International Journal of Education and Development using Information and Communication Technology

ijEDict

Volume 3, Issue 3 October 2007

Participation, collaboration and effective use of ICT

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IJEDICT Sponsoring Organizations:

The University of the West Indies Distance Education Centre, West Indies
and
Cape Peninsula University of Technology, South Africa

Published online by:

The University of the West Indies Distance Education Centre, West Indies

IJEDICT url: http://ijedict.dec.uwi.edu

ISSN: 1814-0556

Editorial Team

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Publication Frequency
There will be five issues of IJEDICT per year, in a continuous publication cycle. Articles will be published immediately in the current issue of IJEDICT on completion of the review/editing process.

Publication Classification Details
Key title: International journal of education and development using information and communication technology
Abbreviated key title: Int. j. educ. dev. using inf. commun. technol.

ISSN: 1814-0556

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;
ICT in local governance;
E-Democracy;
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The Editors welcome submissions at: http://ijedict.dec.uwi.edu/submissions.php

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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.

Book/Media Reviews

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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Authors can upload papers, as well as data sets, research instruments, and source documents through the journal's Submissions section. Papers, figures, and appendices can be submitted in a variety of file formats, including Microsoft Word, WordPerfect, or RTF (Rich Text Format).

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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.
- Submissions can be in Microsoft Word, Rich Text Format (RTF), equivalent Open Source document file format, or HTML format.
- Please use Arial 12-point font for the Title, which should be in bold "title" (upper and lower) case.
- Use Arial 10-point font for the remainder of your article.
- First level headings should be in bold uppercase.
- Second level headings should be in bold "title" (upper and lower) case.
- No footnotes please - instead use endnotes.
- Photographs, maps, diagrams and other audio-visual aids are encouraged. Please include these in the text where and as they should appear. Please provide images in gif or jpeg formats.

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Please supply a short (100 word) biography for each author. This should include the name, rank, institution, institutional address, and email address. Do not place the biography in your submission file but copy it into the appropriate text box during the on-line submission process.

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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: Participation, collaboration and effective use of ICT

Stewart Marshall
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Welcome to Volume 3 Issue 3 of the International Journal of Education and Development using Information and Communication Technology (IJEDICT). This issue brings articles from and/or about Bangladesh, China, Greece, the Netherlands, Oman, South Africa, Tunisia, Turkey, Uganda, United Kingdom.

In “E-learning data warehouse maintenance system for collaborative learning availability resources optimization”, Jalel Akaichi studies the issues of using agent’s based architecture to achieve e-learning data warehouse maintenance under schema changes by repairing automatically affected view definitions. This implicitly optimizes e-learning resources availability by automatically finding replacements for affected components belonging to view definitions.

“Teaching history using a Virtual Reality Modelling Language model of Erechtheum” by Demetra Eggarxou and Sarantos Psycharis presents a Virtual Reality Modelling Language VRML exploration of the Erechtheum in Athens. The design principles of the applications are described in detail as well as the technical characteristics of the application. A pilot evaluation of the teaching approach is also presented and the results indicate a strong positive impact on students’ performance.

In “Construct validation of ICT Indicators Measurement Scale (ICTIMS)”, Yavuz Akbulut, Mehmet Kesim and Ferhan Odabasi report on their study of the psychometric features of a scale developed to measure indicators of ICTs at an undergraduate institution in Turkey. Issues forming successful ICT integration were identified according to competencies stated by UNESCO (2002). Besides, each competency sheltered further sub-components which were adapted from UNESCO (2002) and Odabasi et al. (2006).

Poor internet connectivity is hampering the transition of developing countries to the global information society. In her article “Can the Internet in tertiary education in Africa contribute to social and economic development?” Anna Bon discusses how the recent emergence of national and regional research and education data communication networks in parts of the developing world have shown large benefits arising from collaboration amongst tertiary education institutes. She goes on to argue that collaboration amongst tertiary education institutes in Africa is essential to make them key players in the enhancement of ICTs for society. The University of Nottingham, UK and the Beijing Foreign Studies University, China have been engaged on a collaborative project to develop a generic module for the training of online tutors as part of the eChina-UK programme. In the article “Researching a participatory design for learning process in an intercultural context”, Gordon Joyes and Zehang Chen describe the participatory design approach in this project and explores an activity theory based analysis approach that is used to identify some of the factors that affected the design process.

Johnnie Wycliffe Frank Muwanga-Zake studied 26 teachers from 23 South African disadvantaged schools to report on evaluation strategies that could be used to introduce an educational computer programme (ECP) in disadvantaged schools. His article - “Introducing educational

computer programmes through evaluation: A case in South African disadvantaged schools" - discusses the strategies, the concepts the ECP presents, and considers the curriculum issues around ECP use in teaching. Babalola Isiaka reports on the "Effectiveness of video as an instructional medium in teaching rural children agricultural and environmental sciences". The study also examined the effect of gender and grade on the performance of the pupils taught with four instructional media. The study revealed that the pupils taught with the video performed equally as well as those taught with real objects (Realia), while both groups performed significantly better than those taught without either.

In the article "The innovative elements in non-formal education of Bangladesh: Perspective of income generating programmes for poverty alleviation", Md. Islam and Ahmadullah Mia describe a study based on a survey of the beneficiaries, focus group discussions, and documentary review. The study shows that most of the NGOs have programmes for socio-economic development but a very few of them have innovative elements in non-formal education linked income generating programmes for poverty alleviation. In the article "The status of Omani women in the ICT sector", Ayman Elnaggar fears that women in the Arab Gulf region in general and in Oman in particular are at a higher risk of being marginalized from today's knowledge-based economy. The article presents a gender sensitive assessment of the ICT space in Oman and the status of women within it, and to develop the seeds of an information base that provides gender analysis of opportunities and challenges in the ICT space.

Joseph K. Ssewanyana and Michael Busler examined the extent of adoption and usage of ICT on one hundred and ten firms in Uganda, and established benchmarks that can be utilized in future research and comparison between firms. The results reported in their article "Adoption and usage of ICT in developing countries: Case of Ugandan firms", revealed that the adoption and usage of ICT by firms in developing countries follow the same pattern as in developed countries, and they only differ in the level of usage and adoption.

This issue of IJEDICT concludes with a project report - "Improving production and accessibility of agricultural information through capacity-building, networking and partnerships in the South Pacific" - by Danny Hunter. The three main project components are: to develop appropriate agricultural technologies based on farmer livelihood needs; to improve access to agricultural information; to build institutional capacity and partnerships with National Agricultural Research and Extension systems (NARES), NGOs, information providers, and farmer and community groups, in order that technology identification and knowledge dissemination will be sustained beyond the end of the project.

Stewart Marshall and Wal Taylor
Chief Editors, IJEDICT

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 4-15.

The status of Omani women in the ICT sector

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ABSTRACT

Women in the Arab Gulf region in general and in Oman in particular are at a higher risk of being marginalized from today's knowledge-based economy, due to factual findings related to a traditionally male-dominated ICT sector, unequal access to training, the lack of "Arabized" Internet content and training, and the lack of awareness and policy advocacy, among others. The aim of this research is to present a gender sensitive assessment of the ICT space in Oman and the status of women within it, and to develop the seeds of an information base that provides gender analysis of opportunities and challenges in the ICT space.

Keywords: *Gender Empowerment; Gender Equality; Gender & ICT; ICT4D.*

INTRODUCTION

ICT has proven to be the single most powerful tool for development in the past ten years (Hafkin & Taggart 2001). It has become the bridge of communication among countries; a tool for creating a common language that opens opportunities, connects people, and creates channels for personal and country development (Geldof & Unwin 2005).

Today ICT is the most effective tool in the hands of women to enabling them to extend their participation in a variety of productive fields and providing them with an avenue to express the development of their personalities and capacities (Huyer & Sikoska 2003). It can enable them to participate effectively in numerous development fields, including planning and decision-making, at the level of the family, institutions and society (Gurumurthy 2004). Therefore, ensuring gender equal access to ICT has become an essential core objective and integral element in the many extensive research and development initiatives at the global level in order to effectively improve women's lives by increasing their capacities to share and access information and knowledge (Copper & Weaver 2003). As a result, more and more women have begun to utilize ICT through the initiatives that promote women's access to and understanding of ICT (Rainer, Laosethakul & Astone 2003).

Gender digital divide among Arab countries

Despite these advances in many regions however, women's access and utilization of ICT among Arab countries continue to lag behind men creating a widening gender digital gap. As shown in Table 1, women population is as low as 4% of Internet users in Arab countries, one of the lowest in the world in quantitative terms (Internet World Stats, 2006).

Table 1: *Internet users in the Middle East and in the world*

Internet Users in the Middle East and in the World							
Middle East region	**Population (2005)**	**Pop. % of world**	**Internet users, latest data**	**% Population (penetration)**		**Usage % of world**	**Use growth (2000-2005)**
				Female	Male		
Total for the Middle East	187,258,006	2.9 %	16,163,500	4%	8.3%	1.7 %	392.1 %
Rest of the world	6,232,844,716	97.1 %	956,664,501	15.3%	15.3%	98.3 %	167.4 %
World total	6,420,102,722	100.0%	972,828,001	15.2%	15.2%	100.0%	169.5 %

Table 2: *Middle East Internet Usage and Population Statistics.*

Middle East Internet Usage and Population Statistics						
Middle East	**Population (2005)**	**Usage**	**Internet Usage, Latest Data**	**% Population (Penetration)**	**(%) of M.E.**	**Use Growth (2000-2005)**
Bahrain	707,357	40,000	152,700	21.6 %	0.9 %	281.8 %
Iran	68,458,680	250,000	5,500,000	8.0 %	34.0 %	2,100.0 %
Israel	6,986,639	1,270,000	3,200,000	45.8 %	19.8 %	152.0 %
Jordan	5,788,340	127,300	600,000	10.4 %	3.7 %	371.3 %
Kuwait	2,530,012	150,000	600,000	23.7 %	3.7 %	300.0 %
Lebanon	4,461,995	300,000	600,000	13.4 %	3.7 %	100.0 %
Oman	2,396,545	90,000	245,000	10.2 %	1.5 %	172.2 %
Palestine	3,997,861	35,000	160,000	4.0 %	1.0 %	357.1 %
Qatar	768,464	30,000	165,000	21.5 %	1.0 %	450.0 %
Saudi Arabia	23,130,024	200,000	2,540,000	11.0 %	15.7 %	1,170.0 %
Syria	18,586,743	30,000	800,000	4.3 %	4.9 %	2,566.7 %
United Arab Emirates	3,750,054	735,000	1,384.800	36.9 %	8.6 %	88.4 %

With exception of Israel and Gulf countries, most of the Arab countries suffer from a very low Internet population. Oman, being one of the Gulf countries, has the lowest Internet access population among countries in the region as shown in Table 2. Access to ICT, especially the

Internet, is particularly difficult for women in poorer and less urbanised areas where telecommunications infrastructure is poor. The problem is not only the lack of access to computers, telephones and other resources. It also involves a severe absence of training and application opportunities for women and girls (UNDP-POGAR 2005). These issues remain critical for most women in the region.

