implementation of the e-school initiative ensures that the implementation process is manageable and the development of best practices and lessons learned is gradual. It also provides opportunities for evaluations, so that the policy can be revised and fine-tuned through the feed-back process. In general, the demo projects aim to accrue empirical knowledge about the implementation of ICT in schools across Africa. The acquired body of knowledge from the demo will serve as a forerunner to a full scale and extended rollout of the broader e-schools initiative (NEPAD Dialog, 2004). Thus, the dynamic concept of the e-schools demo project involves the notion of a learning community in which the various stakeholders are both learners and contributors to the education reform process through ICTs. This will provide a good basis for the successful implementation of ICT in education policy in the region. Through formative and summative evaluations of lessons from the e-school demo projects, the best practices and lessons learned can be integrated in the ICT in education policy in Africa.

The demo projects, which started in July 2005, are expected to establish a total of 96 secondary e-schools in 16 countries (six schools in each of the participating countries will initially benefit from the e-schools demo). The demo project is expected to directly impact approximately 150,000 African learners and teachers in the participating countries (NEPAD, 2004). The following 16 countries are participating in the demo project: Algeria, Burkina Faso, Cameroon, Egypt, Gabon, Ghana, Kenya, Lesotho, Mali, Mauritius, Mozambique, Nigeria, Rwanda, Senegal, South Africa and Uganda (see Table 1). The e-Schools Demo, which is designed to run for 12 months, will be monitored and evaluated by the Commonwealth of Learning and the INFODEV program of the World Bank. The e-school demonstration projects in each country are under the sponsorship of private partners for a period of 12 months (NEPAD Communications and Outreach & The MMI Group, 2005). Among other things, the e-school demo projects are expected to provide a platform for:

- Determining typical e-school scenarios and requirements in various circumstances in Africa;
- Highlighting the challenges inherent in the large-scale implementation of e-school programs;
- Monitoring the effectiveness of multi-country, multi-stakeholder partnership;
- Determining ‘best practice’ and working models for the large-scale implementation of e-school;
- Demonstrating the benefits of the envisaged satellite-based network; and
- Demonstrating the benefits of ICTs in African schools (NEPAD, Dialog, 2004).

Demonstration schools in the first phase of the NEPAD e-school implementation process will serve as models for ICT integration. These schools could encourage the staff to share their experiences and expertise with staff from other schools, or they could post their teachers to other schools that wish to start ICT integration. Alternatively, staff from other schools could be attached to these demonstration schools to observe best practices and immerse themselves in a culture that supports ICT integration during the second phase of the implementation process. The e-school demo projects have also benefited from the inputs of other organizations in Africa working in the field of educational technology. The e-Africa Commission consulted with organizations, such as the Mindset Network organization and the Khanya Educational technology Project, which have been involved in technology-enhanced education projects in South Africa for many years. Schools selected for the e-school demo projects provide a reasonable representation of the spectrum of African secondary school environment. The schools are required to comprise a mixture of rural and urban schools with differences in demography and infrastructural provision (Chetty, 2005). Therefore, ministries and departments of education in different countries participating in the e-schools demo projects are required to provide the basic infrastructural amenities, such as good roads, classrooms and electricity for rural and remote schools selected for the e-school demo project.

Prospects of the e-School Collaborative Initiatives

Realizing the lofty objectives of the NEPAD e-school initiative is based on the implementation structure established by the e-Africa Commission. This implementation structure requires national execution with close continental coordination. With the collaboration of major private sector partners, national governments will oversee the core tasks of: installing hardware and software in schools; providing supportive infrastructures; and deploying and training teachers for ICT integration. On the other hand, the continental tasks of formulation, coordination, monitoring and evaluation will be handled by the NEPAD e-Africa Commission (NEPAD, 2001). To ensure proper implementation, a National Implementation Agency (NIA) would be established in each of the participating countries. The NIA would have representation from the key players in the e-schools project, including government, private sector, development agency and CSO (civil society organizations) representatives. The e-schools national implementation entity will oversee the provision of infrastructure, content and teacher training and deployment. The national implementation entities have independent governing bodies with strong links with the government of the country (NEPAD, 2001).

To implement the NEPAD ICT program, under which the e-school initiative falls, the e-Africa Commission created a partnership known as Information Society Partnership for Africa's development (ISPAD). Many private sector entities operating in Africa, especially those in the field of ICT are partners in ISPAD and many e-school ventures. The private sector partners are grouped in consortiums for the NEPAD e-schools demonstration program in the participating countries (See Table 1). In line with this arrangement, two ISPAD-led consortiums are assigned to each participating country. Each consortium is responsible for three schools in its country of operation. The details of the allocation of consortiums for the e-school project to the participating African countries are provided in Table 1. Among of the participating private sector groups are: HP, Microsoft Corporation, AMD, Oracle Corporation South Africa, Cisco Systems, SAP and Intelsat. Others corporations participating in the initiative are Sentech, Grintek Telecom and ZTE Corporation Africa (Chetty, 2005). The multilateral and strategic method of project implementation has a number of advantages. These include among others, cost reduction, shared learning, access to expertise, standardization, resource mobilization and enhancement of political goodwill and support (NEPAD Communications and Outreach & The MMI Group, 2005).

Generally, the NEPAD e-Schools system has three levels of operation, namely: regional, national and the school level. According to the NEPAD Communications and Outreach & The MMI Group (2005), each participating country appoints a member of the national implementation team as the country's liaison person on e-schools project management and implementation activities. Each participating country is expected to sign the NEPAD e-school Memorandum of Understanding (MOU) with the NEPAD e-Africa Commission, the private sector members of ISPAD-led consortiums. In other words, the partnership model set up by the NEPAD e-schools project at continental level is also replicated at the country level. Such direct involvement of governments creates not only a sense of project ownership, but also the vital obligation of sustaining the e-school project in Africa. One of the envisaged advantages of the NEPAD e-Schools system is economics of scale. Through the e-Africa Commission, the e-school network will negotiate and access satellite Network and associated solutions as a group. This harmonized approach is intended to reduce the cost of the internet connectivity, digital content development and airtime to African schools by bulk purchasing of satellite capacity and by providing efficient management of satellite bandwidth (NEPAD, 2005; Farrell, 2006). This approach would promote resource sharing to overcome shortages currently experienced in many African states.

Table 1: *Assignment of Consortia to Countries and schools*

Country	School	Consortia
Algeria	Lycée Draa Mohamed Sadek	HP &Cisco
	Lycée Abdelhak Benhamouda	
	Lycée Bouchoucha	
	Lycée Cité Olympique	
	Lycée Abderrahmanr Ben Ouf	
	Lycée Ben Sahnoun El Rachedi	
Burkina Faso	Lycée Provincial de Ziniare (Launch School)	HP
	Lycée Yadega	
	Collége d'Enseignement Général (CEG) de Pobe Mangao	
	Lycée Untaani	AMD
	Lycée Provincial de Boulsa	
	Collége d'enseignement général de Komtoega	
Cameroon	Government High School, Buea - Bokwango	Microsoft
	Government High School, Mvengue	
	Lycee Classique d'Edea	
	Lycee Technique de Bamenda	AMD
	Government Bilingual Secondary School, Bafia	
	Government Secondary School, Mbansan (Launch School)	
Egypt	Iben senai secondary (Launch School)	HP
	Rafah Secondary School	
	Moubarak Secondary	
	Al Sadat	Oracle
	Arafaat Ahmed Mostafa	
	Alkhrga Secondary	
Gabon	CES Lucien NKOUNA-Bongoville (Launch School)	AMD
	CES Edouard MOSSOT-Moabi	
	Lycée Paul Marie YEMBI NDENDE	
	CES André Gustave ANGUILE	Oracle
	Lycée Richard NGUEMA BEKALE	
	CES Mouapa BEOTSA	
Ghana	Acherensua Secondary school	Oracle
	Ola Girls Secondary School (Launch School)	
	Akomadan Secondary School	
	Walewale Secondary School	Cisco
	St Augustine's Secondary School	
	Wa Secondary School	
Kenya	Mumbi Girls secondary	Oracle
	Menengai Mixed secondary	
	Isiolo Girls Secondary School (Launch School)	
	Maranda High school	Microsoft
	Chavakali High School	
	Wajir Girls secondary	

Country	School	Consortia
Lesotho	Lesotho High School (Launch School)	Oracle
	Bereng High School	
	St. Cyprian's High School	
	Sechaba High School	Microsoft
	Qacha's Nek High School	
	Sefikeng High School	
Mali	Lycée Fodie Maguiraga	AMD
	Lycée Bocar Cisse	
	Lycée Alfred Garcon	
	Lycée Mamadou Sarr	Cisco
	Lycée Attaher Ag Illy	
	Lycée Dowele Mariko	
Mauritius	Belle Rose State Secondary School	Oracle & Cisco
	Mon Lubin College	
	MEDCO (Cassis) Secondary School	
	Rose Belle High School	
	Windsor College	
	Ambassador College	
Mozambique	Escola Secundaria deEmilia Dausse	Microsoft
	Escola Secundaria de Angoche (Launch School)	
	Escola Secundaria de Cuamba	
	Escola Secundaria de Vilanculos	HP
	Escola Secundaria Joaquim Chissano	
	Escola Secundaria de Gurué	
Nigeria	Federal Government Academy Suleja (Launch School)	Microsoft
	Federal Government Girls College Bakori	
	Federal Government Girls College Owerri	
	Federal Science & Technical College Uyo	HP
	Federal Science & Technical College Lassa	
	Federal Government College Odogbolu	
Rwanda	Collège ST André (Launch School)	Cisco
	G.S. Muhura	
	Lycee de Zaza (in Kibungo-Zaza-Ruhembe)	
	Collège Christ-Rois de Nyanza (in Nyanza-Mugozi)	Microsoft
	Ecole Secondaire St Francois de Shangi	
	ESSA-Gisenyi	
Senegal	Lycée DE NIAKHAR (Launch School)	Microsoft
	Lycée WAOUNDE NDIAYE	
	Lycée DE DAHRA	
	Lycée DE BARGNY	AMD
	Lycée IBOU DIALLO	
	Lycée ALINE SITOE DIATTA	
South Africa	LG Holele High School	HP
	Lomahasha Secondary School	
	Maripe Secondary School (Launch School)	
	Isiphosethu High School	Oracle & Cisco
	Jamangile Secondary School	
	Ipetleng Secondary School	

Uganda	Bugulumbya Secondary School (Launch School)	HP
	Kabale Secondary School	
	Masaka Secondary School	
	Kyambogo College School	AMD
	Bukuya Secondary School	
	St. Andrew Kaggwa Senior Secondary School, Kasaala	

Source: Farrell, 2006 (pp. 43-45)

Challenges of the e-School Initiatives

Both the collaborative partnership and technological intervention of the NEPAD e-schools initiative are innovative approaches to education development in Africa. The collaboration is a good contractual framework for the support of secondary education in Africa. However, there are major obstacles that can hinder or delay the accomplishment of the e-school objectives in Africa. It must me added that some of these initial delays and start-up challenges are expected due to the fact that e-school project is a new and innovative reform approach in secondary education system in Africa. Hence, given the scale of the project couple with the variety of stakeholders, one should not expect a hundred percent hitch-free take-off and implementation activities especially within the context of developing countries in Africa.

Akinsanmi (2005) warns that unplanned introduction and application of ICT in education "without a sustainable model that includes ownership by beneficiaries can intensify existing inequalities in society, and reinforce an internal chasm separating the "haves" and "have-nots" in the society" (p.32). Similarly, sustainable approaches that have been tested and implemented in the advanced countries cannot serve as benchmarks for African countries (Akinsanmi, 2005). In reality, there is little guidance available for policy makers and interested corporate and civil society groups currently partnering or contemplating forming partnerships for the implementation of ICTs in education policies in SSA. Despite this gap in knowledge, many countries in SSA are embarking on this new field of largely untested grounds. To avoid past mistakes made by some African countries in educational technology, [4] more has to be known about the innovative strategies essential for a successful implementation of ICT in education policy by collaborative groups.

Despite the willingness of African countries to participate in the project, the expectations of African government, especially in regard to the sustainability of the project have not been well clarified. As the First Interim Report of the NEPAD e-Schools Demonstration Project (Farrell, 2006) highlights, many countries involved in the e-school project are in the process of developing national ICT in education policies while many do not have such policy framework. Ideally, the formulation of a policy framework in the area of ICT in education should be a good starting point in each participating country. A policy framework with a clearly defined roles and functions should guide ICT in education implementation activities beginning from the departments and ministries of education to the participating schools. The clarification of the role of governments, funding mechanism particularly before, during and after the pilot phase is crucial in order to sustain and realize the objectives of the e-schools initiative. The variations in the processes of demo projects suggest that many countries do not have a good understanding of the e-school project (Farrell, 2006).

The lack of clarity and failure to adequately explain the e-school project to participating African countries are attributable to some leadership gaps on the part of the e-Africa Commission. As the First Interim Report observes, the leadership of the e-school project from the e-Africa Commission "has been uneven" (*ibid,* p.31). Though the Commission has been effective in handling some difficult areas, however, it has been generally criticized for not meeting its responsibilities after launching the e-school projects in different countries, and for leaving too much of the implementation activities on the ground to the consortia (*ibid*). Thus the application of different implementation processes and timeline by the various consortia without a specific guideline from the e-Africa Commission, has in effect, caused significant differences in implementation strategies and unrealistic timelines for the Demo timelines (*ibid*).

Again, there is the need for NEPAD e-Africa Commission to emphasize the fact that the e-school initiative is for the purpose of supporting the business of secondary education in Africa and not a technology project. Thus, the e-schools project is in the first instance an educational project, and only in the second instance a technology project. This clarification is important for two reasons. First, there is a dangerous assumption among many policy makers in Africa that ICT will solve many educational problems facing countries in the region. As Butcher (2003) rightly observed, ICT is not a panacea to the various problems facing secondary education in Africa. A study on the use of ICTs in schools in OECD countries shows that “ICT rarely acts as a catalyst by itself for schooling change, yet can be a powerful lever for realizing planned educational innovations” (Venezky & Davis, 2002, p.13 cited in Butcher, 2003. p.76-77). Second, the e-schools project should not be seen as a way of creating market opportunities for corporate entities operating in Africa. Various studies show that effective and sustainable integration of technology in education is financially intensive (Hawkins, 2002). It is obvious that African countries cannot implement ICT in education projects alone due to high investment cost; hence partnership with the private sector is indispensable. However, foreseeable source of the problem is in the area of business interest among private sector partners and investors in the e-school initiative. It is always very challenging to pursue private investment interest and maintain open standards and platforms that are accessible to the different countries involved. This must be handled very carefully. Undue pressures by the private sector to ensure early return on their investments in the projects will only make the entire scheme another white elephant project in Africa. Such pressure for short-term investment return and financial benefits will jeopardize the chances of accomplishing the primary objectives underlying the projects. It is therefore important to emphasize from the onset that the e-schools initiative is a long-term collaborative project and financial returns to such ventures often require longer term perspectives. The appreciation of the reality among partners implicit in the e-schools project contractual obligations will go a long way to ensure its sustainability.

Conceptually, there is a broad misunderstanding of the true meaning of "ICT" among many policy makers in Africa. Many technology policy makers tend to interpret the "C" in ICT as "computers," hence there is a lack of multiple conception of ICT and a focus on computers for educational enhancement in African schools. In reality, ICT is not limited to computers or satellite and internet technologies. In addition, traditional media technologies such as radio, cassette and television are also part of ICT because they all have to do with "information" and "communication" and they are all tested educational technologies. The role of such traditional media in education, especially in sub-Saharan Africa, is underscored by the high cost of computer technologies for educational purposes in such countries. Mutula (2003, p. 3) argues that, “multiple technologies should be allowed to compete so that the most cost effective [ones] can be chosen.” This conception of educational technology is reinforced by the observation made by the former Education Minister of South Africa, Kader Asmal, when he said, “We should be reminded that ICT connectivity is not about how many computers are in schools, but how teachers and learners use various technologies to achieve educational goals and improve their teaching and learning experiences” (Ministry of Education, South Africa, 2003 cited in Parrott, 2003).