RATIONALE

The recent human resource report published by the ministry of National Economy in Oman indicated that females currently constitute 49.5% of Oman's 1.8 million population (Ministry of National Economy 2006). Specifically, females constitute 0.85 million with 40% of them under 15 years of age, and 30% being school students. Gender differentials in education levels and literacy rates are rapidly disappearing and access to education at all levels has nearly achieved gender parity. Over the last few decades, Oman has witnessed tremendous progress in the area of female education with the percentage of female students in all education levels is 50%. It is worth also pointing out that Oman boasts one of the lowest female illiteracy rates in the Gulf region at 23.8% as of 2005 compared to 33% in 2000. Table 3 lists the ppercentage distribution of Omani population (10 years and over) by educational status & gender. Female illiterate are more than male, even though there is just a small difference between the total number of educated female and educated male.

Table 3: *Percentage Distribution of Omani Population by Educational Status & Gender.*

Male%	Female%	Average %	Educational Status
11.81	23.82	17.77	Illiterate
21.17	18.46	19.83	Can read and write
23.66	18.10	20.90	Primary stage of education
19.14	15.78	17.47	Preparatory stage of basic education
17.36	18.39	17.87	Secondary stage
2.77	2.29	2.53	Post secondary non-tertiary
3.50	2.73	3.12	First university degree
0.38	0.10	0.24	Master degree
0.07	0.02	0.04	PhD degree
0.14	0.31	0.22	Not stated

Although these figures indicate that women's advancement in Oman's society have been great in the area of education, Omani women have a rather low practicing rate in the workforce. The report also pointed out that the percentage of females working in the public sector is 31%, while the percentage of those working in the private sector is as low as 17.9%. The report further indicated that females are only 2% of self-employed Omani and make up less than 1% of Omani employers.

Compared to other countries in the Gulf region, where women are still lagging behind in public life and the work force (Ministry of Information 2006), Oman is doing well in terms of the percentage of women in employment and in education. However, from the above mentioned statistics and knowing that women accounted for 49.5% of the population of Oman, one can deduce that many of the educated women are job seekers.

Barriers for women in Oman to the full use of ICT

Omani socio-cultural norms trap and chain women's thinking and ability, and limit their mobility, whether they are living in a thriving urban center or a remote rural village. In addition, Omani women are at a higher risk of being marginalized from today's Information Society, due to factual findings related to a traditionally male-dominated ICT sector, unequal access to training, the lack of "Arabized" Internet content and training, high Internet connectivity costs, and the lack of awareness and policy advocacy, among others.

Although many gender empowerment initiatives have been published in the literature "(United Nations, 2005)", most of these initiatives targeted certain low income and heavily populated regions such as India, Central Africa, and Central and South America. Here the problem is different. The region has lots of socio-culture gender barriers. Unfortunately, few if any regional statistics were available on the status of women in the ICT sector. As far as we know, our research is the first work to address this issue. However, preliminary studies and observations indicated that women are greatly underrepresented (Albarwani, Alghabshi, & Alzadjali 2006). There seemed to be an obvious gender digital gap that motivated our research.

Our Approach

In response to the need in more information about the status of Omani women in the ICT sector, we started this research to conduct a gender sensitive assessment of the ICT sector in Oman and the status of women within it, and to develop the seeds of an information base that provides gender analysis of opportunities and challenges in the ICT space.

In order to achieve this objective, a comprehensive research on the situation of Oman's ICT sector detailing women's location and specific needs was conducted. The research presents an overview of the current situation of the ICT sector in Oman with focus on the gender dimension. The research also identifies the obstacles and opportunities that exist within the ICT sector for women and means of mainstreaming gender issues within national plans at all levels. It includes statistics and data regarding the labor market, the policies and strategies concerning IT and the status of both the private and public sectors.

This research is also an initiative geared towards developing a model of gender sensitive indicators that may be adopted to assess government and policy makers to evaluate the gender digital divide by other countries in the region, and more importantly, used to establish better ICT policies, program and projects, and thereby promote gender equity to ICT.

Eight sets of research were conducted to gather all related information. These include:

- Desk and Internet Research
- University Field Research: Research that targeted 10 Omani academic institutions.
- Field Research of ICT Students: A questionnaire- based field survey that targeted 500 female high school and intermediate college students.
- Field Research of Unemployed and Head of Houses: A questionnaire- based field survey that targeted 500 unemployed and head of houses females.
- Field Research on Omani women: Random walk interview-based field research was carried out with 500 Omani women from the five largest urban centers in Oman.
- ICT Employers and Stakeholders Qualitative Research: This research was conducted through one-to-one interviews with 100 employers and stakeholders in the ICT industry, as well as educational experts and ICT Instructors.
- ICT Training Centers Field Research: A telephone-based field survey was conducted with 10 ICT Training Centers in Muscat, the Capital.

- ICT Employment Research: 100 organizations were contacted to gather information about their ICT labor force, and in particular their female ICT workers in terms of the positions they were holding and their numbers in each reported position.

The data gathered are analyzed using scientific sampling using international standards for drafting questionnaires, conducting surveys, and calculating and minimizing error will be utilized. We have employed P- Tests, F-Tests, and measure of significance. We employed the statistical packages SPSS to analyze the quantitative data. On the other hand, correlation, integration, and forecasting techniques were employed to produce significant results that were used to build some of the listed recommendations in this manuscript.

QUALITATIVE AND QUANTITATIVE ASSESSMENT OF WOMEN IN THE ICT SPACE

From the previous discussion, it is evident that Omani women face many obstacles that prevent them from entering the field of technology, adopting it as a career and working in the ICT sector. These obstacles play a significant role in shaping the decision-making of women and limiting their choices in the ICT space. They are also factors that have for a long time affected their awareness of their inner strengths and of the benefits of ICT to their social, career, and family lives.

In order to investigate the issues that inhibit women from succeeding in the ICT arena further, two sets of field research were conducted. One, qualitative in nature, included interviews with several key stakeholders in the ICT industry. The interviews focused on the obstacles and opportunities for females in the ICT sector. Field research was also conducted among 300 Omani females from different walks of life living in the major three cities of Muscat, Sohar and Salalah. The research examined their knowledge and involvement in ICT. Following are the most prominent insights:

Family pressure and socio-cultural norms

Omani socio-cultural norms that trap and chain women's thinking and abilities, determine their behavior, constrict their interaction with males and limit their mobility are the factors most limiting their access to ICT. Family support or its non-existence affects almost all of a woman's decisions. The family approval is crucial in her choice of education, in the type of job she takes up, in the choice of workplace and its location, as well as the working hours she keeps (Chatty 2000).

Time is something that females have less of. In most cases how a female spends her time is not her decision. The girl, female student, or mother is burdened with responsibilities that fill the time she needs to study and achieve more at work. A married woman's time is even more rationed and she faces demands from every member of the family. The underlying element to this discussion is that what is needed from women is to be better at time management (Chatty 2000).

The above-mentioned findings regarding the obstacles facing women are supported by field research showing that 40% of the women respondents, and 45% of SQU students viewed family responsibilities and socio-cultural norms as being instrumental in prohibiting them personally from developing their ICT knowledge. The research also indicated that this obstacle affects females of all ages and that they are always burdened by family responsibilities. Obstacles based on social norms are those that females tend to expect especially at a younger, less mature age.

The field research indicated that 25% of the women (above 24 years old) and 44% of the young female students (15-23 years old) perceive and expect social norms to be a barrier for woman in studying ICT related fields or working in the ICT sector. Strongly tied to the social norms that are deeply entrenched within the female are the self-imposed limitations on the type of job she can do. Therefore, the perception of future work in ICT sector to be hard with long hours and late

nights spent at work prohibits women from contemplating it as a career. In support of this fact, 21% of the 15-23 years old female students reported such a perception and considered it as an obstacle for females to study ICT. In addition nearly 55% of them said that they would hesitate to accept an IT-related job if it required working after regular office hours.

Mobility in terms of traveling for business or education is another restricting factor for the female depriving her of specialized training, life exposure and the chance to further her career. A mixed gender environment, whether at the work place or classroom, is another deterrent for females, in most cases not because the female herself objects, but because of family and social norms pressure. The field research touched on this issue when 23% of women (above 24 years old) and 18% of young female students (15-23 years old) reported that a mixed environment is an obstacle perceived as discouraging woman from studying ICT-related fields or working in ICT. Furthermore, 34.5% of the students reported that they would hesitate to accept an IT-related job if it is in a mixed work environment and 26% would even hesitate if the job requires dealing with males as well as females.

The innate character issues of Omani females

From the employer's perspective, the female needs to start thinking out of the box. Omani females are put in a frame of thinking that imprints the innate "do's" and "don'ts" deep into their psychological build. Another destructive streak is a deeply inbred dependency mechanism that she relies on in most aspects of her life. The male family members or the husband provide for a female in most cases; this dependency becomes manifested in the women's lack of seriousness at work.

From the female employee's perspective, and based on the results of the field research conducted among women above 24 years old in all walks of life, around 38% of the respondents agreed that the innate characteristics of the female in shying away from more responsibilities at work and the self-imposed duties needed for developing her career, do present an obstacle to her career advancement. However, nearly 62% disagreed and found this not to be true of females or to be an obstacle to her career advancement. Also, only 28% of the women respondents thought that females lacked the initiative and the ambition necessary for competing in the ICT field.

Another two revealing statistics that are suggestive of the students' desire to adopt ICT as their career path were obtained from the interviewed students on the one hand, 72% reported that they are planning to work in ICT-related fields in the future; on the other hand, nearly 50% indicated that if they could not have a job suitable for them in IT, they were ready to shift to a non ICT-based career.

Female stereotyping

The consensus among all employers was that women are more organized, dedicated, meticulous, precise, persistent and loyal. A lot of good qualities are attributed to the female worker, but still she is not the decision maker nor does she occupy positions at the top of the ICT job scale. ICT companies in Oman, as well as other organizations, boast equal opportunity employment for men and women. One issue is that men tend to take advantage of women's timid nature. When a woman is skipped over in promotion to favor a more ambitious and assertive male, she does not generally object.

Discrimination also lies in stereotyping the female within the common framework of social norms. The other stereotyping that is ongoing is categorizing ICT jobs into "female" or "male" jobs. Field research confirmed the above stereotyping, and more so by the females themselves. Almost 72% of the young female students (research set 3) prefer software related and IT training jobs and

actually 62% of female ICT labor force (research set 8) are working in such fields. In addition, around 73% of B.Sc. Degree female students (research set 2) are enrolled in software related ICT subjects such as programming, system analysis and information system managements.

Career counseling and mentorship

The other crucial issue, apart from education that affects an Omani female's decision to join the ICT sector is the availability of career counseling and mentorship. Young females do not know what ICT is all about; they have their misconceptions that are not discussed or demystified by counselors or mentors. Females are not exposed to success stories of other females or their experiences and there is no forum available for raising their awareness about ICT and helping them to choose it as a career.

Entrepreneurship

Entrepreneurship is another area where an Omani female can excel but she is not taught entrepreneurial thinking, nor is it acceptable from the point of view of social norms. Still, the research indicated that a few women entrepreneurs do actually use ICT in generating more income for themselves. Out of the interviewed females (research sets 4, 6, and 8) who have access to a PC of their own, only 18% reported that they use their PC in private income generating activities. Of those, only 8% have been exposed to training in ICT-based business development skills or e-commerce.

The research conducted among women (research sets 4 and 5) indicated that nearly 44% of them do not know how to operate and use a PC, and less than 32% have access to a computer of their own, with only 45% of those actually using the PC they have. This limits entrepreneurship and employment activities especially, when the Internet is one method that women can use to find markets for their goods and to educate themselves through e-learning.

Access to PC and Internet

Barriers to ICT access are not only about the national availability of telecommunications infrastructure and PC equipment. The know-how is equally or more important than the access itself, as though it was sufficient to provide women with PCs and Internet connections to overcome their enabling problems.
Barriers to individual access are also economic and educational. Therefore, lack of sufficient access to ICT to be able to use it as a tool in their lives is due to a combination of factors, some of which can be summarized as follows:

- Not having access to a PC or the Internet due to the prohibitive costs of owning one.
- ICT illiteracy.
- Lack of Arabized local contents and as well as English language knowledge.
- Lack of awareness of ICT benefits and their effect on human life issues and decisions.

The research conducted among women indicated that nearly 44% of them do not know how to operate and use a PC, and less than 32% have access to a computer of their own, with only 45% of those actually using the PC they have. This limits entrepreneurship and employment activities especially since the Internet is one method that women can use to find markets for their goods, learn about their rights, and educate themselves through e-learning.

These obstacles are magnified when combined with the lack of knowledge in the English language and the lack of financial means to learn PC skills. In fact, 28% of the students (research sets 2 and 3) said that the lack of financial means is an obstacle preventing females from enrolling in ICT specializations at private universities and colleges, and 35% reported that the

same obstacle prevents females from acquiring further education in ICT specializations through certification or post graduate studies. Additionally, nearly 22% of the women (research sets 4 and 5) reported fear and lack of ICT awareness and knowledge as an obstacle stopping them from developing their ICT knowledge.

CONCLUSION AND POLICY IMPLICATIONS

One major factor that demands attention is that ICT is a tool that can either be used to transform and liberate or to continue reproducing traditional ways of life that exclude women. Female users may come to ICT with goals that fit rigidly within the confines of socially defined gender roles but it is possible that, once they are exposed to ICT, they can undergo a process of empowerment. For this to happen, ICT should be promoted within the larger goal of enhancing the capabilities of women and empowering them through information and knowledge gain. In order for the above to take place, the major issue of cultural transformation must be addressed. The process of transformation, where the basic underlying belief system of the individual or organization undergoes a fundamental shift, is what will drive the empowerment at all levels, whether of the rural or urban, male or female, macro or micro levels. This cultural transformation has the goal of broadening the imagination and enhancing the problem solving ability among both females and males. As far as ICT goes, there is no doubt that these deep changes must occur at the level of the woman user, the patriarchal male, and the policy maker. This cultural transformation is not a quick process, however, ICT tools are the most suitable for its acceleration.

Another concern the research team would like to raise is that programs designed to introduce ICT to females are much more likely to be effective if they are designed on the basis of women-centered demand-driven than if they are technical solutions supply-driven. Projects of the latter kind risk becoming experiments that will last while there is external support, but are unlikely to be sustainable or result in appropriation of the technology. Training methods are often 'ad-hoc,' alienating and not customized to women's needs. Learning practices for women should be extended to girls and women, made gender-sensitive (making training women-specific, ensuring ongoing user support, and mentoring in the communities where women live) and deepened (for women as users, technicians, and policy-makers). Moreover, training programs for women should focus not only on how to use the technology and software, but also on how to find, manage, produce and disseminate information. This in turn calls for a serious investment in developing a sustainable strategy, in training people within the program-owning organizations in areas such as information management and production and in developing organizational policies in communications and coordination. If policy makers are unable to do so, we might end up merely solving yesterday’s problem and the gender digital gap will remain or even widen. Policy implication

The analysis and recommendations presented here are intended to assist policymakers who are willing and committed to reorienting ICT policy to take account of the needs, aspirations, and constraints of women in the Omani society. The following are some of the most prominent identified gaps and possible recommendations:

Gender information and statistics Gap

There is no information upon which decisions regarding the development needs of females can be based. There are also no indicators that measure and monitor the effects and changes. Identifying gender indicators in ICT initiatives whether in policies, strategies, programs, projects or activities can be an effective way of ensuring that women's particular needs are considered in the planning processes at all levels in the ICT space. ICT gender-sensitive indicators are useful tools in measuring or evaluating the impact of development initiatives in the ICT field and in

advocating for engendered policies. Mechanisms for continuous collection and synthesis of this information must be devised and systematically applied.

Outreach to Oman females Gap

Statistics indicate that there is a huge market of females to train in ICT, but the challenge is how to reach them. The hardest issue in development work is coordination among the different NGOs, programs and parties involved. ICT is becoming a major focus for a wide range of development actors but the lack of coordination can lead to duplication of effort, incompatibility of solutions, and compromised sustainability. In such a situation where coordination is lacking, development actors end up as competitors and not partners in the service of the national good. The fact that ICT is more effective when carried out as part of a network system is completely lost.

The newly established Information Technology Authority (ITA), the body in the government in charge of all ICT activities, is well positioned among different stakeholders to lead and coordinate women's empowerment through ICT (ITA 2006). ITA, in partnership with Ministry of Education for example, can sponsor initiatives to utilize many female schools in all regions of Oman in the afternoon to act as (telecenters) for girls and job seekers with the aim of increasing ICT access among all communities.

Omani Women Association (OWA 2007) has also started in partnership with Microsoft the Women in IT program (WIT-Oman 2007). The goal of such a program is to transform the 50 branches of the OWA all over Oman into community technology learning centers (CTLCs). Selected graduates from these two initiatives can be appointed as system administrators and trainers who could respond to the women's needs for information, raise their awareness and mentor them and their children about ICT and its economic benefits.

Gender sensitive policies Gap

Gender blindness among the ICT strategies, as well as ICT blindness among female development-related policies is damaging to both the economic situation of Oman and enhanced female contribution to its development. Affirmative actions related to women's role in ICT, whether as students or workers, are essential in the infancy period of these policies. Strategies must be monitored through gender-disaggregated statistics that measure performance, guide actions, and monitor the accomplishment of goals. Above all, strategies must be communicated to females and their female development support components be made known to their female audience.

ITA could take the lead role, in partnership with the Ministry of Manpower, in reviewing national ICT policy frameworks, as well as existing ICT projects and initiatives, and examining them from a gender viewpoint in order to narrow the wide gender gap and advocate for mainstreaming of gender in the different policies. This is the first step towards correcting a situation that could lead to leaving half of Oman's population in information isolation and a declining economic situation. Raising gender and ICT awareness among policy makers and members of the government agencies involved in telecommunications, science and technology is another intervention possible through the above partnership. Gender sensitization training is a starting point in gender mainstreaming and policymakers need to be made aware of the specific issues related to the impact of ICTs on women. This type of training must be conducted with the goal of transforming the perspective of the individuals and the institutions, as opposed to simply informing them.

Entrepreneurship Gap

There is abundant capacity building, business development, and entrepreneurial skills training offered by many NGOs and international organizations and donors. However, none of those organizations combine ICT training or adopt ICT-based business development skills or e-commerce. On the other hand, ICT training does not combine such creativity building, business development and entrepreneurial skills in its offerings. In addition, very few NGOs offer business incubation for female entrepreneurs let alone those with ICT related businesses. There are also no linkage mechanisms between the would-be ICT entrepreneurs and the sources of jobs in the ICT and non-ICT markets.

Graduates from both initiatives (ITA-Telecenters and WIT-Oman) could be instrumental in educating women to utilize the opportunities offered by the provision of them and raising their awareness of the economic benefits of ICT and how it can be a tool for them to re-enter the labor force.