Many of these challenges are intertwined with the overall developmental problems in Africa. One of the major challenges to the e-school initiative is the overwhelming control of the telecommunication system by the African governments. For political reasons (Mbarika, 2002), many governments in Africa control and regulate the telecommunication industry, thereby discouraging free enterprise competition and the associated benefits. The lack of competition and participation by the private sector in the telecommunication industry has given way to inefficiency, high cost of service and redundancy in the telecommunication sector in many African countries. This is one of the major contributing factors of low teledensity[5] in the region. The growth telephone fixed (land) lines used in the measurement of Teledensity, remain slow. See figure 1.

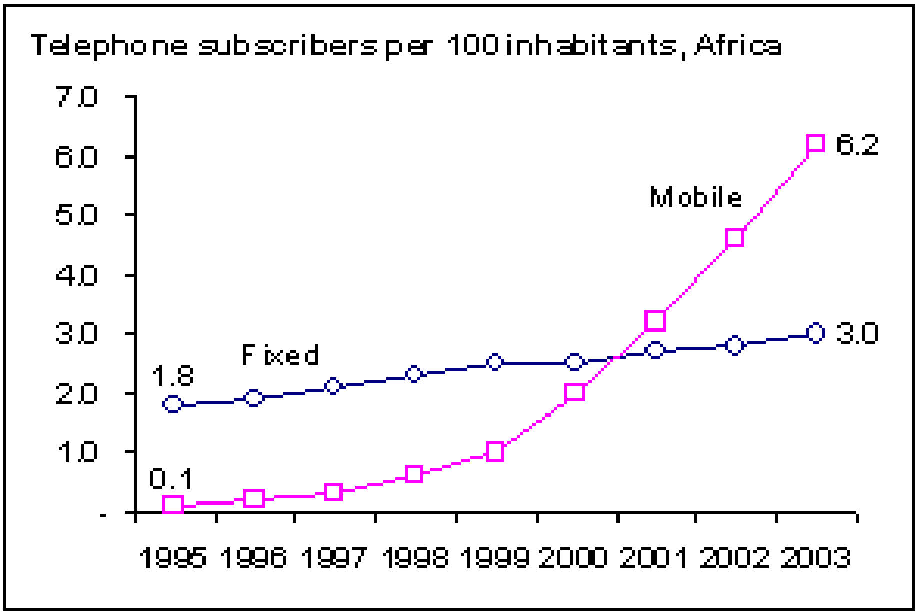

Figure 1: *Growth of Mobile phones in Africa compared to fixed lines*
Source: South African Institute of Distant Education (2005)

The recent boom in the growth and development of the telecommunication sector in many countries around the world, such as internet connectivity, the use of and the diffusion of mobile phone technology are associated with the involvement of the private sector. The liberalization of the telecommunication sector and the participation of the private sector will ensure healthy competition, which will improve the quality of service provision and of course reduce the cost of telephone lines and internet hosts[6] in African countries. Fortunately, many countries in sub-Saharan Africa have begun the process of liberalizing and privatizing their telecommunications sectors (Mutula, 2003). It is expected that this will eventually reduce tariffs and bring down cost in such countries. The above factors will not only improve teledensity in Africa, but also enhance the application of ICTs for the improvement of secondary education in the region.

Moreover, much of Africa lacks the power and telecommunication infrastructure to realize the potential of the modern ICTs (World Bank, 2001). As the Canadian-based International Development Research Center (IDRC) notes, the over-dependence of African countries on foreign technicians and consultants for the maintenance of telecommunication infrastructures and the development and enactment of key telecommunication guidelines, remains a major challenge to the application of ICTs in education in the region (IDRC, 1990 cited in Mbarika, 2002). Such dependence on foreign technicians has stifled the development and utilization of local know-how and expertise in the field of telecommunication and information technology. Furthermore, the reliance on foreign input has negatively affected recent ICT policies in many countries. In some occasions, such policies have been structured to benefit external interest and not the development needs of the country. Therefore, the long-term sustainability of initiatives like the e-schools project will remain questionable until African countries can demonstrate their ability to locally produce and maintain the technological software and hardware needed. Thus, there is the urgency for the training and development of indigenous skills and capacities in various African countries to service the emerging ICT sector in the region.

The expansion of basic services and the development of sustainable infrastructure are key challenges of the e-school project in Africa. Basic infrastructures are critical for successful implementation of the NEPAD e-school strategy. Technical and basic infrastructures, coupled with sustaining schemas, make up structures that will empower or constrain the application of ICT in secondary education in Africa. Infrastructure requirements are costly and involve various stakeholders, particularly the governments of African states. Adequate provision of infrastructure, particularly electricity to schools in rural communities is crucial in the realization of the fundamental objectives of the e-school project. African countries need to commit themselves to innovative rural electrification projects to benefit both rural schools and communities. This can be more innovative with the application of a solar energy system for electric power in communities that are far removed from urban centers.

Another issue of concern is the excessive bureaucracy that characterizes African governments and policy implementation. This makes one to ask how fast the e-school strategies can be put in place to realize the fundamental objective of educating African youths at the ripe age for secondary education and practical training. Generations have come and passed without secondary education and another generation is about to miss this life time opportunity as plans are underway. There is a clear indication that excessive bureaucracy is a setback for policy implementation in Africa. While governmental processes should take their due course, efforts should be made by African governments to cut down on unnecessary and time-wasting bureaucratic processes that can lead to delays of e-school projects, technology roll-outs, and proactive management of the entire project.

Finally, there is also the question of school and community buy-in in the NEPAD e-school projects in different African countries. Although not by design, the e-school initiatives seem to have overlooked the role that schools and communities can play in the sustainability of their e-school projects. Technological and financial resources are not the only vital resources for the success of ICT in education. The involvement of schools and local communities from the planning stage is crucial to success of the project. Thus, the role of the community may be particularly helpful in ensuring the safety and security of ICT infrastructures installed in local secondary schools. Experience shows that local schools where ICT hardware such computers and satellite receivers are installed, are targets of thieves and hoodlums. As stakeholders in the e-school project, the watchful eye of community groups can prevent such thefts. To a large extent, rural and urban communities in Africa will be pleased to be part of such initiative.

CONCLUSIONS

The NEPAD e-school initiative uses policy network framework to harness the potential of ICTs to improve, enrich and expand access to secondary education in Africa. The goal of The NEPAD e-school project is idealistic, however, it remains to be seen how realistic the means to accomplish such goals are. The project has the potential of uplifting secondary education in Africa from its present sordid state, if implemented well. However, the project cannot accomplish its objectives in isolation. The e-school project stands a better chance of succeeding when implemented as a complement to large scale secondary education reform by African governments. The system of the e-school project is not necessarily new in Africa. The NEPAD e-school initiative is only new in terms of its scale and *modus operandi*. Prior to the inception of the NEPAD e-schools project, public-private partnerships have delivered educational curriculum to secondary schools through

ICTs. For example, the Mindset Network Organization and the Khanya Educational Technology Project are two examples of collaborative initiatives in South Africa. Both initiatives employ different forms of ICTs for curriculum improvement and delivery. Therefore, the e-Africa Commission and the various consortia can learn from the existing strategies of these pioneer organizations on how to successfully implement e-learning activities in Africa.

Due to the cost of investment, an effective and sustained technology intervention in secondary education cannot be unilaterally implemented by African governments, hence the need for multi-sectoral collaboration. The development strategy of collaborative partnership on which the initiative is launched has been tested as a rewarding method of development delivery in parts of Africa. Thus, the success or failure of the e-school project is primarily anchored on the resolve of the partner members, especially African governments, than the private sector partners. The ideals of the e-school project can be realized with political goodwill and support of African countries. This will not only ensure the sustainability of a new paradigm of education delivery, but also add value to secondary education system in Africa.

Endnotes

[1] GER2 is the number of children enrolled divided by the number of children of school-going age. Niger, Burkina Faso, , Tanzania, Burundi, Chad, the Central African Republic, Mozambique, Madagascar, and Rwanda stand, out as having the lowest GER2s, while Mali, Uganda, the DRC, Ethiopia, Angola and Senegal are in the next lowest group (Lewin, 2004).

[2] The GER2 is 53 percent in South Asia; 65 percent in East Asia and the Pacific; 60 percent in Arab and North African countries; and 82 in Latin America and the Caribbean (Lewin, 2004)

[3] In the 1970s and mid-1980s many African countries like Malawi, Zambia, Zimbabwe and Côte d'Ivoire mounted several unsuccessful educational technology projects aimed at expanding secondary education opportunities (Kaye, 1976; Paretton & Creed 2000).

[4] In the 1970s and mid-1980s many African countries like Malawi, Zambia, Zimbabwe and Côte d'Ivoire mounted several unsuccessful educational technology projects aimed at expanding secondary education opportunities (Kaye, 1976; Perraton & Creed 2000).

[5] Teledensity is the number of main telephone lines (land lines) for every one hundred inhabitants (Darkwa and Mazibuko, 2000; Mbarika, 2002)

[6] Internet host refers to number of computer in the economy that are directly hooked to the internet (Mbarika, 2002)

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Awareness, access and usage of information and communication technologies between female researchers and extensionists

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ABSTRACT

Information and communications technology (ICT) has become a very important feature in the Nigerian agricultural sector in contemporary times. Even though it is still a new concept, an increasing number of professionals are appreciating its use for development work. Female researchers and extensionists are important stakeholders in the development of agriculture in Nigeria. They are important because they are required to provide support to the female farmers who ordinarily would be more comfortable with female researchers. It is therefore pertinent that female researchers and extensionists be abreast with modern information and communication technologies so as to discharge their duties more effectively. This study examines awareness, access and utilization of ICT among female researchers and female extensionists. Data was obtained from 106 female researchers and 27 female extensionists in SouthEastern Nigeria, with the aid of a questionnaire. Information collected showed that female researchers and female extensionists are aware of ICT; both categories of respondents know how to access Internet on their own. Respondents do not have adequate access to IT. Also, 55.7 and 70.4 per cent of female researchers and female extensionists respectively used ICT for between 3 to 5 times a week. The types of ICT needed by female researchers and female extensionists include; World Wide Web, Electronic Mail, Electronic Spreadsheet, Word Processing, CD-ROM, Use of Projector, Use of computer, Web Design, Chatroom.

Key words: *Awareness, access, utilization, ICT, female researchers, female extensionists*

INTRODUCTION

Information and Communication Technology (ICT) is the scientific, technological and engineering disciplines and the management technologies used in the handling of information, processing and application related to computers. It is also concerned with the interactions with man and machines; and associated socio-economic and cultural matters (UNESCO in Osuagwu, 2001). Information Technology according to Marshall, (1984) in Madu (2000) is the coming together of computing and telecommunications for the purpose of handling information. ICT is also defined as the term used to describe the tools and processes to access, retrieve, store, organize, manipulate, produce, present and exchange information by electronic and other automated means. These include hardware, software and telecommunications in the forms of personal computers, scanners, digital cameras, handhelds/PDAs, phones, faxes, modems, CD and DVD players and recorders, digitalized video, radio and TV and programs like database systems and multimedia applications (http://www.unescobkk.org/index.php?id=1013. The bottom-line is that information technology is all applications that are computer-based for the purpose of sharing ideas, data, and other relevant information for the improvement of the statusquo. According to CTA (2003) Information and Communication Technologies are technologies which facilitate communication and thus the processing and transmission of information electronically. The use of

ICT in agricultural extension and rural development is significant especially now that its use has witnessed an upsurge in almost all areas of rural life in several African countries where it has provided a medium to adequate access to agricultural information, despite the persisting problems of access, connectivity, literacy, content and costs (CTA, 2003). In this respect, Omotayo (2005) observed that agricultural extension depends largely on information exchange between and among farmers and a broad range of other actors. Frontline extension workers who are the direct link between farmers and other actors in the agricultural knowledge and information system (AKIS), are well positioned to make use of ICT to access expert knowledge or other types of information that could facilitate the accomplishment of their routine activities.

Modern agricultural extension system encourages the development of positive attitude in the scientists to appreciate the knowledge, experience and capacities of the local people in the research development process (Amalu, 1998). ICT (ICT) is a means to this end. ICT as an extension tool will enhance flow of information in the application of agricultural extension services Arokoyo (2005) reported that to date, the radio and television have been the major ICTs used in agricultural extension delivery in Nigeria. Despite the importance of these channels, they are principally owned and controlled by government. This means that only programmes that are government-owned and government-based are featured. The information content of these channels is more provider-driven than user-driven and this has serious implications for extension delivery.

Although most of the organizations in the National Agricultural Research and Extension System (NARES) now have computers for information and data management, most of the computers have neither telephone nor internet access. (Arokoyo, 2005). Consequently, a substantial number of research institutes and Extension organizations have no Email contacts.

If modern ICT facilities are not adequately built into the mainstream of Nigerian agricultural system, there is likely to be stagnation in the dissemination, utilization and application of scientific agricultural information for purposeful development of the system. Meera et al (2004) had noted that as a result of the emerging new paradigm of agricultural development, old ways of delivering important services to citizens are being challenged; traditional societies are also being transformed into knowledge societies all over the world. ICT has been a tool for achieving meaningful societal transformation. This transformation is a function of reliable agricultural research network. A network is a group of individuals or institutions linked together because of commitment to collaborate in solving a common agricultural problem(s) and to use existing resources more effectively. The use of computers enhance research network in various ways which are facilitated through communication technologies like electronic mail, electronic conferencing, etc. Through these means scientists, administrators and information personnel are provided with rapid and reliable communication while increasing productivity and decreasing communication costs by reducing the physical means of communication channels (Kerrigan, Lindsey and Novak, 1994).

The use of computers by extensionists has been noted as a crucial part of extension development (Martin, et al 2001). Goode and Elliot (1992) quoted Douce (1979) and Prawl et al (1984) as insisting that for contemporary extension to provide viable educational programmes and opportunities to expanded audiences, the use of new electronic technology, including computers is inevitable. Elliot (1985) classified extension applications of computers into two general categories to include office management uses and educational uses. The educational uses take care of clientele services which is a prerogative of agricultural extension delivery. Astroth (1990) advised that we need to adopt technologies that will enhance our delivery system. According to him, at a minimum we need administrators who will foster on institutional culture with a strong commitment to advanced communications technology. Female professionals fit this description.

Over the years the importance of females to the development of agriculture has been emphasized. They are major stakeholders in food security provision. But in the very conservative settings it is difficult for extension service delivery to reach these women. However, it is only when the female scientists are aware of, have access to, and can use modern ICTs that they can effectively discharge their communication functions. This is because females are almost always not available to reach them because they can empathize more with them. This study therefore examines the level of awareness, access and utilization of ICT among female researchers and extensionists. These two categories of professionals are concerned with agricultural information that will eventually be utilized by relevant clienteles in the long run. The study also determined the types of ICTs needed by respondents for their work.

METHODOLOGY

The study area is South-eastern Nigeria which is made up of five States namely Imo, Abia, Enugu, Ebonyi, Anambra States. Two States namely Abia and Imo were randomly selected for the study. Five organizations were used as sampling frame; Agricultural Development Programmes (ADPs), Universities, colleges of Agriculture, Non Governmental Organizations and research institutes. For the purpose of this study, respondents from the ADPs and NGOs were categorized as extensionists because their mandate borders more on facilitating change to farmers, while respondents from Universities, Research institutes and Colleges of Agriculture/Technology were categorized as researchers because research activities are more pronounced than extension services.