Combining SQU research capacity and the above mentioned initiatives' graduate knowledge of ICT, economic-ICT needs assessment studies could be conducted in the various communities around these community centers. Based on these studies, appropriate ICT programs that respond to these needs could be devised and developed with the female communities. These centers in turn could be used as incubators for identified ICT-based women-owned businesses, thus transforming the center into a business hub where ICT is used as a tool for economic empowerment of women.

Combining the above with the option of obtaining finance from microfinance institutions to enable the incubated ICT-based businesses to graduate and operate outside the community centers, would add to the empowerment of women and the economy of the community. Linking channels between ICT female entrepreneurs and companies needing their services could also be built through a specialized and widely publicized website where both meet in an e-commerce B2B presence.

Female Labor Gap

Females are still responding to gender stereotyping of ICT jobs. Few are attempting to enter the non-conventional engineering and hardware-based ICT space, and even fewer fight their way to the top positions of the ICT scale. Employers are not being encouraged to provide the flexible work environment for females (flexible working hours, on-site daycare, or teleworking from home), nor are they made aware of the benefits of employing and retaining female employees.

Oman is in need of programs to raise the awareness of both employers and employees regarding the benefits of employing females and of creating more professional employees. Such programs could consider exposing young females to successful females in the ICT space in their communities, who could act as role models as well as devising methods for mentoring activities. Efforts are needed among many stakeholders such as government, private sector ICT companies, and larger corporations to facilitate job placement opportunities for ICT female graduates. Graduates could be engaged in the e-government programs and could play a supportive role to work with the infrastructure projects, and to develop integrated system architecture for proper information sharing and protection.

Socio-cultural norms and other ICT obstacles Gap

Socio-cultural norms are perceived and constantly expected by females to be a barrier discouraging them from joining the ICT areas when studying and working. This lower degree of

determination to adopt ICT as a career and the discrepancy between how the employer views the female employee and how she thinks and views herself are issues that must be addressed. This can be achieved through career counseling, campaigns to raise the awareness of ICT career benefits and work opportunities relating to females.

Although ICT is one effective tool to empower women socially and economically, chatting is still considered the most common usage of Internet in Oman among females harnessing the targeted goals of using ICT for female economic empowerment and social empowerment. Moreover, there are no Arabic-based community portals through which women could network and share knowledge and information relevant to their homes, work experiences, and social problem solving. NGOs are often the most important initiators, implementers, intermediaries and beneficiaries of ICT projects, especially those that target female access and other more developmentally minded endeavors. However, to date the majority of such national gender-related NGOs in Oman (mainly the OWA) use the Internet mainly to disseminate static information about the organization and its programs.

Few strategies that advocate women's status, and even fewer allow women to network using their gender advocacy websites. However, the new OWA-WIT program can be extended to tackle all the abovementioned gaps with special programs that respond to the needs of raising awareness, mentorship, and disseminating information to women. Another arena for raising awareness is advertising and advocating ICT through seminars, brochures, and flyers, as well as through radio and TV channels.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 16-29.

E-learning data warehouse maintenance system for collaborative learning availability resources optimization

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ABSTRACT

An E-learning Data Warehouse (EDW) is constituted of information collected from heterogeneous, distributed, and autonomous E-learning Information Sources (EISs). EDW, which is fed by view definitions' built upon EISs, is frequently interrogated by e-learning actors such as educators, learners and decision makers for many reasons going from consultation to analysis. The above view definitions, which represent considerable informational resources, can become undefined when EISs change their schemas. This obviously decreases e-learning resources availability and consequently affects analysis efficiency.

In this paper, we propose to study the issues of using agent's based architecture to achieve e-learning data warehouse maintenance under schema changes by repairing automatically affected view definitions. This implicitly optimizes e-learning resources availability by automatically finding replacements for affected components belonging to view definitions.

Key-Words: *Data Warehouse, Maintenance, Collaborative e-learning, Schema changes, Agents.*

INTRODUCTION

The e-learning data warehouse is built by gathering shared data from e-learning information sources and integrating them into one personalized deposit according to e-learning users needs in order to have persistent information about the e-learning system, to avoid networks traffic saturation and resources unavailability. One of the significant tasks of an e-learning Data Warehouse Maintenance System (e-DWMS) is to update the materialized views during the changes of e-learning information sources data. Moreover, beyond the updates of data, we note that the changes of schema are also rather frequent in the distributed applications such as in the e-learning domain (Breslin, et al 2006; Saliah-Hassane, 2006; Sheehy, et al 2006). A change of schema could occur for many reasons and at any time during participating e-learning information sources life cycle. In fact, the e-learning information sources in such environments can change continuously not only contents but also their schemas which may render view definitions built among e-learning data warehouse undefined, and consequently decrease significantly e-learning resources unavailability.

Our solution has the goal to preserve the maximum number of view definitions instead of being completely bewildered with each information source schema change, while allowing implicitly view materialization by proposing a prototype solution to automate view definitions rewriting thanks to Meta knowledge about information space formed by information sources, to Meta knowledge about user space constituted by evolving view definitions, and view synchronization algorithms (Rundensteiner, et al 1997; Zhang, et al 2001).

Adding to that, the increase in user demand of a quick reach of distributed information large volume, the more autonomy requirements, and the need to avoid network saturation and to minimize communication costs have led to the adoption of the new rising techniques such as

agents, resulting from research in distributed artificial intelligence, to solve several problems such as e-learning data warehouse maintenance by decreasing the maintenance process time, and increasing e-learning data warehouse maintenance system components availability .

The remainder of this paper is organized as follows:

- In section 2, we detail the problem and foundations of view definition maintenance under schemas changes. We also illustrate the maintenance process by some running examples showing how e-learning resources availability may be improved.
- In section 3, we describe our solution based on static agents. We also explain agents' roles and interaction leading to view definitions survival and implicitly to resources availability enhancement.
- In section 4, we improve the solution by integrating agent mobility model which takes into account the system components partition.
- In section 5, and before to conclude, we describe and discuss the implementation.

VIEW DEFINITION MAINTENANCE UNDER SCHEMA CHANGES

In order to increase e-learning information resources availability, we propose a solution to solve the problem of view inflexibility. This solution has the goal to preserve the maximum number of affected view definitions by the occurrence of e-learning information sources schema changes. This implicitly allows the view definition evolving which is, in former work, carried out by the developers. We assume that information sources are integrated in the e-learning system via a wrapper which translates their structures into a relational common model. They are supposed to be heterogeneous and autonomous which join, or change dynamically their capabilities such as their schema.

E-DWMS includes two basic modelling tools: a model that permits to user the expression of view definition evolution via an extended SQL called Evolvable SQL (E-SQL) and a model for the description of the information sources (MISD) (Rundensteiner, et al 1997) and the relationships between them. This model of e-learning information sources description can be exploited for seeking a suitable substitution for the affected view definition components (attributes, relations, and conditions). The View Knowledge Base (VKB), which contains views definition expressed with preferences by users and described by E-SQL and the Meta Knowledge Base (MKB) revealed by MISD, represent the base for any operation of view rewriting or view synchronization process.

The Meta Knowledge Base (MKB)

The e-DWMS constitutes an intermediary between the e-learning user space called E-learning Data Warehouse and the information space including the participating e-learning data sources. When an e-learning information source joins the structure of e-DWMS, it provides its structure, its data model and eventually it's content. This information, also called descriptive knowledge, are stored into the MKB with respect to the MISD, or any other knowledge representation models such graphs.

As well, the relationships between e-learning information sources, also called substitution rules, have to be added by the e-DWMS administrator and/or generated automatically, then inserted into the MKB. This information constitutes the key platform for finding affected view definitions components substitutions.

The e-learning system knowledge is stored into the MKB and constitutes two main classes:

- The descriptive knowledge class composed by a set of e-learning information sources schemas as given in figure 1.
- The substitution knowledge class describing relations between e-learning information sources and composed by a set of rules or constraints such as Join Constraints as given in figure 2, Type Integrity Constraints as given in figure 3, figure 4, and figure 5 and Partiel\Complete Constraints as given in figure 6.

In the following, we give an example (figure 1) of a collaborative e-learning system composed by three institutes collaborating to provide common e-learning resources for e-learning large community. Each institute forms an E-learning Information Sources (EISi) having its proper schemas and contents. This example will be used in the rest of this paper.

EIS ID	**Relation provided**
EIS 1	Course (Course-Id, Name, Duration)
	Professor(Prof-Id, Name, Phone-Number, Address, Title, Diplomas, E-mail)
	Student (Stud-Id, Name, Level, Nationality)
	Course-Ref (Course-Id, Ref-Id)
	Stud-Course (Stud-Id, Course-Id)
	Teach-Course(Prof-Id, Course-Id)
	Reference (Ref-Id, Authors, Availability, Subject)
EIS 2	Course (Course-Id, Name, Duration)
	Professor(Prof-Id, Name, Phone-Number, Address, Title, E-mail)
	Student (Stud-Id, Branch-Id, Name, Level, Nationality)
	Stud-Course (Stud-Id, Course-Id)
	Teach-Course(Prof-Id, Course-Id)
	Branch (Branch-Id, Name, Duration)
	Course-Med (Med-Id, Course-Id)
	Media (Med-Id, Type, Marque)
	Publication (Pub-Id, Publication-Date, Subject, Volume)
	Prof-Pub (Pub-Id, Prof-Id)
EIS 3	Course (Course-Id, Name, Duration)
	Professor(Prof-Id, Name, Phone-Number, Address, Title, E-mail)
	Stud-Course (Stud-Id, Course-Id)
	Teach-Course(Prof-Id, Course-Id)
	Student (Stud-Id, Branch-Id, Name, Level, Nationality)
	Media (Med-Id, Type)
	Course-Med (Med-Id, Course-Id)

Figure 1: *E-learning Information Sources*

JC	*Join Constraints*
JC1	EIS1.Course.Name=EIS2.Course.Name
JC2	EIS1.Course.Name=EIS3.Course.Name
JC3	EIS1.Professor.Title=EIS2.Professor.Title
JC4	EIS1.Professor.Title= EIS3.Professor.Title
JC5	EIS2.Media.Type=EIS3.Media.Type
JC6	EIS1.Professor.Prof-Id= EIS2.Professor.Prof-Id

Figure 2: *Join Constraints*

TCEIS1.Professor (Prof-Id, Name, Phone-Number, Address, Title, Diplomas, E-mail) = Professor(Prof-Id, Name, Phone-Number, Address, Title, Diplomas, E-mail) $\subseteq$ Prof-Id (Number)$\times$Name(String) $\times$Phone-Number(Number) $\times$Adresse (String) $\times$Title(String) $\times$Diplomas(String) $\times$E-mail(String)
TCEIS1.Course (Course-Id, Name, Duration)= Course (Course-Id, Name, Duration) $\subseteq$Course-Id(Number) $\times$Name(String) $\times$Duration(Number)
TCEIS1. Student (Stud-Id, Name, Level, Nationality)= Student (Stud-Id, Name, Level, Nationality) $\subseteq$ Stud-Id (Number) $\times$Name (String) $\times$Level (String) $\times$Nationality (String)
TCEIS1. Course-Ref (Course-Id, Ref-Id) =Course-Ref (Course-Id, Ref-Id) $\subseteq$Course-Id(Number)$\times$Ref-Id(Number)
TCEIS1. Stud-Course (Stud-Id, Course-Id)= Stud-Course (Stud-Id, Course-Id)$\subseteq$ Stud-Id(String)$\times$ Course-Id(String)
TCEIS1.Teach-Course(Prof-Id, Course-Id) = Teach-Course(Prof-Id, Course-Id)$\subseteq$ Prof-Id(Number) $\times$ Course-Id(Number)
TCEIS1. Reference (Ref-Id, Authors, Availability, Subject) = Reference (Ref-Id, Authors, Availability, Subject)$\subseteq$ Ref-Id(Number)$\times$ Authors(String)$\times$Availability(String)$\times$Subject(String)

Figure 3: *EIS1 Type Integrity Constraints*

TCEIS2.Professor (Prof-Id, Name, Phone-Number, Address, Title, E-mail) = Professor(Prof-Id, Name, Phone-Number, Address, Title, Diplomas, E-mail) ⊆ Prof-Id (Number)×Name(String) ×Phone-Number(Number) ×Adresse (String) ×Title(String)×E-mail(String)
TCEIS2.Course (Course-Id, Name, Duration)= Course (Course-Id, Name, Duration) ⊆Course-Id(Number) ×Name(String) ×Duration(Number)
TCEIS2. Student (Stud-Id, Name, Branch-Id, Level, Nationality)= Student (Stud-Id, Name, Level, Nationality) ⊆ Stud-Id (Number) ×Name (String) ×Level (String) ×Branch-Id(Number)×Nationality (String)
TCEIS2. Stud-Course (Stud-Id, Course-Id)= Stud-Course (Stud-Id, Course-Id) ⊆ Stud-Id(String)× Course- Id(String)
TCEIS2.Branch (Branch-Id, Name, Duration) = Branch (Branch-Id, Name, Duration) ⊆ Branch-Id(Number)× Name(String)× Duration(Number)
TCEIS2.Teach-Course(Prof-Id, Course-Id) = Teach-Course(Prof-Id, Course-Id)⊆ Prof-Id(Number) × Course-Id(Number)
TCEIS2.Publication (Pub-Id, Publication-Date, Subject, Volume)=Publication (Pub-Id,Publication-Date, Subject, Volume)⊆ Pub-Id(Number)× Publication-Date(Date)× Subject(String)×Volume(String)
TCEIS2. Media (Med-Id, Type, Marque) = Media (Med-Id, Type, Marque) ⊆ Med-Id(Number)×Type (String)×Marque(String)
TCEIS2. Course-Med (Med-Id, Course-Id) = Course-Med (Med-Id, Course-Id) ⊆ Med-Id (Number)×Course-Id(Number)
TCEIS2.Prof-Pub (Pub-Id, Prof-Id) = Prof-Pub (Pub-Id, Prof-Id)⊆ Pub-Id(Number)×Prof-Id(Number)

Figure 4: *EIS2 Type Integrity Constraints*

TCEIS3.Professor (Prof-Id, Name, Phone-Number, Address, Title, E-mail) = Professor(Prof-Id, Name, Phone-Number, Address, Title, Diplomas, E-mail) ⊆ Prof-Id (Number)×Name(String) ×Phone-Number(Number) ×Adresse (String) ×Title(String)×E-mail(String)
TCEIS3.Course (Course-Id, Name, Duration)= Course (Course-Id, Name, Duration) ⊆Course-Id(Number) ×Name(String) ×Duration(Number)
TCEIS3. Student (Stud-Id, Name, Branch-Id, Level, Nationality)= Student (Stud-Id, Name, Level, Nationality) ⊆ Stud-Id (Number) ×Name (String) ×Level (String) ×Branch-Id(Number)×Nationality (String)
TCEIS3. Stud-Course (Stud-Id, Course-Id)= Stud-Course (Stud-Id, Course-Id) ⊆ Stud-Id(String)× Course- Id(String)
TCEIS3. Media (Med-Id, Type, Marque) = Media (Med-Id, Type, Marque) ⊆ Med-Id(Number)×Type (String)×Marque(String)
TCEIS3. Course-Med (Med-Id, Course-Id) = Course-Med (Med-Id, Course-Id) ⊆ Med-Id (Number)×Course-Id(Number)

Figure 5: *EIS3 Type Integrity Constraints*

PC EIS1.Professor,EIS2.Professor **= (**πProf-Id, Name, Phone-Number, Address, Title, E-mail (EIS1.Professor) $\subseteq$ πProf-Id, Name, Phone-Number, Address, Title, E-mail (EIS2.Professor))
PC EIS3.Media, EIS2.Media = (π Med-Id, Type (EIS3.Media)$\subseteq$ π Med-Id, Type (EIS2.Media))
PCEIS1.Student,EIS2.Student=(π Stud-Id, Name, Level, Nationality(EIS1.Student) $\supseteq$ π Stud-Id, Name, Level, Nationality(EIS2.Student)

Figure 6: *Partial/Complete Information Constraints*

The View Knowledge Base (VKB)

E-SQL language allows including user preferences into SQL view definition. E-SQL is an extension of SELECT-FROM-WHERE SQL enriched by specifications defined by the developer in charge of the view definitions in order to indicate how those latter can evolve after schema changes. This latter can take the following values: attributes, relations or e-learning information sources deletion; attributes, relations or information sources addition; attributes, relations or information sources renaming. The E-SQL defined views are then stored into a structure called View Knowledge Base and respect the following syntax:

CREATE VIEW V [(Local_Column_List)][(VE =[‘$\supseteq$‘ | ‘$\subseteq$‘ | ‘$\equiv$ ‘ | ‘$\approx$‘] **AS**
SELECT Attribute_Name [(AD = [true | false], AR = [true | false])]
[, Attribute_Name [(AD = [true |false], AR = [true | false])] .. .]
FROM Relation_Name [(RD = [true | false], RR = [true | false])]
[,Relation_Name [(RD = [true | false], RR = [true | false])] . ..]
WHERE Clause_Primitive [(CD = [true | false], CR = [true | false])]
[, Primitive_Clause [(CD = [true | false], CR = [true | false])] . ..]

As indicated in the E-SQL view, each view definition component (Attribute, Relation, or Condition) has two evolution parameters which are detailed in the following table (figure 7).

Evolution Parameter	Semantics	Default Value
Attribute Dispensable (AD)	true : dispensable	false
Attribute Dispensable (AD)	false : indispensable	
Attribute Replaceable (AR)	true : replaceable	false
Attribute Replaceable (AR)	false : non replaceable	
Condition Dispensable (CD)	true : dispensable	false
Condition Dispensable (CD)	false : indispensable	
Condition Replaceable (CR)	true : replaceable	false
Condition Replaceable (CR)	false: non replaceable	
Relation Dispensable (RD)	true : dispensable	false
Relation Dispensable (RD)	false : indispensable	
Relation Replaceable (RR)	true : replaceable	false
Relation Replaceable (RR)	false : non replaceable	

Figure 7: *E-SQL View Evolution Parameters*

It should be noted that the replacement view extent can be equivalent, a superset or a subset of the initial view extent. To represent this characteristic, a parameter called VE (View Extend) is used in each E-SQL view definition. VE Values are presented in the following figure (figure 8).

View extends parameters	Semantics
≡	V' is equal to V
⊇	V' is a super set of V
⊆	V' is a subset of V
≈	indifference

Figure 8: *E-SQL View Extent Parameters*

To illustrate the use of E-SQL view definitions for querying e-learning information sources in order to gather information for the e-learning Data Warehouse, we present some examples showing the impact of schema changes on resources unavailability and the solution to this problem performed by view synchronization algorithms, thanks to knowledge stored in the MKB and VKB.

Example 1

Suppose that some users need to have names and emails of professors belonging to EIS1 in order to recruit some of them, or to organize with their help, a kind of a seminar. The following view definition permits to query a common EDW including information gathered from collaborating e-learning information sources. It states that users want the list of assistant professors whatever they teach.

SQL view1:
CREATE VIEW V **AS**
SELECT P.Name , P.E-mail
FROM EIS1.Professor P
WHERE P.Title = "Assistant Professor";

Knowing that collaborating e-learning information sources are autonomous, EIS1 administrator may delete "Title" and/or the "E-mail" attributes from "Professor" relation, for a design or security reasons. Obviously, SQL view1 becomes undefined, couldn't work anymore, and decrease resources availability.
The solution increasing resources availability comes from view synchronization process which have the role to find replacements for disappeared components, and rewrite view definition thanks to Knowledge stored in the MKB and preferences embedded in view definitions based E-SQL (see E-SQL view 1).
The semantic of the following example, states that users may accept the replacements of EIS1 assistant professors by assistant professors, either from EIS2.Professor, or EIS3.Professor, if EIS1.Professor is deleted. They would also accept professors E-mail from EIS2.Professor, if the E-mail attribute is deleted.