In Imo State, out of 107 respondents identified, 74 were randomly selected made up of 59 researchers, (which cut across Federal University of Technology (33), Imo State University (14), Michael Okpara College of Agriculture and Technology (9), Nigeria Institute of Horticulture(3); and 15 extensionists which cut across the Agricultural Development Programmes (9) and two Non-Governmental Organizations (6). In Abia State, out of 91 respondents identified, 65 were randomly selected made up of 47 researchers, (which cut across Michael Okpara University of Agriculture (20), Abia State University (12), Forestry Research Institute (5), National Root Crops Research Institute(10); and 18 extensionists, (which cut across the Agricultural Development Programme (12) and Non Government Organization (6). In all, 139 respondents were identified with the help of senior extension personnel, heads of units and a list of respondents generated from where the sample was drawn and used for the study, but data was available for 133 respondents made up of 106 researchers and 27 extensionists.

Data collection and analysis

The instrument for data collection was a questionnaire which elicited information on personal characteristics of respondents, awareness, access and utilization of ICT and types of ICT needed. The study lasted for 5 months from May to September. The Statistical Package for the Social Sciences (SPSS version 11) was the computer software used for data analysis. The statistical tools used for the study include; frequencies, percentages, means

RESULTS AND DISCUSSION

Personal characteristics of female researchers and female extensionists

Table 1: *Personal characteristics of respondents*

Variables	Female Researchers	Female Extensionists
Marital Status	**(n = 106)**	**(n=27)**
Single	28(26.4)	8(29.6)
Married	78 (73.6)	19(70.4)
Age		
29-34	15(14.2)	27(100.0)
35-40	62 (58.5)	-
41-47	29(27.4)	-
Working experience		
3-8	94(88.7)	27(100.00)
9-13	12(11.3)	-
Academic qualification		
HND/BSC	-	11(40.7)
MSc	95(89.6)	16(57.3)
PhD	11(10.4)S	-
Category		
Educational	54(50.9)	10(37.0)
ADP	2.3(21.7)	11(41.0)
Research Institution	21(19.8)	3(11.0)
Non Governmental Organization	8(7.5)	3(11.0)
Hours spent on ICT (weekly)		
0 - 4	59 (55.7)	8 (29.6)
5 - 8	47 (44.3)	19 (70.3)
ICT skill rating		
0-1	66(62.3)	-
2-3	40(37.7)	27(100.0)
Length of Exposure to ICT (years)		
2-5	73(68.9)	19(70.4)
6-9	16(15.1)	8(29.6)
9-11	17(16.0)	-
Distance of ICT facility from office (km)		
0 -11.5	20 (18.9)	11 (41.0)
12 - 23	86 (81.1)	16 (59.0)

Source: Field Survey data, 2005

Table 1 shows that 73.6 percent of the female researchers are married while 70.4 percent of the female extensionists are married. The findings showed that 58.5 percent of the female researchers are between 35 and 40 years old, with mean age of 38 years while 100% of the female extensionists are between 29 and 34 years old, with mean age of 31 years old. It is obvious that female researchers were relatively older than female extensionists. The study also reveals that 88.7 percent of the female researchers reported that they have work experience of between 3 and 8 years, with average working experience of 6 years, while 100 percent of the female extensionists reported work experience of between 3 and 8 years, with mean work experience of 4 years suggesting that female researchers had relatively higher working experience than female extensionists. Findings further showed 89.6 percent of the female researchers had MSc as highest academic qualification, while 57.3 percent of the female extensionists reported having MSc. The findings revealed that 50.9 percent of female researchers belong to educational institutions (universities, colleges of Agriculture/Technology, and Research Institutes). However, 41 percent of the female extensionists belong to the Agricultural Development Programmes (ADP). The ADP is the major organ of agricultural extension in Nigeria, while some rural development NGOs also carry out extension work.

In order to determine if respondents were skilled in the use of ICT, they were requested to rate their skills themselves. Among the female researchers, information technology self-rating of between 0 and 1, with mean rating of 1.49, while ICT rating of female extensionists was between 2 and 3, with mean rating of 2.29. The implication of this finding is that female extensionists had higher mean ICT skill rating than female researchers. Female extensionists have been more receptive to ICT suggesting a moderate level of ICT skills.

Gregg and Irani (2004) reported average self-rating of ICT skills among Extension agents. This present study reveals that 68.9 percent and 70.4 percent of female researchers and female extensionists respectively have been exposed to ICT for between 2 and 5 years with mean years of exposure of 4.5 years. It is pertinent to note that ICT made significant entry into Nigeria around Year 2000. This obviously could have accounted to the few years of exposure. The findings of the study showed that 81 percent of female researchers and 59 percent of female extensionists travel for between 12 and 23 km to use ICT facility far away from their respective offices because their office computers are not connected to the Internet. This shows that female researchers and female extensionists obtain ICT services from Public cybercafés. Omotayo (2005) stated that Public cybercafés offer value-added services and are key instruments in telecommunication policy. Public cybercafes are common features in the study area hence respondents utilize the services easily.

Respondents' awareness, access and utilization of ICT

About 84 percent of the female researchers indicated that they are aware of ICT while 88.5 percent of female extensionists indicated that they were aware of ICT suggesting that a relatively higher percentage of female extensionists are aware of ICT. Also, about 82 percent of the female researchers indicated that they know how to access Internet on their own while 74.1 percent of female extensionists indicated that they know how to access Internet on their own. Whereas 71.7 percent of the female researchers indicated that they do not have adequate access to ICT, 59.3 percent of the female extensionists indicated that they have adequate access. The findings which showed that female researchers do not have adequate access to Information Technology is a clear indication of the dearth of computer and computer related facilities in their work environment. This is further compounded by inadequate seminars and workshops on the use of Information Technology as attested to by respondents.

The findings of the study showed that 60.4 percent and 59.3 percent of the female researchers and female extensionists respectively have no Personal Computers in their offices. Those who indicated that they have Personal Computers in their offices stated that they were not connected to the Internet. This is a serious situation that shows that there is still a lot to be done if the Nigerian agricultural sector must meet up the global challenges of ICT. When asked to indicate how frequent they used information technology in a week, 55.7 per cent and 70.4 per cent of female researchers and female extensionists respectively indicated 3 to 5 times a week. As expected female extensionists recorded a higher percentage compared to female researchers.

Table 2: *Awareness, access and utilization of ICT between female researchers and extensionists*

	Female Researchers	Female Extensionists
Awareness Yes No	89 (84.0) 17 (16.0)	22 (88.5) 5 (18.5)
Do you know how to access Internet on your own? Yes No	87 (82.1) 19 (17.9)	20 (74.1) 7 (25.9)
Do you have adequate access to ICT? Yes No	30 (28.3) 76 (71.7)	16 (59.3) 11 (40.7)
Do you have Personal Computer in your office? Yes No	42 (32.6) 64 (60.4)	11 (40.7) 16 (59.3)
Is it connected to the Internet? Yes No	17 (16.0) 89 (84.0)	4 (14.8) 23 (85.2)
Frequency of ICT use (number of times per week) 0-2 3-5	47(44.3) 59(55.7)	8(29.6) 19(70.4)

Source: Field survey data, 2005

Types of ICTs needed by respondents

Using an open ended question, the types of ICT needed by female researchers and female extensionists were found to include; World Wide Web, Electronic mail (Email), Electronic Spreadsheet, Word Processing, CD-ROM, Use of Projector, Use of computer, Web Design, Chatroom.

Table 3: *Types of ICT needed by respondents*

World Wide Web
Electronic Mail
Electronic Spreadsheet
Word Processing
CD-ROM
Use of Projector
Use of Computer
Training on Web Design
Chatroom

Source: Field survey data, 2005

Gregg and Irani (2004) reported the use of Email, Microsoft PowerPoint, World Wide Web, Spreadsheets, Web page editing and development. There is no doubt that Information and Communication Technologies such as email, www, etc., are required for effective agricultural extension. This is because they have potentials to reach larger audience; they are also effective for training that enhances capacity building of the end-users. Their usefulness in the search and packaging of information on demand and for exploring alternative production options and technologies have been reported (Arokoyo, 2005).

Differences in hours used on ICT between female researchers and female extensionists

Table 4 shows that female researchers spent an average of 3.5 hours on ICT, while female extensionists spent an average of 4.4 hours on ICT. The result reveals that female extensionists spend relatively higher number of hours on ICT compared to female researchers.

Table 4: *Z-test analysis showing differences in hours used on ICT between female researchers* and female extensionists

Category	N	Mean	SD	df	z-value
Researchers	106	3.528	2.458	131	1.758^{NS}
Extensionists	27	4.407	1.647		

Source: Computed from survey data, 2005

The Z-test analysis showed that there is no significant difference in the number of hours spent on using ICT weekly. The implication of this finding is that female researchers and female extensionists are not spending enough time on ICT. When compared to findings of Goode and Elliot (1992) who found in their study that extension personnel spent an average of six hours each week on IT, it is easy to conclude that female researchers and female extensionists in Southeastern Nigeria still need to spend adequate time on ICT to enable them increase their skills on the tools.

Differences in the distance from office of respondents and ICT facility

Table 5 shows that female researchers indicated the distance between their office and the ICT facility is an average of 13.99 km, while female extensionists indicated an average of 12.74km.

Table 5: *Z-test analysis showing differences in distance of ICT facility from the office of researchers and extensionists*

Category	N	Mean	SD	Df	Z-value
Researchers	106	13.991	8.194	131	0.452NS
Extensionists	27	12.741	5.088		

Source: Computed from survey data, 2005

The Z-value of 0.452 shows that there is no significant difference in the distance to ICT facility between office of female researchers and female extensionists. Respondents had indicated that they have computers in their offices but these are not connected to the Internet. The long distance indicated in this study is a manifestation of frustration experienced in using ICT tools among respondents. The frustration experienced are mainly because they have to interrupt their work schedule to get to a cybercafe and also because of the poor transport network. In addition they pay for the time used in the cybercafe.

CONCLUSION

The study investigated awareness, access and utilization of ICT between female researchers and female extensionists. Female scientists are significant stakeholders in the agricultural sector. The study identified that awareness of ICT among female researchers and female extensionists is high and found that respondents know how to access the Internet but reported inadequate access to ICT. Most respondents do not have computers in their offices and for those who indicated that they have personal computers in their offices reported that they are not connected to the Internet. It was found that majority of the respondents used ICT for between 3 and 5 times a week. The study found that female researchers spent an average of 3.5 hours on ICT weekly, while female extensionists spent 4.4 hours weekly. There was no significant difference in the number of hours spent on ICT weekly between female researchers and female extensionists. Also, it was found that the distance between ICT facility and office of female researchers is approximately 14km, while for the female extensionists a distance of approximately 13km was indicated. The types of ICT needed by female researchers and female extensionists include World Wide Web (www), Electronic mail (E-mail), Electronic spreadsheet (Microsoft Excel), word processing, compact Disk Read Only memory (CD ROM). Use of projector, use of computer, training on web design, chatroom, VCD and DVD.

RECOMMENDATIONS

Based on the findings of the study the following recommendations are hereby made:
Since a dearth of computers in offices of female researchers and female extensionists was identified, the need to equip offices with personal computers and link them up with the Internet is very important. This will reduce the stress of travelling for distance of 13-14 km to utilize ICT facilities. A situation where scientists go to public cafes to use ICT tools is saddening. The use of CD ROM, chatroom and Electronic spreadsheet should be given serious consideration in ICT applications among respondents. It is disappointing that many researchers and extensionists find it difficult to use these tools. This has serious implication for scientific agriculture in Nigeria as a whole.

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Computer-based testing on physical chemistry topic: A case study

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ABSTRACT

According with national trends in the objective evaluation of undergraduate students' knowledge, an auto-calibrated online evaluation system was developed. The aim of the research was to assess the knowledge on physical chemistry topic of the undergraduate first year students' at the Faculty of Materials Science and Engineering, the Technical University of Cluj-Napoca, Romania by the use of the developed auto-calibrated system. The methodology of multiple-choice questions construction and the evaluation methodology are presented. The students performances in terms of number of correct answers and time needed to give a correct answer were collected and analyzed. The future plans of system development are highlighted.

Keywords: *Auto-calibrated online evaluation, multiple choice questions (MCQs), physical chemistry, undergraduate students*

INTRODUCTION

In universities, the cardinal premise of the end-of-course examination is to assess as objective as possible the students' knowledge and skills acquired on the courses, practical activities and seminars.

Development of communication (Valcke & De Wever 2004) and information technologies (Kidwell, Freeman, Smith & Zarcone 2004; Matusov, Hayes & Pluta 2005) provide today the opportunity of creation interactive computer-assisted environments used in many domains, including in chemistry training (Beasley 1999; Frecer, Burello & Miertus 2005; Chen, Chen & Cao 2002) and evaluation (Timmers, Baeyens, Remon & Nelis 2003; Stewart, Kirk, LaBrecque, Amar & Bruce 2006).

In many academic domains, educational measurement has been moving towards the use of computer-based testing, define as tests or assessments that are administered by computer in either stand-alone or dedicated network, or by other technology devices linked to the Internet or the World Wide Web most of them using multiple choice questions (MCQs). The computer-assisted evaluation strategies are used in medicine (Oyebola, Adewoye, Iyaniwura, Alada, Fasanmade & Raji 2000), chemistry (Ananda, Gunasingham, Hoe & Toh 1989), language testing (Brown 1997), biology (Evans, Gibbons, Shah & Griffin 2004), computer science (Barker & Britton 2005), and economics (Judge 1999).

Currently in Romania, at the Faculty of Materials Science and Engineering, the Technical University of Cluj-Napoca, the traditional method (a combination of essay examination, practical examination and/or tutor assessment) is the most frequently used as evaluation of students' knowledge. In the last years, the number of students increased and the conventional examination method become time consuming in term of the examination time as well as in term of papers assessment. Thus, the students received their final marks beyond the day of examination (the next day after examination in the best case and up to one week or more). A solution of examination in large classes of students is an automated testing system which to allow testing the students knowledge and displaying immediate on the screen the examination results.

According with national and international trends in objective undergraduate students' knowledge evaluation, and starting from the experiences obtained by creation of the multiple choice examination system for general chemistry topic (Naşcu & Jäntschi 2004a; Naşcu & Jäntschi 2004b), an auto-calibrated online evaluation environment was developed (Jäntschi & Bolboacă 2006). The aim of the research was to study students' knowledge on physical chemistry topic by the use of the developed auto-calibrated online evaluation system.

MATERIAL AND METHOD

Auto-calibrated online evaluation system

The auto-calibrated online evaluation system (Jäntschi & Bolboacă 2006) embodies:

- Multiple-choice banking. The characteristics of the MCQs and respectively of the multiple-choice banking are as follows:
    - The question anatomy: a statement or a situation, a problem (*steam*) and a list of five suggested solutions (*options*). Each question had one or up to four correct options;
    - The students enrol voluntarily in the team responsible by creation of the items banking (a team of two students was responsible for creation of MCQs from the material presented at one course or one practical activity);
    - A number of four hundred and twenty-four MCQs were included into database: 49.3% with *one correct option*, 26.9% with *two correct options*, 16.5% with *three correct options*, and 7.31% with *four correct options*;
    - Score methodology: *all-or-none rule* (one point if the correct answer is selected (for questions with one correct option) or if all the correct options (respectively two for the questions with two, three for the questions with three, and four for the question with four correct options) and none of the distracter(s) - the incorrect option(s) presented as a choice in a multiple-choice test - are selected, and zero points otherwise).
- Testing environment. The online testing environment embody:
    - A description of the testing methodology, with following specifications: the location of the examination (at the test centre); the type of the examination (computer- and teacher-assisted); the period and the time of the examination (according with the structure of academic year and with the students and teacher program);
    - A description of the test methodology witch contains the following specifications: the number of MCQs (thirty); the generation of the MCQs tests (double randomization from MCQs banking - randomization of the steam and randomization of the options order), the number of tests (as many times as the student wanted in the imposed period of time), the penalties (applied each time when a student give up to a begun test);
    - A description of the scores and of the final mark methodologies;
    - The testing environment.
- Results:
    - The results of individual tests. At the end of each test, the students' identification data, the time when the test begun and ended and the number of correct answers are displayed. There was considered that a student give a correct answer, for a question with option A and B correct, if he/she selected both options (A and B) and did not select any other option(s).