E-SQL view1:
CREATE VIEW V1 VE = '⊇'**AS**
SELECT P.Name, P.E-mail (AD=false, AR=true)
FROM EIS1.Professor P(RD = false, RR=true)
WHERE (P.Title = "Assistant Professor") (CD = false, CR = true);

Example 2

The following query (E-SQL view 2) permits to obtain list of students learning the course "algorithmic", from the relation EIS1.Student. However they would accept information belonging to EIS2.Student in the case of unavailability information from the first source.

E-SQL view 2:
CREATE VIEW V2 VE = '⊆'**AS**
SELECT S.Name (AD=false, AR=true), S.Stud-Id (AD=false, AR=true)
FROM EIS1.Student S(RD = false, RR=true), EIS1.Stud-Course SC(RD = false, RR=true),
EIS1.Course C (RD = false, RR=true)
WHERE (SC.Stud-Id = S.Stud-Id) (CD = false, CR = true) **and** (C.Course-Id=SC.Course-Id)
(CD = false, CR =true) **and** (C.Name=" Algorithmic") (CD = false, CR = true);

Example 3

The following query permits to get the list of courses taught using a media type =”X” from EIS2.Media, and may accept to have this information from EIS3.Media in the case of EIS2.Media deletion.

E-SQL view3:
CREATE VIEW V3 VE = '⊆'**AS**
SELECT C.Name (AD=false, AR=true)
FROM EIS1.Course C (RD = false, RR=true), EIS1.Media M(RD = false, RR=true), EIS1.Course-Med CM (RD =false, RR=true)
WHERE (C.Course-Id = CM.Course-id) (CD = false, CR = true) **and** (CM.Med-id = M.Med-Id)
(CD = false, CR = true) **and** (M.Name=" X") (CD = false, CR = true);

Example 4

The following query permits the get the list of shared courses between e-learning information sources EIS1, EIS2, and EIS3. It can give only common courses between EIS1 and EIS2 in the case of EIS3 deletetion.

E-SQL view 4:
CREATE VIEW V4 VE = '≈'**AS**
SELECT C1.Name (AD=false, AR=true)
FROM EIS1.Course C1(RD = false, RR=false), EIS2.Course C2(RD = false, RR=false), EIS3.Course C3(RD = false, RR=true)
WHERE (C1.Name = C2.Name) (CD = false, CR = false) **and** (C1.Name =C3.Name) (CD = true, CR = true)

We mention that, due to the integration of the e-learning resources into the EDW, the above view definitions give results independently on networks traffics, faults or costs. Moreover, affected view definitions by schema changes may survive, thanks to repairing process which takes into account user preferences. These too facts contribute considerably into the enhancement of e-learning resources availability.

Note that e-learning information sources participating to such systems may increase and consequently the possibilities of resources substitutions may also increase. This means that the

collaboration between e-learning users' community and availability factors may increase in an e-learning dynamic environment where information sources schemas evolve frequently.

2.3 View synchronization

The view synchronization [2] consists in determining legal rewritings for the affected views, referring to the rules or constraints embodied into the MKB. These rules enable substitutions retrieval for the affected view definition components while respecting preference parameters described into the VKB.
The view rewriting is legal when it is compatible with the current information space. This rewriting have to preserve the information presented by the initial view definition according to preferences parameters associated to the view definition components and the possibilities of substitutions offered by the MISD.

Example 5

In the case of E-mail attribute deletion from EIS1.Professor relation, using partial/complete constraints, view synchronization algorithms may replace the affected attribute by EIS2 E-mail attribute. This is due to the fact that the two attributes have a same type and EIS2.Professor relation is a subset of EIS1.Professor relation. Consequently, the E-SQL view 1 becomes:

> E-SQL view1':
> **CREATE VIEW** V1' VE = '⊇'**AS**
> **SELECT** P.Name (AD=false, AR=true), P2.E-mail (AD=false, AR=true)
> **FROM** EIS1.Professor P (RD = false, RR=true), EIS2.Professor P2 (RD = false, RR=true)
> **WHERE** (P.Title = "Assistant Professor") (CD = false, CR = true) **and** (P.Prof-Id=P2.Prof-Id);

In the case of EIS1.Professor relation deletion, synchronization algorithms may replace EIS1.Professor relation by EIS2.Professor, thanks to partial/complete constraints established between them.

> E-SQL view1'':
> **CREATE VIEW** V1'' VE = '⊇'**AS**
> **SELECT** P2.Name, P2.E-mail (AD=false, AR=true)
> **FROM** EIS2.Professor P2 (RD = false, RR=true)
> **WHERE** (P2.Title = "Assistant Professor") (CD = false, CR = true);

AGENT-E-DWMS

Previous works (Lee, et al 1997; Rundensteiner, et al 1997), related to Data Warehouse maintenance under schema changes, adopt a centralized framework for maintaining view definitions under schemas changes, which is not suitable for distributed and dynamic environments. In fact, e-DWMS was implemented as a compact module including administration, detection and synchronization. For these reasons, our system evolved to integrate new design, functionalities and technologies. In spite of centralized framework, Agent-e-DWMS framework is distributed using static agents to solve the problem of view synchronization in distributed collaborative learning environments. In Agent-e-DWMS, a static agent is an autonomous entity that pursuits its own goals and objectives, and resides only in the system where it starts

execution. If it needs information from another system or needs to interact with agents in another system, it uses a communication mechanism such as messaging or remote procedure calling.

A figure schematizing Agent-e-DWMS framework related to our collaborative learning example is presented in the following figure (figure 9).

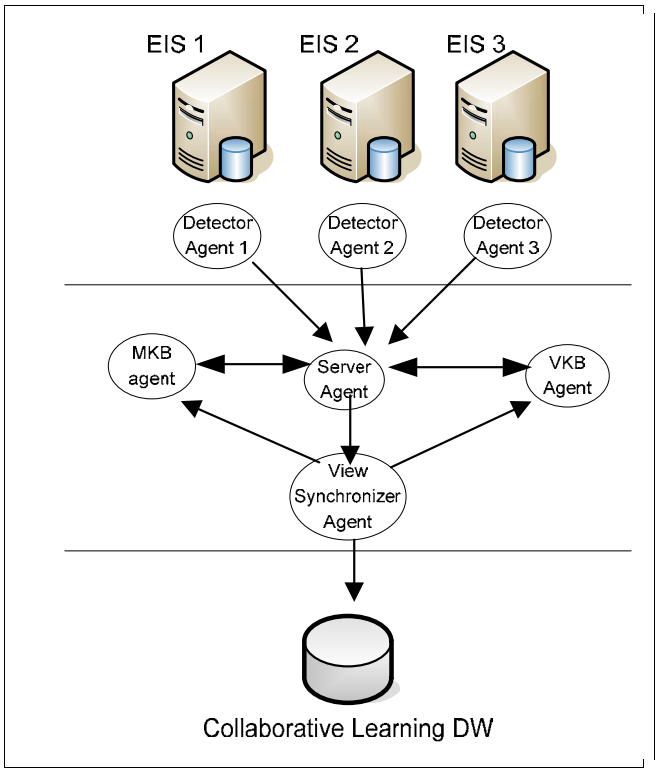

Figure 9: *Agent-e-DWMS framework*

Agent-e-DWNS architecture is distributed on five entities: the Server Agent, the Detector Agent, the MKB Agent, the VKB Agent and the View Synchronizer Agent, as shown in figure 9. Communication between agents [4] can be ensured either by message sending or by agent migration. In our model communication will be guaranteed by the traditional message sending. In fact, all the e-learning agents of the model know each other directly via their identifier, names and sites. Thus, any agent of the system can communicate directly with any other agent. The different exchanges messages between agents needed to resolve the problem of views synchronization in the collaborative learning system are shown in the following figure 10.

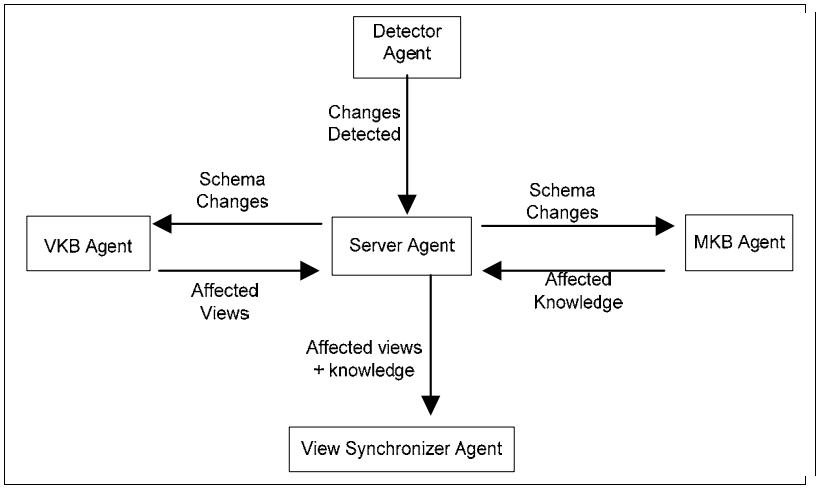

Figure 10: *Agents' communication*

Dispatching e-DWMS Tasks

The Server Agent is the heart of the e-DWMS. It has the role of initializing the system and dispatching e-DWMS tasks on Detector, MKB, VKB and View Synchronizer Agents. In fact, the Server Agent supervises the correct functioning of all the other agents' instances deciding on their creation, suspension and ending allowing coordination and synchronization between them. In other words, it plays the role of the manager of all the Agent-e-DWMS. When the collaborative learning system is triggered, the Server Agent starts by creating the various agents of the model.

Detecting e-DWMS affected EIS schemas

The Detector Agent is an agent implemented into each e- learning information source. It is responsible of the detection of changes which have occurred on the level of the structures of the participating e-learning information source to the system. Indeed, it traverses an e-learning information source with an aim to detect a change by comparing the schema of the source at moment t and at moment t-1. Its mission consists on, transmitting any schema change occurred in the e-learning information source, to the Server Agent.

Affected e-learning Rules Determination

The MKB Agent processes the data received from the Server Agent. This latter transmits to it any schema changes occurred into any e-learning information sources. After that, the MKB Agent analyses the Meta Knowledge Base in order to detect the whole unit of affected knowledge or rules by the schema changes received to send them to the Sever Agent.

Affected e-learning Query Computing

The VKB Agent has the role of detecting the subset of views definitions affected by occurred schema changes. In fact, following the changes received, VKB Agent checks within the VKB to determine the set of views definitions which contain one or more components affected by the changes. After that, the VKB Agent transmits the result, composed by the affected views definitions, to the Sever Agent.

Affected e-learning Query Rewriting

After the reception of the affected rules, the affected knowledge and the affected views definitions from the Server Agent, the View Synchronizer Agent starts to check if it is possible to determine a legal rewritings for the affected views in order to create new views definitions compatibles with the current state of the information space. For that, it refers to the e-learning users preferences expressed into the E-SQL affected views received. When the synchronization process is well done, the View Synchronizer Agent transmits its results to the MKB Agent and the VKB Agent in order to update respectively the MKB e-learning rules and the VKB views definitions, according to the new e-learning information space state.

MOBILE E-DWMS

Mobile-e-DWMS evolves Agent-e-DWMS framework to become more adapted to dynamic environments. These environments are characterized by a great number of information sources. Each one has a huge mass of information that can not be implemented in a single machine, but in a local or wide network. In fact, an e-learning information source can be distributed in many machines forming a network. It is the same thing for the VKB and the MKB. Even the collaborative learning data warehouse can be divided into many data marts according to repartition criteria. So, Agent-e-DWMS detector agent, MKB agent, VKB agent must be replaced by mobile ones to become able to move from one machine to another of respectively an e-learning information source, an MKB, and a VKB networks. Concerning the View Synchronizer Agent and the Server Agent, they don't need the mobility characteristic because they don't move from one machine to another of a network to accomplish their tasks. Mobile-e-DWMS keeps the same agents' communication (figure 10). The following figure (figure 11) represents a collaborative learning system using the Mobile-e-DWMS framework.

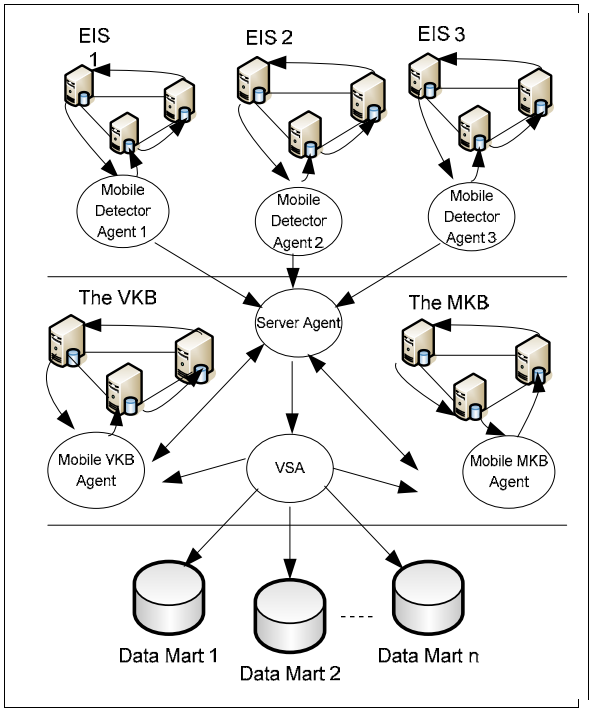

Figure 11: *Mobile e-DWMS framework*

By adding the mobility paradigm, e-DWMS agents evolve towards new dimensions. In fact:

- As we have seen, an e-learning information source can be distributed in a local or wide network. For that reason, the Detector Agent should become a mobile one able to move from one machine to another of an e-learning information source network to find all schema changes occurred.
- The Meta Knowledge Base can be distributed in a local or wide network. To compute affected knowledge, the MKB agent is replaced by a mobile one capable to look into all MKB components residing in different machines, compute affected rules and knowledge and transmit it to the Server Agent.
- The View Knowledge Base can be distributed in a local or wide network. To compute affected views, the VKB agent becomes a mobile one able to look into all VKB components distributed in different machines, compute affected views and transmit it to the Server Agent.
- The role of the view synchroniser agent states the same as in the Agent-e-DWMS which is to find legal rewritings for affected views using the MKB information and E-SQL views preferences and to transmit it to the Mobile VKB agent and the Mobile MKB agent in order to update respectively the MKB and the VKB.

IMPLEMENTATION AND EVALUATION

To demonstrate the feasibility and the advantages of our mobile e-DWMS, we developed a prototype based on IBM aglets. Agents transformed to aglets become serializable Java objects able to move through the network. When they arrive to destination, they are reloaded as classes and executed. The performed application was implemented and simulated on eleven personal computers linked through a local area network.

The computers were assigned as follows:

- One computer was dedicated to View Synchronization Agent which is responsible for view repairing according to schema changes happened in EISs.
- Two computers were assigned to the MKB and the MKB Agent which migrate from one machine to another in order to determine affected knowledge.
- Two computers were assigned to the VKB and the VKB agent which migrate from one machine to another in order to determine affected view definitions. The separation between the VKB and the MKB permits parallel determination of affected knowledge and view definitions.
- Six computers were dedicated to information sources and the associated Detector Agents. Each information source was partitioned on two computers. This permits parallel schema changes detection by allowing mobile Detector Agent migration and running over distributed EISs' components.

Compared to centralized e-DWMS, mobile e-DWMS solution permits to gain 29 percent of time on each synchronization operation related to one schema change. The estimated time gained for n schema changes is around 0.29*n units of time.

CONCLUSION

An e-learning Data Warehouse is constituted by e-learning informational resources collected from heterogeneous, distributed, and autonomous collaborating information sources. It has to be regularly updated and maintained, when e-learning information sources change their contents

and/or their schemas, in order to ensure integrity, accessibility, availability and the consistency of the afforded information.

In this paper, as our knowledge, we are the first to exploit data warehousing maintenance techniques to optimize e-learning informational resources availability and sharing. This was ensured essentially by view synchronization concepts which make view definitions, embedding e-learning resources, survive.

We also, studied the issues of using static then mobile agents to achieve e-learning data warehouse maintenance under schema changes. We focus on agents' collaboration leading not only to the availability optimization of e-learning informational resources, but also to the increasing of the system components autonomy, avoiding network saturation and to the decreasing of a variety of costs such as communication and execution times.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 30-49.

Introducing educational computer programmes through evaluation: A case in South African disadvantaged schools

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ABSTRACT

I report on evaluation strategies that could be used to introduce an educational computer programme (ECP) in disadvantaged schools. The strategies include social dialogue, using the teachers' value systems such as Ubuntu together with participant evaluation methodologies, by which teachers learn about evaluation, computer skills, and the concepts the ECP presents, as well consider the curriculum issues around ECP use in teaching. The study involved 26 teachers from 23 South African disadvantaged schools.

Keywords: *Evaluation of educational computer programmes; disadvantaged schools in Africa; Ubuntu*

INTRODUCTION

Context

Bantu in South Africa attended schools in which a curriculum was specifically designated for them in low-income areas that couldn't afford computers. These schools produced most of the current poorly skilled teachers who teach in them. These are the disadvantaged schools where the South African Department of Education (DoE) has consistently tried various projects to improve teaching and learning, sometimes with provision of computers. My work in disadvantaged schools indicated that Bantu education had persisted against newer curricula such as Curriculum 2005, at least up to the time this research was conducted from 2001 to 2004.

Computers-based innovations are now almost culturally embedded in developed countries that drive globalisation. In contrast, teachers in Africa find computers in tertiary institutions (e.g., Blignaut & Venter, 2002: 1; Hewett, Erulkar, & Mensch, 2003: 5, 12); but even then, rarely use educational computer programmes (ECPs) (although they might use computers) during their teacher training (personal observations at the University of Kwa-Zulu Natal from 2000 – 2006).

Despite increased interest in computer use in South Africa (SA) (e.g., White Paper on ICT use in Education, DoE, 2003), my participation in education projects indicated that few teachers were equipped with basic computer skills and literature revealed little research on curriculum and cultural implications of ECP introductions and use in SA schools. For example, the University of Natal designed an ECP it named Zadarh (Amory, 2001), but the ability of teachers to use it in their lessons was still to be researched.

An Educational Computer Program (ECP) named Zadarh

Zadarh is a constructivist adventure, fun and drama game (Amory, 2001), designed to address some of the unrelenting Biology curriculum problems in SA (e.g., from Chacko, 1996 to DoE, Muwanga-Zake, 2000; to Sanders, 2002). Amory explains that explorations of Zadarh involve cognitive (interpretive) and/or social constructions (when students group-play), and model dialectic between pedagogical and game elements. Fun could increase playing time and

therefore time for scientific inquiry, around problematic concepts, hoping that students can apply these in real life adventures. Zadarh deals with photosynthesis, respiration, genetics, and evolution at school-leaving level. The challenge is whether teachers are able to identify these Zadarh objectives and use it effectively in their lessons.

Components which teachers have to understand before evaluating and implementing an ECP

I propose that the knowledge and skills needed to use an ECP in lessons can be summed up in Figure 1 below. Figure 1 shows concerns various authors raise about developing teachers and ICT use in teaching (e.g., Whittier & Lara, 2006: 3; Minaidi & Hlapanis, 2005: 241- 243; Gredler, 2001: 537). These include distinguishing between harnessing computers for curriculum objectives and the computer skills needed, in their subject of specialization and culture, economic standards, cognitive strategies, and social processes executed. Thus, Figure 1 represents teachers' competencies to evaluate and use an ECP. Such an evaluation could achieve the transformation, which Muffoletto (1996: 145) recommends is necessary to use ECP in lessons. Unfortunately, according to Minaidi & Hlapanis (2005: 245), *the majority of teachers form a didactical model without ICT and would prefer to remain with that feeling of competency*.

Rationale for this study

It appears that teachers' institutions in SA exclude the 'ICT & skill' set in Figure 1 from teacher training thus the '*didactical models without ICT'* is apparent among teachers in SA.