- The test results. A page that contains the test results for the whole class of students, express as the number of correct answers and the time needed to give a correct answer can be visualized. It was considered a *correct answer* if for example, for a question with three correct options all the correct options were selected and none of the two distracters.
- The auto-calibration of the final mark. The system assigned to the lower score the mark equal with 4 and to the highest score the mark equal with 10 and place each individual score between these ranges. Each time when a student gave a test, the system auto-calibrated the final marks for all students according with the distribution of individual scores of whole students'.

Assessment of students' knowledge

There were included into the study a number of forty-two students from the Faculty of Materials Science and Engineering. The familiarization of the students with the evaluation environment was possible before the examination; the students had the possibility to use the system and to evaluate themselves as many time as he/she desired, per a period of one month.

The following variables were store into database for each evaluation: the students' identification data, the data and the time when the test begin and end (according with the yy.mm.dd hh.mm.ss format), and the number of correct answer(s) (out of thirty). There were also calculated based on stored data the individual time needed to give a correct answer (express in seconds) and the average time needed to give a correct answer (this parameter took into consideration all students).

Data were analyzed with Statistica 6.0 at a significance level of 5%. The 95% confidence intervals for proportions were calculated by the use of an original method, based on the binomial distribution hypothesis (VLFS 2005).

RESULTS

The auto-calibrated online evaluation system on physical chemistry topic was created and it is available via the address: http://vl.academicdirect.org/general_chemistry/physical_chemistry/.

The access to the system is restricted (by checking the IP addresses), being available just at the imposed test location.

Each student performed at least one time the online test by the use of the auto-calibrated online evaluation system. Seventeen students out of forty-two (40.5%, 95%CI [26.25, 57.09]) were content with performances obtained at first test. The distributions of the number of tests express as relative frequency and associated 95% confidence intervals are:

- Two tests: twenty-five students' out of forty-two (59.52% [42.91, 73.75]);
- Three tests: ten students' out of forty-two (23.81% [11.96, 40.42]);
- Tour tests: five students' out of forty-two (11.90% [4.82, 26.13]);
- Five tests: two students' out of forty-two (4.76% [0.06 16.61]);
- Six and seven tests: one student out of forty-two (2.38% [0.06, 11.85]);

The intervals between first and last examination (where were applicable) varied from 1 day (minimum) to 17 days (maximum), with an average of 6 days (95%CI [3.86, 8.13]) and a median of 4 days.

Statistical characteristics associated with the number of questions at which the students gave a correct answer and the time needed to give a correct answer, according with the evaluation (1st test, 7th test), express as average (Ave), standard deviation (StDev), mode (Mode), minimum (Min) and maximum (max) are in table 1.

Table 1. *Statistical characteristics of the number of correct answers and of time needed to give a correct answer*

	Test	Average [95%CI]	StDev	Mode	Median	Min	Max
Number of correct answers	*1st*	6.40 [5.44, 7.37]	3.09	7	6	1	17
	2nd	6.60 [5.02, 8.18]	3.83	7	7	1	14
	3rd	5.80 [2.86, 8.74]	4.10	5	5	2	15
	4th	3.60 [1.03, 6.17]	2.07	N.A.	4	1	6
	5th	5.00 [-7.71, 17.71]	1.41	N.A.	5	4	6
	6th	1.00 [N.A., N.A.]	N.A.	N.A.	1	N.A.	N.A.
	7th	2.00 [N.A., N.A.]	N.A.	N.A.	2	N.A.	N.A.
Time needed to give a correct answer	*1st*	214.53 [174.46, 254.60]	128.59	N.A.	173.65	50.1	682
	2nd	182.90 [121.82, 243.98]	147.96	N.A.	125.80	44	713
	3rd	93.46 [51.89, 135.03]	58.12	N.A.	71.65	31	204.8
	4th	85.98 [-11.49, 183.45]	78.50	N.A.	52.50	28.8	216
	5th	30.35 [-104.97, 165.67]	15.06	N.A.	30.35	19.7	41
	6th	65.00 [N.A., N.A.]	N.A.	N.A.	N.A.	N.A.	N.A.
	7th	52.50 [N.A., N.A.]	N.A.	N.A.	N.A.	N.A.	N.A.

N.A. = not applicable

Seventeen students were content with the performances obtained at the first test. On this sample the statistical characteristics of the number of questions at which they give correct answers and of the time needed to give a correct answer are:

- The number of correct answers: Ave = 8.76 (95% CI [7.11, 10.42]); StDev = 3.21; Mode = 7, Min = 5; Max = 17;
- The time needed to give a correct answer: Ave = 137.96 (95% CI [102.20, 173.72]); StDev = 69.55; Median = 112.4; Min = 50.1; Max = 310.4.

The performances obtained by the students which performed the test more than one time, express as number of correct answers out of thirty (n_{ca}), and time needed to give a correct answer (t_{ca}(s), express in seconds) are in table 2 and 3.

Table 2. *Performances of the students which performed two tests*

Student id	Param	Test 1st	Test 2nd	Student id	Param	Test 1st	Test 2nd
id_01	n_{ca}	6	4	id_22	n_{ca}	4	2
	t_{ca}(s)	171.5	125.8		t_{ca}(s)	365.8	449
id_03	n_{ca}	2	7	id_24	n_{ca}	5	8
	t_{ca}(s)	682	152.7		t_{ca}(s)	195.4	112.4
id_06	n_{ca}	7	14	id_26	n_{ca}	5	12
	t_{ca}(s)	128.7	72.2		t_{ca}(s)	268	83.2
id_07	n_{ca}	4	9	id_27	n_{ca}	6	11
	t_{ca}(s)	387.8	119.4		t_{ca}(s)	134.5	70.2
id_13	n_{ca}	1	2	id_31	n_{ca}	7	14
	t_{ca}(s)	542	44		t_{ca}(s)	312.1	87
id_17	n_{ca}	3	12	id_33	n_{ca}	5	9
	t_{ca}(s)	321	100.8		t_{ca}(s)	342	100.2
id_20	n_{ca}	6	7	id_42	n_{ca}	6	7
	t_{ca}(s)	175.8	92.7		t_{ca}(s)	247.8	189.6
id_21	n_{ca}	7	8				
	t_{ca}(s)	150.7	86.4				

Param = parameters;
n_{ca} = number of correct answers
t_{ca}(s) = time needed to give a correct answer

Table 3. *Performances of the students which performed more than two tests*

Student id	Param	Test 1st	Test 2nd	Test 3rd	Test 4th	Test 5th	Test 6th	Test 7th
id_05	n_{ca}	4	2	3	N.A.	N.A.	N.A.	N.A.
	t_{ca}(s)	159.30	245.00	31.00	N.A.	N.A.	N.A.	N.A.
id_09	n_{ca}	7	7	15	N.A.	N.A.	N.A.	N.A.
	t_{ca}(s)	170.60	205.70	40.00	N.A.	N.A.	N.A.	N.A.
id_18	n_{ca}	4	3	9	N.A.	N.A.	N.A.	N.A.
	t_{ca}(s)	212.80	281.00	85.30	N.A.	N.A.	N.A.	N.A.
id_35	n_{ca}	4	5	9	N.A.	N.A.	N.A.	N.A.
	t_{ca}(s)	414.80	396.40	127.90	N.A.	N.A.	N.A.	N.A.
id_41	n_{ca}	4	4	5	N.A.	N.A.	N.A.	N.A.
	t_{ca}(s)	168.00	198.80	52.20	N.A.	N.A.	N.A.	N.A.
id_16	n_{ca}	4	4	2	4	N.A.	N.A.	N.A.
	t_{ca}(s)	285.50	125.30	58.00	28.80	N.A.	N.A.	N.A.
id_34	n_{ca}	7	5	5	5	N.A.	N.A.	N.A.
	t_{ca}(s)	225.30	212.60	204.80	30.40	N.A.	N.A.	N.A.
id_39	n_{ca}	3	5	5	6	N.A.	N.A.	N.A.
	t_{ca}(s)	223.00	167.80	167.20	102.20	N.A.	N.A.	N.A.
id_30	n_{ca}	6	3	3	2	6	N.A.	N.A.
	t_{ca}(s)	244.70	141.30	110.70	52.50	19.70	N.A.	N.A.
id_19	n_{ca}	3	1	2	1	4	1	2
	t_{ca}(s)	136.00	713.00	57.50	216.00	41.00	65.00	52.50

Param = parameters;
n_{ca} = number of correct answers;
t_{ca}(s) = time needed to give a correct answer;
N.A. = not applicable

In order to compare the number of correct answers gave by the students which performed the test more than one time, the Student test at a significance level of 5% was applied and the results are in table 4. The number of correct answers gave by the students at the evaluation tests was abbreviate as n_{ca-i} (where i = 1 for first test, …, i = 4 for the fourth test). There were analyzed four null hypotheses as follows:

1. There was not significant difference between the average of the number of correct answers give at the first test comparing with the second test in the sample of students which performed the test by two times (n_{ca-1st} & n_{ca-2nd});
2. There was not significant difference between the average of the number of correct answers give at the second test comparing with the third test in the sample of students which performed the test by three times (n_{ca-2nd} & n_{ca-3rd});
3. There was not significant difference between the average of the number of correct answers give at the third test comparing with the fourth test in the sample of students which performed the test by four times (n_{ca-2nd} & n_{ca-3rd});
4. There was not significant difference between the average of the number of correct answers give at the first test comparing with the last test in the sample of students which performed the test more than one time (n_{ca-1st} & $n_{ca-last}$).

Table 4. *Results of comparison regarding the number of average correct answers gave by students which performed more than one test*

	n_{valid}	T	p-value
n_{ca-1st} & n_{ca-2nd}	25	64.5	0.0441*
n_{ca-2nd} & n_{ca-3rd}	10	4	0.0910
n_{ca-3rd} & n_{ca-4th}	5	4	0.7150
n_{ca-1st} & $n_{ca-last}$	25	35	0.0017*

n_{ca-i} = the number of correct answers;
n_{valid} = the number of valid cases;
T = the parameter of Student test;
* p significant

The results of comparison regarding the time needed to give a correct answer applied to students which performed more than one test are in table 5 (where t_{ca-i} is the time needed to give a correct answer for evaluation i, where i = 1 (for 1st evaluation), …, 4 (for 4th evaluation)). There were analyzed three null hypotheses as follows:

1. There was not significant difference between the average time needed to give a correct answer at the first test comparing with the second test in the sample of students which performed the test by two times (t_{ca-1st} & t_{ca-2nd});
2. There was not significant difference between the average time needed to give a correct answer at the second test comparing with the third test in the sample of students which performed the test by three times (t_{ca-2nd} & t_{ca-3rd});
3. There was not significant difference between the average time needed to give a correct answer at the third test comparing with the fourth test in the sample of students which performed the test by four times (t_{ca-3rd} & t_{ca-4th});

***Table 5.** Results of comparison regarding the time needed to give a correct answer on sample of students which performed more than one test*

	t_{ca}	Mean	StdDev	n_{valid}	t
$t_{ca\text{-}1st}$ & $t_{ca\text{-}2nd}$	$t_{ca\text{-}1st}$	266.60	134.330		
	$t_{ca\text{-}2nd}$	182.90	147.964	25	2.01
$t_{ca\text{-}2nd}$ & $t_{ca\text{-}3rd}$	$t_{ca\text{-}2nd}$	268.69	174.292		
	$t_{ca\text{-}3rd}$	93.46	58.115	10	2.88*
$t_{ca\text{-}3rd}$ & $t_{ca\text{-}4th}$	$t_{ca\text{-}3rd}$	119.64	65.679		
	$t_{ca\text{-}4th}$	85.98	78.498	5	0.62

t_{ca} = the time needed to give a correct answer; StdDev = standard deviation;
n_{valid} = number of valid cases; t = parameter of Student t test; * $p < 0.05$

The average time needed to give a correct answer obtained by students at the last examination (average = 98.22 seconds, Min = 50.1 seconds, Max = 682 seconds) was significantly lower ($p = 0.000002$, $n_{valid} = 25$, see figure 1) comparing with the average time needed to give a correct answer obtained at the first evaluation (average = 266.60 seconds, Min = 19.7 seconds, Max = 449 seconds).

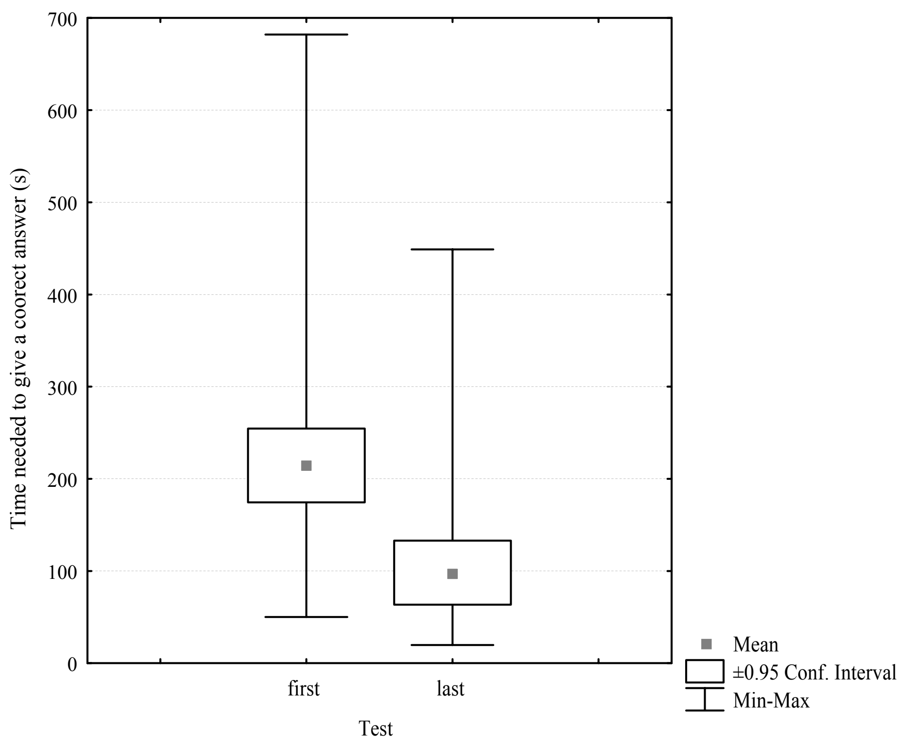

***Figure 1:** Distribution of time needed to give a correct answer at the first and respectively at the last test*

DISCUSSION

The assessment of the students' knowledge is a common task at the end of the semester and/or academic year. Testing methods which imply multiple-choice questions are usually used in evaluation of students' knowledge for speed, accuracy, and fairness in grading (Toby & Plano2004).

The proposed system offer to the students involve directly in MCQs baking the opportunity to deep understand of the information regarding physical chemistry topic using an active learning method. Thus, the students were motivated to formulate questions, to create options for each question, and to define the correct answer.

Being a new evaluation method the students' had the possibility to use the system before evaluation, as pre-test evaluations. There were two aims of the pre-test evaluations. The first aim was allows familiarization of the students with proposed computer assisted evaluation environment. The second aim was to give the students possibility to test their physical chemistry knowledge, to identify their knowledge gaps, the difficult subjects and the information which need a special attention in preparation for the examination.

As it was described in Material and Method chapter, for obtaining the final mark for physical chemistry topic, each student had the possibility to test his/her knowledge as many times as desired. More than one third of students were content with performances obtained at first test. Analyzing their performances and comparing them with the whole sample, it can be observed that the average of the number of corrected answers is higher than the average reported to the whole sample, the minimum value is higher and the obtained values are not more disperse comparing with the whole sample. Comparing the average of time needed to give a correct answer, the student that decide to performed the test just one time obtained better results (137.96 seconds comparing with the whole sample, where the average was equal with 214.53 seconds). The minimum value for the variable time needed to give a correct answer was the same for the students that were content with results obtained at the first test, comparing with the rest of the sample. A significant difference was observed at the maximum value for the time needed to give a correct answer, where the value obtained by the sample of students which were content with the results obtained at the first test was half from the value obtained by the students which performed the exam more than once. This sample of students was more interested by the physical chemistry topic comparing with the colleagues who performed more than one test.

Looking at the period of time between first and last test, it can be observed the majority of students performed the test after one day, respectively three days. The students which test their knowledge after one day could by those students which learn the materials but did not try to see how the evaluation system works. Those students that performed the test again after more than one day look to be the ones which learn the materials but they were not content with obtained performances.

The results obtained at the second test, show that fifteen students out of twenty-five obtained better results in terms of number of correct answers (see table 2 and 3), and the differences vary from 1 point (id_13, id_20, id_21, id_42, id_35) to 9 points (id_17). In seventeen cases out of twenty-five, the time needed to give a correct answer decreased at the second test comparing with the first test (see table 2 and 3). The greatest decreasing was of almost 530 seconds (for the student with id_03, from 682 seconds to 152.7 seconds, table 2). These decreasing of the time needed to give the correct answer (see table 2) demonstrate that the students which presented at the second test were self-confident on their knowledge and were able to make better connections between their acquired knowledge and the correct option(s) in less time comparing with first test.

Five out of ten students which presented to the third evaluation were able to exceed personal previous performances in terms of number of correct answers (id_09, id_18, id_35, id_39, and id_41) and of average time needed to give a correct answer (see table 3). A decrease of the average time needed to give a correct answer from 713 seconds at second test to 57.5 seconds at third test was observed at the student with id_19.

Five out of forty-two students performed the evaluation by four times. From this sample of students, three students obtained lower performances regarding the number of correct answers comparing with first evaluation, into a range from 2 points (id_34, and id_19) to 4 points (id_30). One student out of five has improved his/her performance (id_39) with two points at second evaluation comparing with first evaluation, obtaining the same performances at third evaluation as at the second evaluation, and with one point at forth evaluation comparing with third evaluation. Regarding the time needed to give a correct answer at this sample of students, except one student, the time decreased from first to forth evaluation with 121.10 seconds (id_39), 192.2 seconds (id_30), 194.9 seconds (id_34), and respectively 256.7 seconds (id_16).

Analyzing the results obtained in terms of number of correct answers and time needed to give a correct answer it can be concluded that students had improve their performances, obtaining results significantly better at the last evaluation comparing with the results obtained at the first evaluation.

Even if some students try to cheat and to obtain performances without learning the material, the auto-calibrated online system proved to be valid and did not allow or encourages these kinds of practices.

It can be conclude that the presented system is a reliable solution in students' knowledge evaluation on physical chemistry. In order to improve the auto-calibrated online evaluation system, the future direction of development has two directions: the creation of a homogenous distribution of the questions with one, two, three and respectively four correct options and the analysis of the answers gave by students to each question. The analysis of the students' answers can reveal information about the level of knowledge and will allow identification of the materials which were difficult for students to understand. With the obtain information, the practical activities, seminaries and courses on physical chemistry topic could be improving.

CONCLUSIONS

The proposed auto-calibrated online evaluation system proved to offer a stable and valid evaluation environment on physical chemistry topic.

Students' performances in terms of number of correct answers and time needed to give a correct answer reveal to be improved at final evaluation comparing with first evaluation, showing an improvement of acquired physical chemistry knowledge.

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Integrating technology into the teaching-learning transaction: Pedagogical and technological perceptions of management faculty

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ABSTRACT

Despite research and testimony that technology is being used by more faculty, the diffusion of technological innovations for teaching and learning has not been widespread, nor has IT become deeply integrated into the curriculum. Although there are a growing number of faculty who are very enthusiastic about adopting technology because of the potential of newer tools for their students, there is still a large number of faculty who seem hesitant or reluctant to adopt technology for their teaching tasks. Given the size of investment in instructional technology in higher education, the increased demand for distance education in the future, and the demonstrated effectiveness with some educational outcomes, it seems reasonable to investigate why the integration of technology for teaching and learning is so appealing to some faculty, and not to others. The study examines the faculty perceptions about technology enabled constructivist pedagogy Vs the didactic pedagogy followed even today in most of the management education institutes. The study tries to evaluate the perception of management faculty about the impact of instructional technology tools on the teaching process, the perceived benefits and limitations of use of instructional technology tools. Also the study tries to find out that do factors such as age, experience, time for lecture preparation and academic background of the faculty members have an effect on the extent of use of instructional technology tools?

Keywords: *instructional technology; technology enabled constructivist pedagogy; technology enabled teaching; effective teaching pedagogy.*

INTRODUCTION

Colleges and universities invest billions of dollars per year for the acquisition of computer technology [Geoghegan, 1994]. Instructional technology may support and increase the efficiency of the teaching-learning transaction or even modify educational processes, especially with regards to distance education and "anytime, anywhere" access [Daniel, 1997]. Formal evidence linking this investment to higher productivity [Schwalbe, 1996] and changes and improvements in the teaching and learning process is accumulating [Kulik & Kulik, 1980, 1987] [Ehrmann, 1995], and new research approaches and methodologies are being developed to adequately study the unique issues involved in educational technology [Bull, et al, 1994] [Clark, 1989] [Reigeluth, 1989]. In some cases, integrating technology into the teaching-learning transaction has been found to transform the teacher's role from being the traditional "sage on the stage" to *also* being a "guide on the side", and student roles also change from being passive receivers of content to being more active participants and partners in the learning process [Alley, 1996] [Repp, 1996] [Roblyer, Edwards, & Havriluk, 1997].

Since management education requires inputs fro the fast changing internal/global business environment, it becomes imperative for management faculty to use information instructional technology tools like business databases, statistical tools, library databases, internet, office tools, websites, online business games etc. to enhance learning outcomes. The faculty's planning of learning activities will be easier, less time consuming and expanded in scope with the availability of instructional technology and their skill in drawing from it will improve their teaching ability [Ololube 2006]. Information Technology is currently being used effectively in Management education for information access and delivery in libraries, research and development, as a communication medium, and for teaching and learning. Increased access to and use of the Internet is making a unique contribution to the teaching and learning process [Shaw, 1994] and will be an important part of future strategies to provide services to increased number of students in very diverse locations [Daniel 1997, Czerniewicz and Brown 2005].

Given the size of investment in instructional technology in education, it seems reasonable to investigate the integration of technology into teaching and learning. Although most of the faculty has adopted information and communication technologies like power point slides and internet into their teaching, they are still reluctant to adopt more complex computer-based activities or other teaching pedagogy innovations, such as active learning techniques involving video-conferencing and groupware solving of assignments. Decisions made by the teacher about the use of information and communication technologies in the classroom is likely to be influenced by multiple factors including: **demographic** factors (like age, educational background); accessibility of hardware; **experience** in use of instructional technology, perception about **usefulness** (encouraging interaction, teaching more systematic, creativity in the faculty and the students, intellectual enhancement of the faculty, number of years of existence of the institute etc (Samuel and Bakar 2006), **ease of use** (teaching process less personal, intimidating, highly training intensive, time saved in lecture preparation).

The study under review has three mains objectives: (1) to investigate the relationship between age of the institute and the adoption of instructional technology tools (H_{01}, H_{02}, H_{03}, H_{04}); (2) to investigate the relationship between demographic factors and the adoption of instructional technology tools (H_{05}, H_{06}); (3) to evaluate the relationship between perceived usefulness and choice of pedagogy (H_{07}, H_{08}, H_{09}, H_{010}); (4) to analyze the relationship between ease-of-use and choice of pedagogy (H_{011}, H_{012}, H_{013}).

H01 Is the pedagogy followed significantly associated with the number of years the institute has been in existence?

H02 Is the use of the more advanced instructional technology tools like the business databases, statistical tools, library databases, dependent upon the number of years the institute has been in existence?

H03 Is there a relationship between the age of the institute and the access to instructional technology tools?

H04 Is the pedagogy followed associated with access to instructional technology tools?

H05 Is the age of the faculty related with the pedagogy followed?

H06 Is there a relationship between academic background (technical/non-technical) of the faculty and choice of pedagogy?

H07 Is there is a relationship between the choice of pedagogy and time saved in lecture preparation?

H08 Is there is a relationship between the choice of pedagogy and enhanced student involvement?

H09 Is there is a relationship between the choice of pedagogy and perception that instructional technology tools make teaching more systematic and creative?

H010 Is there is a relationship between the choice of pedagogy and perception that instructional technology tools encourage interaction between the faculty, students and between students?

H011 Is there is a relationship between the choice of pedagogy and perception that the use of instructional technology tools is intimidating and complex?

H012 Is there is a relationship between the choice of pedagogy and perception that the use of instructional technology tools is highly training intensive?

H013 Is there is a relationship between the choice of pedagogy and perception that the use of instructional technology tools makes teaching less personal?

METHODOLOGY

Our study is based on the perceptions of the faculty on the use of instructional technology tools in management education, because management education teaches students to analyze and interpret the fast changing business environment and respond to the ever changing needs of the business. The present investigation surveyed faculty members from management Institutes offering Masters of Business Administration /Post Graduate Diploma in Business administration. Items gathered information about technology use patterns, computer experience and use of technology for teaching, the impact of instructional technology on the teaching process, using a survey instrument. The instrument had 36 questions. There were questions related to the age of the institute, pedagogy followed, effective pedagogy, age, academic background of the faculty, preference for which instructional technology tools, perceived ease-of-use, perceived usefulness etc. The responses were measured on a likert scale of 1 to 5. The survey was distributed using paper-based mail and e-mail. Complete data was obtained from 150 respondents, 25 of whom completed the web-based survey and 125 the paper-based version. Respondents were on 37.5 years old, had an average of 12.5 years experience as faculty member.

To find out the causal relationships between certain variables, some statistical tests were conducted to validate the results. The statistical methods used were Ch-square test, Z-tests and factor analysis. The researchers conducted a factor analysis (table 3 and table 4) to find out the most important factors which according to the sample determined the adoption of instructional technology tools for instruction. A factor analysis (Table 5 and Table 6) was also conducted to find out common perceptions related to instructional technology.

RESULTS

Our survey revealed that out of the respondents interviewed only 62% had access to PCs. About 40 % followed the lecture method to teach, 4% used only instructional technology while a majority (54%) used a hybrid mix of both methods.

In spite of 62% respondents having access to instructional technology tools, it was found that most of the respondents did not prefer using the various information and communication technology tools for the purpose of teaching. Internet and databases were the most preferred information technology tools used as teaching aids. LCD was also used to some extent as a teaching aid. The faculty hardly ever used videoconferencing and E-grouping technology as part of teaching pedagogy.

The respondents were asked to give their comparative assessments for both instructional technology and lecture method as Teaching-learning Tools as shown in Table 1.

Table 1: *Descriptive statistics for use of instructional technology tools vs. lecture method of teaching*

Perceptions of instructional technology -Vs -lecture method	Mean	SD
Use of instructional technology is complex	2.95	1.30
Use of instructional technology is intimidating	2.55	1.33
Use of instructional technology makes teaching more systematic	3.59	1.09
Use of instructional technology makes teaching more creative	3.48	1.37
Use of instructional technology lacks personal touch	3.24	1.40
Use of instructional technology requires high administrative support	4.10	1.14
Use of instructional technology is less time consuming	3.42	1.13
Use of instructional technology leads to greater student involvement	3.44	1.25
Use of instructional technology ensures greater instructor availability round the clock	3.20	1.49
Use of instructional technology leads to easier student assessment	2.87	1.34
Use of instructional technology gives a global orientation to students	4.08	1.32
Use of instructional technology leads to intellectual enhancement of the faculty	3.44	1.29

Table 2: *chi square tests to analyze the relationship between the variables*

Hypothesis	Pearson chi-square between	p value
H01	Pedagogy followed and perception about effectiveness of a pedagogy	.972
H02	Age of the institute and the pedagogy followed	.002
H03	Age of the institute and the use of more advanced instructional technology tools	.031
H04	Age of the institute and access to instructional technology tools	.000
H05	Pedagogy followed and access to instructional technology tools	.003
H06	Pedagogy followed and the age of the faculty	.698
H07	Pedagogy followed and academic background of the faculty	.501
H08	Pedagogy followed and the time saved in lecture preparation	.01
H09	Pedagogy followed and enhanced student involvement	.685
H010	Pedagogy followed and perception that instructional technology tools make teaching more systematic and creative	.327
H011	Pedagogy followed and intellectual enhancement of the faculty	.003
H012	Pedagogy followed and the perception that instructional technology is complex and intimidating	.008
H013	Pedagogy followed and the perception that instructional technology is highly training intensive	.694
H014	Pedagogy followed and the perception that instructional technology makes teaching less personal	.301

It was revealed that a majority of the respondents agreed that instructional technology is more complex than lecture method and felt intimidated by instructional technology (Mean 2.95, SD 1.30). The respondents found instructional technology to be more systematic and organized than lecture method and felt that instructional technology enabled them to be more creative than lecture method (Mean 3.59, SD 1.09). However a large percentage felt that Teaching through instructional technology lost the personal touch factor that helps to connect with the students in as better way. With respect to administrative support required a large majority felt that instructional technology required high administrative support than lecture method. A large percentage of the respondents felt that instructional technology saved time and that there is greater student involvement and learning with instructional technology than with lecture method (Mean 3.42, SD 1.13).. Also the instructor availability is more with instructional technology than with lecture method mode of teaching. Respondents were divided on the issue of which method lend itself to easier assessment of student performance. A large majority agreed that instructional technology lead to the global orientation of the students (Mean 4.08, SD 1.32). An overwhelming majority of 80% respondents felt that instructional technology is highly beneficial for students, especially students pursuing a professional course.

DISCUSSION

Interestingly it was found that in spite of the faculty members feeling that the use of instructional technology tools was beneficial for students ,there was found to be no significant relationship between the pedagogy followed and perceived usefulness of instructional technology tools (H_{07},H_{08}, H_{09}, H_{010}).The question that comes to the fore is that despite the availability and access of technology tools to the faculty members and their preference for instructional technology, why were most of them still not using the various technology tools available to them to make their teaching more effective. There was found to be no significant relationship between the pedagogy followed and the effectiveness of pedagogy (H_{01} p value .972). This means that there could be certain other factors which limit the adoption of the instructional technology for teaching in spite of the fact that the faculty were convinced about the benefit of instructional technology. Could there be certain factors like age of the faculty, academic background, and the age of the institution, lack of training etc. which limit the integration of these tools into the teaching learning transaction?

The survey revealed that new age technology teaching was partly intimidating. A large population found it easier to prepare lectures on transparencies rather than use the computer. Most of them also felt that instructional technology was highly training intensive and they needed guidance for using instructional technology as a teaching Aid. Many faculty members felt that given a choice they would still prefer to use the lecture method for effective instruction in class. But on a positive note they also felt that they had more time to devote to intellectual enhancements as instructional technology has resulted in saving time for the respondents. Only a small percentage believed that instructional technology was more easily adopted by faculty who had IT/Engineering background. A very large population was of the strong belief that effectiveness of the lectures is still person oriented and not technology oriented, given the flux of technology enabled teaching environment in the country today. An Overwhelming majority felt that instructional technology enhanced their global orientation as it exposed the faculty to the best practices in the rest of the world.

Normally it is expected that as the institute builds up its infrastructure over the years and the faculty gains experience the pedagogy followed shifts from pure lecture method to instructional technology. The survey revealed that Hypothesis H_{02} is rejected as p value is less than .05 (p value is .002). This implies that there is a statistically significant relationship between numbers of years the institute has been in existence with preference for more advanced (read instructional technology) mode of teaching. Also it was found that as the institute became older, the faculty started using more advanced instructional technology tools (H_{03} p value .031).

It is usually expected that older faculty resist the use of technology enabled teaching and technology tools for research (Taylor & Todd 1995; Kwon & Chidambram 2000). The study revealed that there was no significant association between the two variables: age and pedagogy followed (p value is .698), so the hypothesis H_{06} is accepted. The demands of professional education are especially high on faculty. Most professional institutes especially private institutes are imposing rigorous standards on the faculty to upgrade develop and deliver more effectively. Also there has been a significant shift from the traditional didactic style of teaching to a more interactive constructivist style of teaching. This requires that faculty across all age groups converge in terms of lecture delivery content as well as context. With an increased focus on quality in professional education gaining momentum instructional technology is an expected style of teaching across all age groups. The study also revealed that even the younger faculty members found instructional technology to be a complex and more demanding style of instruction which involved a lot of pre-preparation for instruction delivery. In spite of a unanimous agreement on the benefits of instructional technology there were doubts with respect to matching of their own personal teaching style with instructional technology.

It is usually felt that a pedagogy adopted by a faculty is dependent on perceived usefulness in lecture preparation (Davis et al 1989). The survey revealed that, there exists definite relationship between time saved and preference of instructional pedagogy. Thus the hypothesis H_{08} is rejected (p value is .01). This indicates that instructional technology has a major benefit in terms of time saved in lecture preparation and delivery. This could be majorly attributed to the time saved in preparing the course plan in the subsequent semester terms. Much of the repetition involved in drafting, designing, and lecture wise handouts is reduced with the active use of instructional technology in instructional pedagogy.

Usually more advanced professional institutes believe in providing complete facilities to its faculty, with the belief that the faculty would utilize these resources in course design, planning delivery, evaluation and up gradation. The purpose is intellectual enhancement of the faculty in terms of not only lecture design and delivery but also in terms of research capability. The survey revealed that the type of pedagogy followed is highly dependent on the access and availability of personal computers to a faculty. Thus the hypothesis H_{011} is rejected (p value .003 at 95% confidence interval).

Usually the academic background of a faculty in a management institute is assumed to have some impact on the ease with which a faculty adapts to instructional technology. The findings of the preliminary survey revealed that this might not always be so. Demands of professional education require quick adaptation to various technological tools and applications which the institute provides to the faculty. Also management as a discipline involves the large number of non-technical sub areas which also use technology in some way or the other such as scientific decision making. Thus the hypothesis H_{05} is accepted (p value .501).

The researchers conducted a factor analysis (table 3 and table 4) to find out the most important factors which according to the sample determined the adoption of instructional technology tools for instruction. Accordingly three factors emerged. The rotated component matrix revealed Eigen values of instructional technology more complex, instructional technology more intimidating, and instructional technology high administrative support with scores of .844, .780 and .551. Thus these components can be clubbed as **factor 1** and labeled as **technology intensive** attributes. **Factor 2** reveals components instructional technology more systematic, instructional technology more creative, and instructional technology more student involvement with scores of .719, .785 and .745. These components can be clubbed as factor 2 and labeled as **learning enhancement** attributes. **Factor 3** comprises components- instructional technology lacks personal touch and instructional technology is less time consuming and this factor can be labeled as **professional interaction**.

Table 3: *Total Variance Explained for factor analysis on instructional technology Vs lecture method*

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.113	26.412	26.412	2.113	26.412	26.412	1.888	23.601	23.601
2	1.571	19.641	46.052	1.571	19.641	46.052	1.717	21.464	45.065
3	1.274	15.921	61.973	1.274	15.921	61.973	1.353	16.908	61.973
4	.955	11.943	73.916						
5	.686	8.579	82.496						
6	.589	7.367	89.863						
7	.462	5.777	95.639						
8	.349	4.361	100.000						

Table 4: *Rotated Component Matrix for factor analysis on instructional technology Vs lecture method*

	Component		
	1	**2**	**3**
instructional technology more complex	.844	-.004	-.056
instructional technology more intimidating	.780	.052	-.004
instructional technology more systematic	.304	.719	-.069
instructional technology more creative	.085	.785	-.046
instructional technology lacks personal	.346	-.058	.735
instructional technology-HIGH adm support	.551	.146	.258
instructional technology less time consuming	-.156	.014	.853
instructional technology greater student involvement	-.143	.745	.083

Thus there are three principal areas where the major differences in perception exist as regards use of instructional technology and lecture method in teaching pedagogy. These relate to farads and doubts regarding the perceived technicality of the use of instructional technology, most faculty associate instructional technology with being more complex, and hence feel intimidated by the use of computers in classroom teaching. This could be more a question of mindset and resistance to new changes in the sphere of teaching, lack of computer training and short sightedness on the part of management. The factor 2 analyses revealed that most faculty members agree that there is greater student involvement with the use of instructional technology than with lecture method. The teaching by instructional technology was thought to be a more creative process than lecture method as the students were exposed to more visual and multimedia presentations in the class which made information much more interesting and exciting. Consequently it was perceived that the students absorption capacity was enhanced leading to greater learning. Studies in communication theory have also supported that there is greater learning through a visual medium of expression. Instructional technology facilitates a more professional interaction and this is revealed by factor 3. Therefore in instructional technology, it is sometimes assumed that instructional technology lacks personal touch factor that helps to connect with students.

A factor analysis (Table 5 and Table 6) was also conducted to find out common perceptions related to instructional technology. Three factors were identified (see rotated component matrix). Components of factor 1 are instructional technology is intimidating, instructional technology is difficult to learn for non IT background faculty and given a choice, clear preference is for lecture method .**Factor 1** can be labeled as **negative presumptions**. **Factor 2** comprises lecture preparation high training intensive and effectiveness orientation; these components can be clubbed as **comfort factor**. **Factor 3** can be labeled as intrinsic **intellectual enhancement**

Table 5: *Total Variance explained for factor analysis on perceptions of instructional technology*

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulati ve %
1	2.434	34.773	34.773	2.434	34.773	34.773	1.780	25.432	25.432
2	1.216	17.377	52.150	1.216	17.377	52.150	1.536	21.941	47.373
3	1.081	15.444	67.594	1.081	15.444	67.594	1.415	20.221	67.594
4	.788	11.256	78.850						
5	.549	7.847	86.698						
6	.472	6.748	93.446						
7	.459	6.554	100.000						

Table 6: *Rotated Component Matrix for factor analysis on perceptions of instructional technology*

Perceptions of instructional technology	**Component**		
	1	**2**	**3**
instructional technology intimidating	.555	.185	.578
lecture preparation	.327	.689	.010
background	.825	.042	.192
high training intensive	.037	.725	-.108
global orientation	-.010	-.056	.900
lecture method preference	.827	.194	-.139
effectiveness	.018	.677	.450

This analysis helped the researchers to club the faculty into three broad categories. The first category of faculty comprised those faculty members who had negative perceptions with respect to instructional technology and were unwilling to change. This category was labeled as Cynic and had strong pedagogical beliefs. The second category comprised those faculty members who with a little training and guidance could adopt instructional technology as classroom practices. These were labeled Moderates as they were ready to change and adapt to newer pedagogical practices. The third category was the intellectual leaders who used instructional technology as a means for intrinsic enhancement and greater global orientation. These were labeled as Adaptors and were continuously innovating their teaching pedagogy by introducing the latest technologies into classroom pedagogy.

CONCLUSION

The study has examined the relationships among teachers' levels of technology use and a number of key factors including years of experience, ease-of use, and access to resources. Achieving meaningful technology use is a slow process that is influenced by many factors. When educators and researchers look for ways to help teachers use technology effectively, it may be important to look at what they have (in terms of equipment) in addition to what they do not have (in terms of positive technology inclinations). Understanding teachers' visions for technology use and their beliefs about teaching and learning may be necessary if we want to initiate an adoption of modern technology interventions in teaching pedagogy.

Many exciting applications of information technology in classrooms validate that new technology-based models of teaching and learning have the power to dramatically improve educational outcomes. But, classroom computers that are acquired as panaceas end up as doorstops. Unless other simultaneous innovations in pedagogy, curriculum, assessment, and school organization are coupled to the usage of instructional technology, the time and effort expended on implementing these devices produces few improvements in educational outcomes - and reinforces many educators' cynicism about fads based on magical machines. To further the study, it is imperative to further research into whether teachers who use technology are smartly predisposed to democratic, collaborative, problem based pedagogy, or does technology bring these behaviors into the classroom? Does improved student learning occur only when technology is introduced along with different teaching practices? What teaching practices are best suited to maximizing the potential of technology to improve student learning?

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Computer mediated communication for effective teaching-learning of coastal zone management module

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The University of Mauritius

ABSTRACT

A prototype application for an online coastal zone management module has been described that consists of three main components - the web-based interface, the mobile access interface and the adaptation mechanism that is used to provide just-in-time tailored content according to students' individual preferences. From a pedagogical perspective, this implies a complete re-engineering of courseware in CZM to meet the constraints imposed by an m-learning environment. Alteration of any of the component would cause an ecological imbalance in the system and the blending of the pedagogical approach in CZM to support mobile learners adds more flexibility to the learning process.

Keywords: *e-mobile learning; asynchronous forums; coastal zone management.*

INTRODUCTION

One of the main reasons behind the justification of universities going for distance education courses was the democratization of access to education to people residing in poor/excluded regions of the world. When e-learning was introduced, the same reason was used as one of the main driving forces in the justification process. One significant attribute of the technologies used in current educational enterprises is their capacity for real time interactivity. Well designed instruction is more likely to bring about a desired change in human learning and performance than is technology, regardless of the types of technology used. Computer-mediated conferencing (CMC) is also unique among distance education media because of its ability to support high levels of responsive, intelligent interaction between and among faculty and students while simultaneously providing high levels of freedom of time and place to engage in this interactivity (Rourke *et al.* 1999). Instructional interactivity is active learner participation in the instructional process and gives the learner some control over the pace and sequence of the instruction. Regardless of the signals being used, information needs to be transmitted interactively between the source and the destination between teacher and students, students and students or, between information to be learned and the students (Wagner, 1994).

The availability of advanced mobile technologies, such as high bandwidth infrastructure, wireless technologies, and handheld devices, has started to extend e-learning towards mobile learning (m-learning) (Sharples, 2000). Successful interaction in the mediated educational transaction is highly dependent upon how comfortable the learner feels in working with the delivery medium. As technology increasingly becomes the means of communication between learner-teacher, learner-learner, and learner-content, the design of these mediating technologies becomes correspondingly important. The inability to achieve learner-interface interaction successfully can be a significant problem to those comfortable with technology yet unfamiliar with the specific communication protocols. Successful learner-interface interaction requires the learner to operate from a paradigm that includes understanding not only the procedures of working with the interface, but also the reasons why these procedures obtain results.

In Europe, mobile phone technologies and use are much more widespread thus making the mobile phone a useful avenue to be explored to support technology-enhanced education practices and engage young people at risk of social exclusion to engage in learning activities and change their attitudes to learning thereby contributing to improving their skills, opportunities and lives. For example, simple short message service (SMS) to alert and remind the student that submission date for a given assignment is approaching can help the student better manage and organize his learning activities to meet the deadlines. Kinshuk and Lin (2004) explored how to improve learning process by adapting course content presentation to student learning styles in multi-platform environments such as PC and PDA.

The online forum used in the Coastal Zone Management (CZM) module provided a very good collaborative environment for multiple interactions (tutor-students and students-students) unlike traditional classroom settings.

THE M-E ADAPTIVE ARCHITECTURE AND SUPPORTED FUNCTIONALITIES FOR CZM.

The online coastal zone management CZM module at the University of Mauritius has two forums at the disposal of the students –one for module content discussion and one which addresses technical issues concerning the module. The web site of the virtual platform *i*-learn was put at the disposal of the students for them to access the study guide and related information about the module, Figure 1.

Figure 1: *Online Coastal Zone Management module*

The highly interactive electronic teleconference media, especially personal computers and audioconference media, allow a more intensive, personal, individual and dynamic dialogue that can be achieved in using recorded medium and more effectively bridge the transactional distance. A photo gallery is consulted online and is linked to the various CZM topics as shown Figure 2. The module which is equivalent to 3 credits is assessed on continuous basis.

Assessment is made on three topic assignments including an EIA case desk study. Students are able to interact with one another and their tutor in an asynchronous mode through forums on line on *i*-learn. Students participation on online CZM asynchronous forums is shown in Figure 3. The evaluation criteria is based on three main criteria – reading of messages, confirming peers opinions or adding value to any discussion threads.

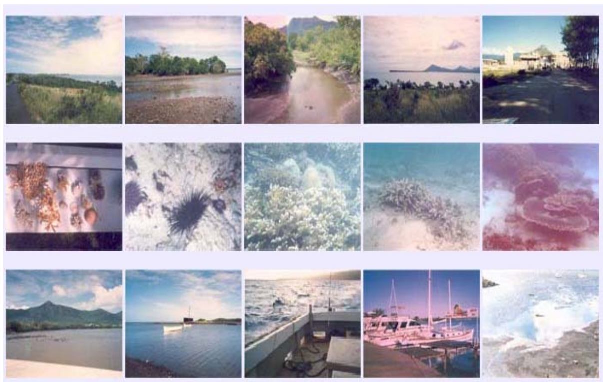

Figure 2: *Photo Gallery in CZM online module*

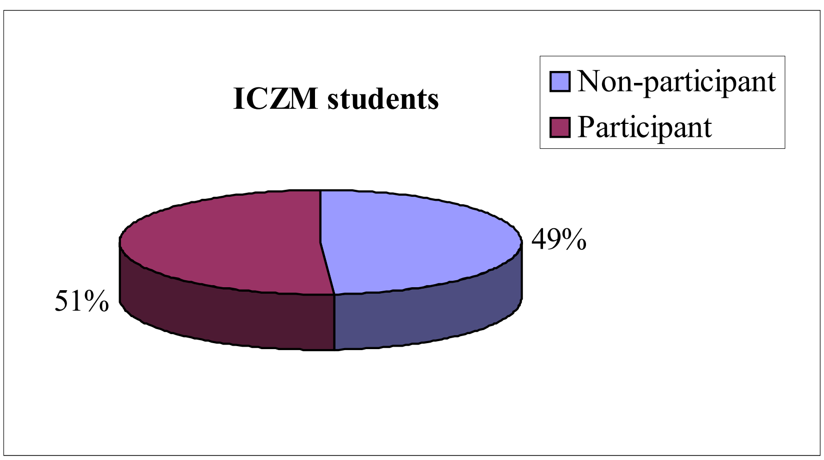

Figure 3: *Participation in CZM asynchronous forum*

The two classes of users for CZM are web users and mobile users. The web user connects to the system traditionally on a desktop computer via their browsers and by using the HTTP protocol while the mobile user will likely be connecting with a smart phone or PDA device via a wireless network. On the server-side, the database contains information on courses, activities, exam question banks and student profiles that will be retrieved and used in the adaptation process. The lecturer uses the web interface to author assessment instruments that will be hosted by the

University secure web server and also gets access to a range of tools such as monitoring students' progress on the tests to determine the effectiveness of instruction.

THE ADAPTATION PROCESS: A LEARNING STYLES APPROACH FOR CZM.

The concept of 'adaptation' is an important issue in research for learning systems and systems that allow the user to change certain system parameters and adapt their behavior accordingly are called adaptable. Systems that adapt to the users automatically based on the system's assumptions about the user needs are called adaptive. Aptitude treatment interaction (ATI) research developed as a way to find the best methods of instruction for the student population. Peck (1983) stated that ATI is research correlating teaching methods with measures of student aptitudes finding that students may respond differently to a particular method depending on such variables as intelligence, learning style, or personality.

The notion of flexibility and autonomy was encouraged with the CZM online module and created independence among distance learners. The main defining feature of online delivery was the separation of teacher and learner, usually in both time and space (Holmberg, 1989). This separation fostered noncontiguous communication (communication that occurred between the learner and teacher from a distance), which had to be mediated. Consequently, mediated communication became the second defining feature of e-learning. Mediated communication is an important feature in both e-learning and traditional distance education (McConnel, 1994). The separation of students and teachers in space and time involve two main systems for providing education at a distance. An asynchronous system where messages were pre-recorded in print or computer through online forums for use by learners at a different time from the time and/or place of recording was used during the CZM online module. E-learning of CZM was flexible and adaptable in that learners could study anywhere and anytime. If we have e-learning and web-enhanced learning such as the online CZM module, Marjanovic and Orlowska (2000) stress that the challenge here is not to re-create the face to face teaching situation with all its inherent problems with new technologies, but rather create new learning environments providing unique communication patterns, changed limitations to the types of learning activities that are possible and provide a new high quality learning experience. The autonomist model used for the CZM module mainly favours interaction between the student and his learning objects and has a tendency towards the constructivist approach. The autonomist approach seems to correlate well with the case of e-learning and web-enhanced learning where the importance of a new or better learning methodology is stressed. The academic model used during the CZM learning process seems to cater for this disadvantage since the simulation of a traditional environment is at the base of it while the autonomist model seems to cater for independence, flexibility and better learning methodology. The first component of the model most likely falls in the cognitive dimension allowed student to know better about the environment he will be operating in and other related information. The orientation session and the helpdesk support can be broadly categorized to the technical side of the model. The model tentatively consisted of two broad categories – technical and academic. An orientation session was important as a means of "climate setting" in order to introduce learners to the technology. The session which separates learning to use the delivery technology from the course content has several benefits: it does not compete with the course content, it helps ensure uniform minimal proficiency, and it removes the stress of graded performance (Hillman et al. 1994).

The student can have a variety of options to take a test in CZM. The first option is that the student takes it online on a desktop computer. The next two options mentioned are currently under investigation - on synchronous mode through a portable device or offline mode where the student download the test application and synchronize performance afterwards with the server. Concerning the adaptation feature, when the students register in the system, they will be invited to take a learning style test that will help build a student profile in the system. Each question in the question bank is also rated with a 'learning style weight' that categorizes the question according to the learning style in use.

ASYNCHRONOUS COMPUTER MEDIATED COMMUNICATION.

Networked learning during the CZM online module delivery at the University of Mauritius was interactive, flexible, promoting active engagement and social interaction and providing new opportunities for group working (Ramessur and Santally, 2003; Ramessur and Santally, 2005; Ramessur, 2006).The online forum used in the CZM module provided a very good collaborative environment for multiple interactions unlike traditional classroom settings. The difference was that through the forums, students took the lead and viewed the lecturer as a resource and a guide. The lecturer monitored the processes of group and collaborative work easier since the contribution of each student was made more obvious when they work online.

The CZM online class consisted of 39 students but only 20 participated in the discussion forums. The tutor read the students' postings, provided answers to queries, added pedagogical comments and provided advice. During the fifteen weeks that the asynchronous discussion forums were operational a total of 131 posts were made. Table 1 below shows the types of messages posted by the CZM students on the asynchronous forums.

Interactions between the instructor and students and interactions among students with the CZM asynchronous online forum provided opportunities for an educational transaction. Without interaction, teaching becomes simply "passing on content as if it were dogmatic truth," and the cycle of knowledge acquisition-critical evaluation-knowledge validation is nonexistent. The use of new technologies during the CZM online delivery permitted live interaction and allowed for immediate feedback and interaction between teacher and student(s). Successful interaction in the mediated educational transaction was highly dependent upon how comfortable the learner felt in working with the delivery medium. The inability to achieve learner-interface interaction successfully can be a significant problem to those comfortable with technology yet unfamiliar with the specific communication protocols. Successful learner-interface interaction required the learner to operate from a paradigm that included understanding not only the procedures of working with the interface, but also the reasons why these procedures obtain results. An orientation session was important as a means of "climate setting" in order to introduce learners to the technology. The session which separates learning to use the delivery technology from the course content has several benefits: it does not compete with the course content, it helps ensure uniform minimal proficiency, and it removes the stress of graded performance (Hillman *et al.,* 1994).

Table 1: *Messages sent by students in CZM asynchronous forum*

Types of messages sent	Number of messages sent
Testing messages	23
Queries on assignment	27
EIA assessment	15
Course content and exam questions	3
COSMO problem and video viewing	7
Messages not related to course	1

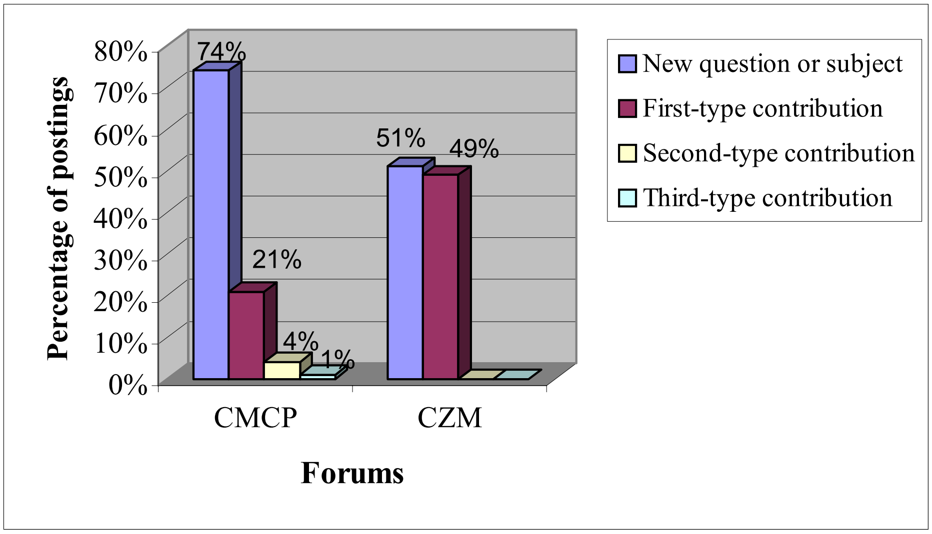

Figure 4: *Postings in CZM and CMCP (Computer Mediated Communications and Pedagogy) asynchronous discussion forums.*

LEARNING MEDIA AND METHOD

The inability to achieve learner-interface interaction successfully can be a significant problem to those comfortable with technology yet unfamiliar with the specific communication protocols required to interact with the tools to accomplish a desired task.

The combined capabilities of multimedia and the access that they bring, provide designers with powerful new tools that they can use to construct their design which would engage students in interactions within these technological environments in favour of learning. Understanding the ways in which students use the unique processing capabilities of the computer during the online CZM module is essential to understanding the influence the computer may have on learning and to building media theory. From an interactionist perspective, learning with media can be thought of as a complementary process within which representations are constructed and procedures performed, sometimes by the learner and sometimes by the medium. As opposed to Clark (1994) who argued that selection of method was more important than the medium used, Kozma (1994) insisted that medium and method should have a more integral relationship as both are part of the instructional design where the medium's capabilities enable methods and the methods that are used take advantage of these capabilities. Students benefited from e /m learning because the capability of the medium of the CZM online module was used to present problems and scenarios using the COSMO software that allowed students to connect their knowledge in understanding and simulating coastal zone conflicts. Constructivist environments facilitate learning through collaboration, context, and construction of knowledge. However Jonassen *et al*. (1994) argues that there should be more emphasis on the attributes of the human learner involved in learning and shift the debate and the practice of instructional design from instruction- and media- centred to a learner- centered conception of learning. By selecting specific learning inputs, knowledge can be constructed efficiently as students become responsible for recognizing and judging patterns of information and then organizing it, while the computer system should perform calculations, store and retrieve information

FROM E- TO M-LEARNING

An evaluation criteria was devised based on three aspects of online forum participation – reading messages, replying (confirming or rejecting peer views) and adding value to the messages that obviously had higher weighting. This obviously resulted as a filter and students consequently made more effort to raise the level of quality of the messages they posted. Learning during of the CZM module occurred through the interaction of three core components: cognitive presence, teaching presence, and social presence. The development of cognitive presence was defined as the extent to which the participants in any particular configuration of a community of inquiry were able to construct meaning through sustained communication. Teaching presence included designing and managing learning sequences, providing subject matter expertise, and facilitating active learning. Social presence in the CZM module was defined as the ability of learners to project themselves socially and emotionally in a community of inquiry and supports cognitive objectives through its ability to instigate, sustain, and support critical thinking in a community of learners.

As part of the quality assurance for the online courses, students were requested to complete an evaluation questionnaire of the online course and 85% students found that the online forums were a good learning experience and that they benefited from it. There were however some students who found the tool difficult to use. This is mainly a problem of computer proficiency. Many students pointed out the flexibility in the course as being a real advantage for them taking into account their normal semester load of work in class. Concerning access to the online module, 80 % of the students said they accessed the module frequently on campus while 60 % accessed the module frequently at home.

Concerning course content 35% of the CZM students found it good while 22% answered that some software was not accessible and 43% found that there was a lack of visual information. Students also said that they did not have any expectations for this module (78%) while 22% said that through this module they would like to be more proficient in using the internet and become more familiar to the online mode of learning. They expected to have lot of interaction between students and tutor to discuss an area of interest. The majority of postings were new questions with no replies and it was not surprising to see so many postings were new questions and first-type and fewer postings of higher type postings as shown in Figure 4. Students also found that time management was the most difficult aspect of online learning. Distinguishing the postings that are first-degree replies from those that build on the other students' messages helped to assess what proportion of the postings were built on another students' message. A first-type contribution replied directly to the question posted in the discussion forums while a second-type contribution was a message that responded to another students reply (or first-type contribution) to the question posted online. A third-type contribution was a message that responded to students' second-type contribution and so on. We however did not actually compare results of students who followed the online module with those who followed the traditional classroom based lectures

STUDENTS' PERCEIVED IMPORTANCE OF MOBILE TECHNOLOGY IN THE LEARNING PROCESS FOR CZM

In case the student does not perform as per expectations, that is achieves a score below the pass rate, or successively achieves a borderline score, then the system initiates the
remediation phase where the student is given academic support and tutorials that are related to the content of the tests.

The fact that students following online courses do not prefer to read pages of text online can be explained by two possibilities. The first possibility is that with the growing familiarity of students with the Internet and mobile devices, there could have been a paradigm shift and perceptions have evolved. The second possibility is that students are much more at ease with such devices (mobile phones and PDAs) that these tasks seem so basic and appealing (fashionable) to them (Santally *et al*., 2006). It is also clear that, for the student, the teacher/lecturer still has a very vital role in supporting the learning process in CZM. Most students have designated SMS/email messages as very important for approaching deadlines of assignments, class scheduling and whenever the lecturer posts something online. The student community is also widely accustomed to these SMS messages. It is obvious that they would welcome such initiative. There is also the argument that the evolution of mobile devices and 3G networks can bring about a revolution in the learning environment in that students can attend 'live' lectures even when they are on the move. This argument is not a new one as similar claims were made for video-conferencing on the Internet. Videoconferencing is still highly inaccessible because of the cost of telecommunications involved in the process, while with the limited Internet bandwidth available in mainly developing countries and with reference to Mauritius, videoconferencing is still not a widely used feature. The implied costs for 3G services are still too high for the wide adoption of this technology among the student population and ultimately the educational system in Mauritius. The problem that exists with the emergent technologies nowadays is that it seems imperative that there is a feeling that it is compelling to integrate every new technology in the teaching and learning process. It is not because a chat facility exists in a learning platform that it should be included in every activity or pedagogical scenario and that a face-to-face session should be excluded solely because the new technology of chat or 3G helps bypassing a classic conversation.

CONCLUSION

It is therefore obvious that emphasizing on the flexibility brought about by the new technology can become a means to redynamize the CZM teaching and learning process through the provision of a permanent communication and coordination link for the student with his/her learning environment. This aspect can be seen as an enhancement to the learning support process. A constraint that has been highlighted by some of the respondents relates to the relatively small screens of such devices that take the problem in another dimension. The size of the screen definitely affects the usability aspect, the range of features that can be supported, the organization of the navigational structure and the pedagogical approaches that can be adopted. Although from the study, it seems learners are not against downloading and reading documents on their mobile devices. From a pedagogical perspective, this implies a complete re-engineering of courseware in CZM to meet the constraints imposed by an m-learning environment. In any virtual learning environment the concepts of usability, pedagogy and technology form a balanced triad. Alteration of any of the component in the detriment of another would cause an ecological imbalance in the system. For instance, focusing too much on a complicated pedagogical approach may decrease the usability of the system, as the m-learning environment will possibly contain highly unlinear navigation structure.

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The use of digital materials for instruction in sport topics at the University of West Hungary

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ABSTRACT

This article describes research and development work, in the course of which a digital multimedia course book was produced, and its effectiveness examined in regards to teaching sport subjects at the Faculty of Pedagogy in the University of West Hungary. The purpose of this study was to examine whether applying ICT in teaching Physical Education (PE) increases pedagogical effectiveness. The special e-book on sports was made in CD-ROM format, because of the low rate among our correspondence students who have access to the Internet. The CD-ROM contains theoretical and practical general material used in the course of teaching PE, demonstrates specialized vocabulary through videos and charts and provides the possibility for testing and self-testing.

The CD-ROM also contains an audio version of the material for the benefit of sight-impaired students. The experimental group consisted of 133 correspondent students from Sopron who used the digital course book and then were given written examinations on three topics in PE, while a control group of 99 correspondent students from Papa studied with a traditional textbook, and then wrote examinations on the same topics as the experimental group. The results indicated that using ICT increases the effective factor in teaching PE.

Keywords*: digital education materials, ICT, sport recreation*

INTRODUCTION

Sports play a key role in maintaining one's health, bringing about completeness and improves one physically and psychologically. This approach in attitude is useful in higher education also. Every Branch in the Western Hungarian Colleges teach physical education, but there are some faculty departments where course specific athletic training lessons are practiced. These courses are Teaching, Kindergarten Teaching, and Social Education training.

The Elek Benedek Faculty Department of Social Pedagogy employs to its advantage fundamental theoretical and applied basic constituents which make up the training instruction, where the students receive not only educational support in order that they may survey their own fitness level and development, but in addition they are also given the learning tools to exploit in exploring health developments and athletic maturation possibilities (Bucsy, 2003). The presently selected physical education topics (Sport recreation, Leisure time sports theory and practice I and II) have been worked up in a digital format, consisting of e-learning materials, in order that the supervision of the education level and effectiveness might be enhanced.

PRELIMINARY SURVEY OF THE STUDENT BODY

Method

At the outset of developing the teaching materials, a written survey was given several years in advance in order to determine the possible usefulness of digital materials among the Social Education Training Department first year students, as well as their knowledge of basic computer skills. The questionnaire was given to 83 students in 2002, in 2003 to 88 students, and in 2004 to 87 first year full-time students. Furthermore in 2004 the questionnaire was extended to correspondent students also, which there were 169 students, a body which was comprised of 82 students from Sopron and 87 students from Papa. What the researchers wished to determine was what percent of students actively used their own computer, used the Internet, and how many years had they studied computer science related subjects, the results of their digital attitude were then mapped out (European Commission, 2005). The survey employed was supplemented with questions pertaining to the area of health culture using standard basic sociological information science questions (Aszmann, A., 1997). The questionnaires were filled out by the students at the beginning of the school year.

Results

Of primary interest was what the percentage results within the main categories of the data processed would show how these categories would be distributed and how they had changed. The results gathered together may be seen on Table 1.

Table 1: *Results of the preliminary questionnaire polling the number of students who own a computer, have internet access, and have previous knowledge in computer science*

	Full-time students in Sopron			Correspondence students in Sopron	Correspondence students in Papa
	2002.	2003.	2004.		
Home PC	59 %	70 %	80 %	85 %	80 %
Home internet access	27 %	40 %	48 %	51 %	45 %
Length of the preliminary computer science study more then 4 years	41 %	59 %	61 %	13 %	15 %

The table's data plainly show that the bulk of the student body employs the use of their own computer, but that only every other student has Internet access available at home. ,, There exists however, serious differences between the different categories of students - full-time and correspondent - which is primarily of a generational in nature. The results also indicate that personal home PC use and the use of the Internet at home is increasing among the student body is growing steadily year by year, as well as increased ability in computer sciences.

Conclusions

The personal use at home of the Internet in 2004 still remained around 50%, which obviated to the researchers that they would not be able to devise learning materials based upon the Internet, and that they would not be able to employ classic e-learning frameworks. For this reason a self-contained work was developed, in which the student could bring home the materials on CD-ROM. Parameters at this time indicate positive change, that within a few years the students' digital competency, and embodied within this, expanded Internet possibilities will have been developed to a level, indicating that such materials may soon be expandable for use in the student curriculum in correspondent teaching.

DIGITALIZING THE INSTRUCTION MATERIALS

For the digitalization of the instruction materials as well as their development, reliance was made upon both at home and abroad international sport e-learning observations and experiences (Kokvay, 2003, White & Bridell, 2003). The digitalization was made by NeoBook software (NeoSoft Corp., 2003). During the time when the learning materials were to be compiled together, the Social Pedagogical's Physical Education curriculum was already fixed (Sport recreation, Leisure time sports theory and practice I and II), educational programs that included actual investigational results. The result was that material received the name *Sport Recreation: a Digital Course Book of Basic Knowledge on Recreational Training*. The book's chapter divisions occur along a unified concept, and thus the authors strove to adapt the subsections of the digital course book to conform to this—its understandability, transparency, ease of use in how it was integrated. The headings of the book touch upon the basics of sport recreation, the role of sports in the preservation of health and welfare, issues involving the concepts of exercise and its components, stages of fitness, and recreational training basics and constitution. Moreover the book's supplement contains charts showing actual investigations and results are made known.

Far more theoretical and practical materials were developed and worked up into the model than were necessary for the beginning project, as forethought had convinced the authors that such materials would be advantageous down the road, thus yielding formidable tool known, as an "input approach" to be offered in other subjects of study also. At the time of compilation, outside of the subject's ordinary domain, the authors of the work also endeavored to create a digital tool that could offer help to those also who are interested in recreation and sport recreation, or those whose line of work these elements wish to use. At the time of compilation, the text of the book's content and understandability were the main criteria. For this reason at the time of determining the form and level of recreational related materials and similar web-pages to be selected, the overall appearance was chosen which would be similar to other sport e-learning materials in circulation. (Ying-Koh, 2006). On the other hand, in structure what was striven for, that the material to be familiarized with would reveal its deep structure, allowing for self-motivated study and use as well as easy navigation should be a consideration on behalf of the user (Forgo S. - Hauser Z.- Kis Toth L, 2005).

The approach in the course book of leading to an understanding of the kinetic movements in turn were described in text, in drawings, and on video approaches, thus through three channels each would reciprocally strengthen the understanding of the others. A visual example of this may be seen in Figure 1.

In the digital course material's structure a place was given for testing and self-testing possibilities also. At the ending of every heading and subheading self-help questions can be found, upon which the user may click on the given choice of related topic questions, and in this way test his or her knowledge. An important part of the structure's contents is the Test and Exam module, which gives the student the possibility of taking a factual examination of equal form and content as would be required on different subjects, allowing them to take a trial exam with the help of the CD-ROM on the student's own computer. Acquaintance through the attainment by employing the mechanism avoids having the module end with exam questions formed unintentionally, that the student is unfamiliar with. (When in the actual practice of examining students, it is with this program that the students are tested using a central leading module that has been created, and in this way in the faculty department of information it may give its exams on-line to allow students to give account of what they know.)

The course book was developed in an audio version as well, which would be of aid to the sight-impaired as well as giving the blind student benefit of the materials use. The audio text may be activated through the use of the mouse and key-stroke commands. In the interest of integrating the materials into the educational coursework, it was decided that special terms and the presentation of related course subject items, that a conventional paper text would also be released.

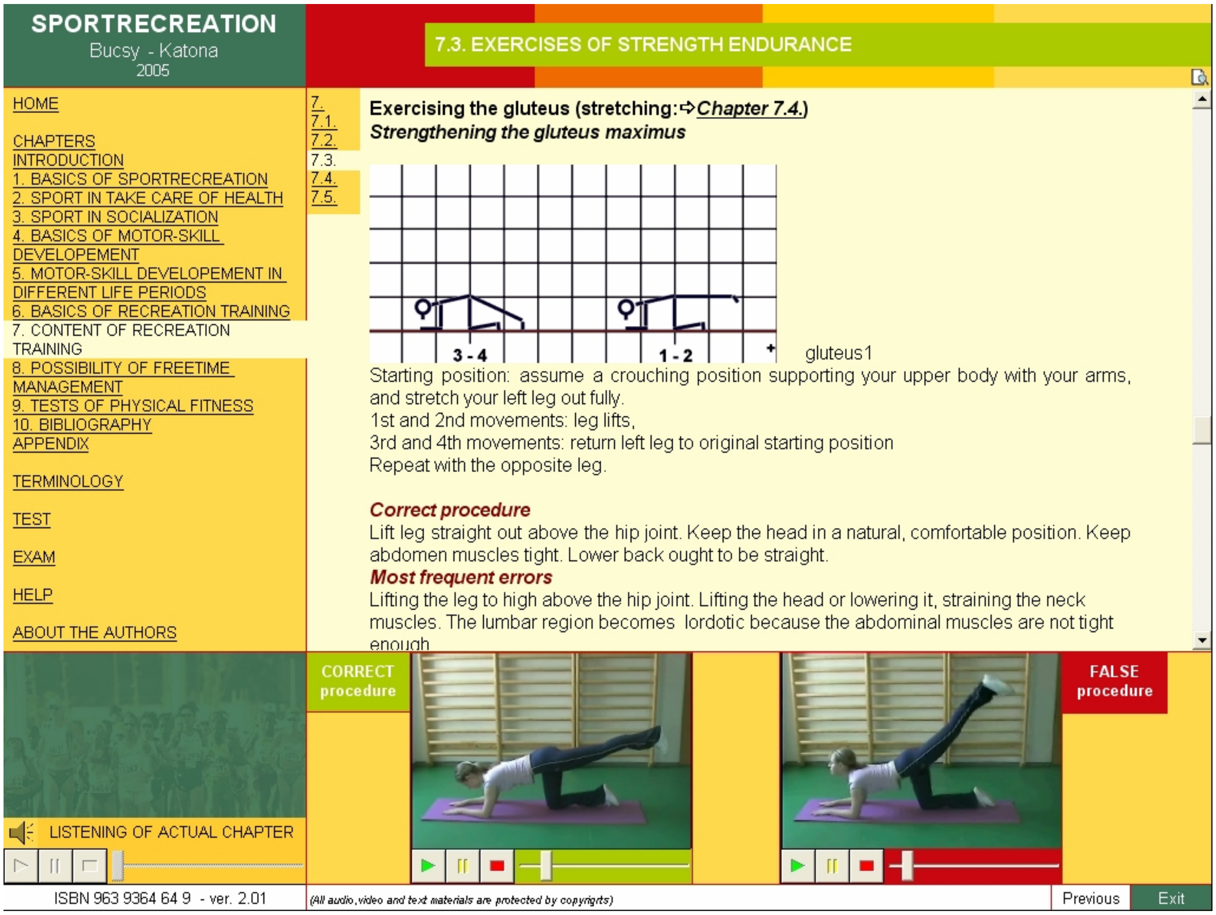

Figure 1: *A sample page of the digital book showing the application's structure with the main menu on the left side and the three demonstration channels of movement material*

QUALITY CONTROL

Method

The digital package of educational material, created as stated above, was first employed in the 2004/05 school year in the Social Education department. At the beginning of the second semester, a written questionnaire was distributed among the students about the digital course book, inquiring about its quality, ease of use, and faults. The bulk of the questions were answerable on a scale of five degrees using the Likert scale, but there were other types of fixed questions and an open ended question as well, where the student might write in using his or her own words their personal opinions. The 218 students (123 correspondent students, 50 part-time students, and 45 full-time students) gave their replies in which they truly "ranked" the digital course book, layer by layer (aesthetic questions, technical program questions, communication structure questions), appraising the work. The received means and standard deviations have been put together for viewing in Table 2.

***Table 2**: Students' opinions about the digital book on a scale of five*

Value layer	Mean	Standard deviation
Aesthetic questions	4,07	0,85
Technical-programming questions	4,06	1,23
Structural – communication questions	4,30	0,87
Overall question	4,03	0,76

Results

The results clearly indicate that the students both in its parts and as a whole were satisfied with the digital course book, giving the book a "B" average. Replying to the overall question "What grade would you give this digital course book?" the means differentiated by class divisions (full-time mean, 4.22; part-time mean, 4.12; correspondent student mean, 3.92) and the standard deviations as well (full-time, 0.64; part-time, 0.72; correspondent, 0.81). This is observable in the target diagram (Figure 2.)

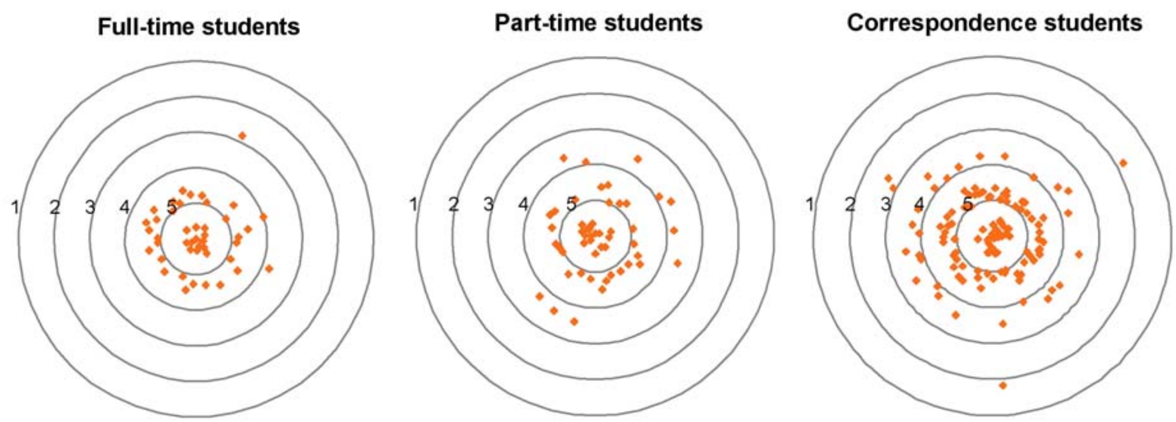

***Figure 2:** Distribution of answers to the question, "Give an overall mark to the digital book!" Arranged from left to right: full-time, part-time and correspondence student groups (the random amplitude is 0.5)*

Conclusions

The opinion of the full-time students on means and standard deviations well indicates that the younger generation are more predisposed and open toward digital materials, contrasted with the older part-time and correspondent students. When analyzing the open question on the questionnaire, the result was that the students said they gladly employ in other subjects as well teaching in an e-learning format.

EDUCATIONAL EXPERIMENT

Method

Also it was sought to determine how conventional teaching materials compared in effectiveness compared to the digital course book with the students, which is why and experiment was conducted in which direction a test group (133 correspondent students in Sopron) studied with the digital educational materials, while the control group (99 correspondent students from Papa) learned with the aid of conventional textbooks three subjects of study (Sport recreation, Leisure time sports theory and practice I and II). The learning materials, the subjects of study, the presentations during lessons, and even the test questions were wholly identical in both cases. The measure of effectiveness would be in the test results from the final exam that would be administered.

Comparing the results of the two final exams by two sample T test, which is appropriate in the case of two samples with identical standard deviations to discover any given significant that are to be displayed. Assuming a null hypothesis, that there was no difference in knowledge between the two groups. Prior to the T test an F test was completed, in which it was verified that the standard deviation of the two samples might be deemed equal, and for this result a T test, or a Welch test was depended upon, where the received results gave a theoretically 0.05 significant level which was taken into consideration.

Results

The results of the experiment are grouped together in Table 3. It can be readily read from the table, that in all three subjects that were made use of in the experiment, the group taking advantage of the digital course book had significantly better results compared to the students making use of conventional educational materials. This is shown in Figure 3 also.

Table 3: *Results of the tests of the experimental and control group and significance of difference between the two groups*

Subject	Experimental Group (133 persons)		Control Group (99 persons)		T-test/Welch test results p < 0,05
	Mean	Std dev.	Mean	Std.dev.	
Sport recreation	3,57	1,19	3,26	1,14	(T test) t = 1,99 significant difference
Leisure time sports theory and practice I	4,06	1,03	3,08	1,07	(T test) t = 7,06 significant difference
Leisure time sports theory and practice II	4,76	0,56	4,48	0,96	(Welch test) t = 2,64 significant difference

Conclusions

The educational experiment demonstrated that for the social education department instruction of sport related topics, the use of digital educational materials was in fact more effective.

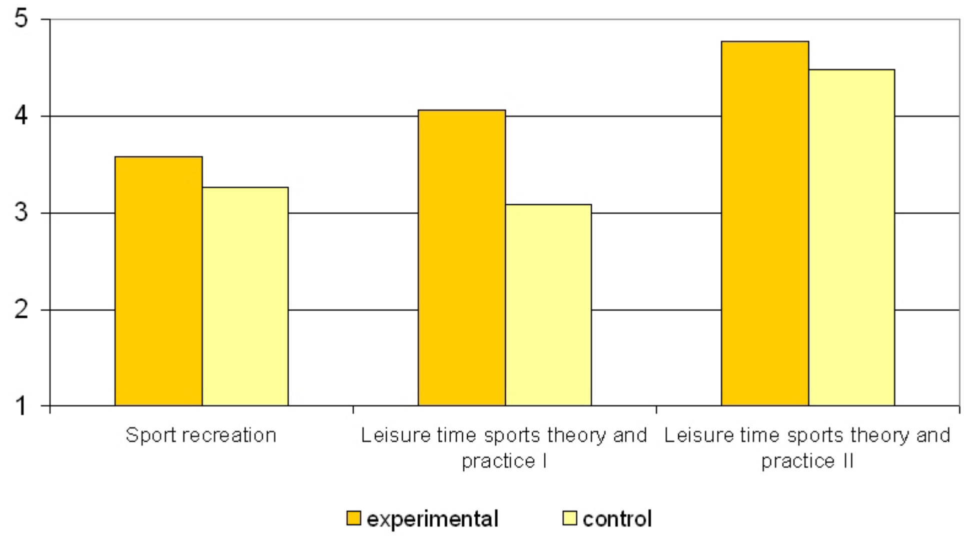

Figure 3: *The experimental (Sopron, 133 persons) and control (Papa, 99 persons) group according to examination subjects in the experiment.*

DISCUSSION

This developmental experimental project indicates that without making preliminary student surveys, it is not possible to develop useful educational materials, and in the course of conception it turned out that materials useful for the teaching of physical education can only be effectively prepared where by professionals who are willing to be innovative and cooperative in carrying the work out. The quality of the digital course book is determined by the quality of the various phases of development. If compromises should develop, whether they be gaps or faulty paths, they will affect the educational materials worth and use.

The prepared educational material was accepted positively by the students, though foremost in the matter of human interest, the majority of students who took part operated with a low level of digital competency. The usefulness of the course book is also supported by the fact that already in the third semester and the fourth teaching center it is being used in higher education.

As a result of the experiment it was also brought to light that an interactive course book in Physical Education was not only a beneficial material for teaching athletics in itself, but that the spread of the digital culture also played a role in that the students indicated that in other subjects as well they would gladly use similar educational materials.

The employment of a multimedia course book in educating also indicated that in learning from digital materials, the pitfall of mechanical or rote learning is more difficult to avoid, and thus when creating educational materials of this sort one needs to be especially aware while creating the complex form. Furthermore, unified opinion gathered from the experience of the educators is that teaching Physical Education through the use of a digital course book is only successful when combined in a mixed form, that of using conventional materials with digital systems used in parallel (blended learning).

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