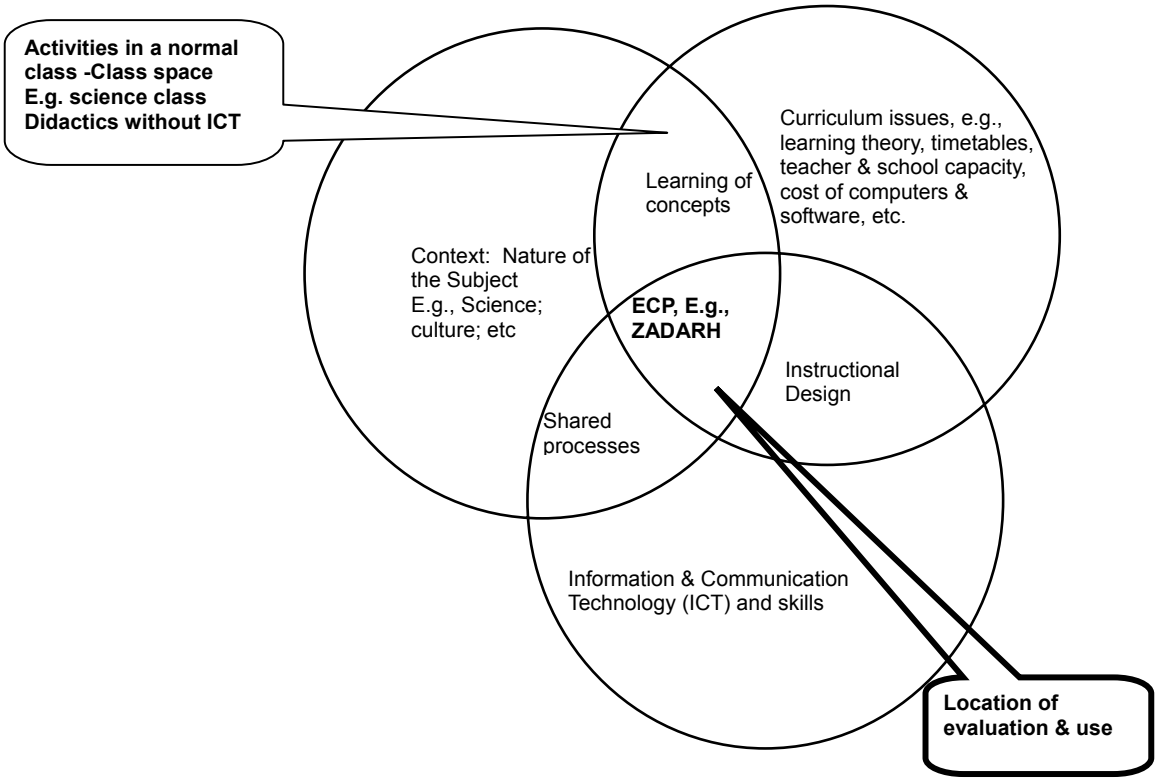

Figure 1: *Elements of focus in evaluating and implementing Zadarh*

Hence, the need for teacher training in ICT uses is as critical in SA as it is internationally (Mutton, Mills & McNicholl, 2006: 2). This is complicated by the varying competencies among teachers (Minaidi & Hlapanis, 2005: 242), requiring individuals to choose a technology and level of training about its use (Ottesen, 2006: 277). Nonetheless, the DoE banned out of class in-service training, arguing that teaching time is spent on teachers' professional development. Scaffolding an in situ teachers' evaluation of an ECP (Barbera, 2004, 13) could satisfy the DoE, while improving the teachers' competencies in Figure 1.

Participants

In year 2000, to each of 101 schools, the DoE provided 20 computers for teaching in a project it named Dinaledi. I worked for the Centre for the Advancement of Science and Mathematics Education (CASME), which was among those contracted to train teachers, and this gave me access and acquaintance with participants. Of these schools, using data from a Dinaledi preliminary survey, I selected 23 schools (i.e., 22.8%) with passable roads and working computers in the Eastern Cape, KwaZulu Natal, and Mpumalanga provinces of SA from which 26, Grade 12 teachers volunteered (Cates & Goodling, 1997: 30).

RESEARCH QUESTION

The evaluation of Zadarh was extensive but this paper reports on only one question: *What does introducing Zadarh in disadvantaged schools entail?* The introduction of Zadarh into schools happened as an evaluation process using the following evaluation philosophies, methodologies and methods.

ADOPTING EVALUATION PHILOSOPHIES AND STRATEGIES FOR INTRODUCING AN ECP

Evaluation as research

Evaluation and research could adopt similar strategies (e.g., LeCompte, Preissle, with Tesch, 1993; Hickey & Zuiker, 2002: 541). In this case, the evaluation was a collection of information about the worth of Zadarh (Fink, 1995: 2; Hitchcock & Hughes, 1995: 31, Greene, 1994: 530-531), against the desirability of outcomes associated with its use.

The philosophical framework

Firstly, the idea was to introduce and get teachers to use Zadarh in their teaching using an evaluation as a strategy. Secondly, with the belief that teachers' practices are *historically contingent, socially enacted, and culturally constructed* (Ottesen, 2006: 277, citing Holland *et al*.), while the teachers' local contexts, including culture (Ubuntu), poverty, and poor training in ICT use, informed the philosophical framework, it was Ubuntu that made this study unique.

Ubuntu, in relation to humanity can be viewed as a philosophy, but could be a methodology in its executions. In this case, Ubuntu was relevant in redressing social relationships, which were damaged by a repressive political past. Bantu in SA desire to emancipate themselves and their culture towards what Denzin (2001: 24) refers to as freedom from *prejudice, repression and discrimination,* but in the process, are sensitive to externally initiated innovations. It is therefore prudent to introduce such innovations through their paradigm, Ubuntu.

Ubuntu as an imperative in research and in introducing innovations among Bantu

Bantu inhabit over three quarters of Africa, from West to South Africa. An individual is a Muntu. The term Ubuntu as used in this paper is a Xhosa and Zulu reference to the social conduct of a Muntu. Other Bantu languages such as Luganda have different terms for Ubuntu. In relation to introducing innovations, Ubuntu negotiations are communal and *interrogate truths or credibility* (Louw, 2004) by analysing the facilitator's relationships with the community, as well as the credibility of the evaluation, and the ECP. According to Mkabela (2005), Ubuntu pursues consensus, which in case of the introduction, evaluation and uses of an ECP, ought to be cognisant of Bantu norms and values. Furthermore, the facilitator would be expected to become a Muntu, through explicit exposition of who s/he is and her/his intentions. A Muntu (and this includes the facilitator) flourishes through assisting and interacting, and is discouraged to take precedence over the community to the extent that innovations that would benefit a few or just the facilitator would most likely be rejected. Thus, the facilitator has to show how the community gains from the innovation.

Tutu (2004) identifies Ubuntu-based research with participative research paradigms in stating that we are bound in life. In support, Broodryk (2006: 6) emphasises Ubuntu togetherness and cooperation, including thoughts, for a common good. Ubuntu desires mutual empowerment; what in Western paradigms translates into social responsibility. The mutual benefits confers equality of purpose and of responsibility upon the researcher and participants, and ameliorates power relations to enable communal decision-making to the extent that there are no 'researched individuals or informants' but participants with a common purpose. Essentially, Ubuntu puts a human face to research, against a top-down research process, allowing the participants to state their problems (Mkabela, 2005: 183), (their poor qualifications, spirituality, poverty, culture, values, etc), so that the research addresses some of these. Greet, sit, talk, understand their needs, and if possible eat with Bantu. In short become a Muntu, and the Bantu will fully cooperate and validate your research.

It is apparent that Ubuntu is compatible with Western participative paradigms, which seek facilitator-participant collaboration in the research design and in the interpretation of results, especially coupled with a developmental social agenda. The interactive nature of Ubuntu ("mutual exposure" and respect) satisfies some requirements of reducing 'Internal Value Constraints' (LeCompte, *et al.*, 1993: 322-349).

Choosing participative research philosophies

An important competency for teachers, also recommended in teacher qualifications, is the ability to evaluate an ECP. An evaluation before the teacher uses an ECP in class is vital, but evaluation competencies were not part of Bantu education. Teachers in disadvantaged schools have to be trained to evaluate and use ECPs. The teachers' social fabric, local context, priorities, and culture have to be considered (Evans & Powell, 2007; Wells & Wells (2007: 3), because no universal truths in ICT applications in education exist (Pedro, *et al.,* 2004: v), and *technology is not value neutral, but has inbuilt assumptions and ideologies, which* influence *possible use (*Jefferies, Carsten-Stahl & McRobb, 2007: 117). Unfortunately, varied or complete lack of competences and experience complicate such training (Whittier & Lara, 2006: 3; Koedinger, Anderson, Hadley & Mark, 1997: 1). Thus, teachers' should actively participate in evaluating, planning their own training and in setting policy for ECP uses (Pedro, Enrique, Ernesto & Lucio, 2004: 3).

While Ubuntu forms the ground for entry into local schools, Western-based research paradigms are necessary, since ECPs originate from Western-based epistemology. Hence, the internationally renowned participative research philosophies were impregnated with indigenous local discourses (Pinkus, 1996), and emerged into processes that were unique and suitable for

training the participants.

The philosophical frameworks that guided this evaluation

Qualitative evaluation

Quantitative evaluations similar to those carried out by both Adams (1998) and Ivala (1998) might be responsible for incongruence between evaluator's conclusions and what teachers' experiences (Randel, Morris, Wetzel, & Whitehill, 1992; Stratford, 1997) as these do not reveal discourses during the introducing, using, and evaluating ECPs. Myers (2000:2) vies that qualitative research emerged to study discourses of actors. In this case, qualitative evaluation was necessary to seek participants' social transactions and views as they used Zadarh in their schools (Savenye & Robinson, 2001: 1171-1172). Among the qualitative genre, Ubuntu could be amicable with a cocktail of the developmental, post-modern, interpretative, and constructivist approaches, as these would support teacher empowerment (Reeves& Hedberg, 2003: 31-34; Greene, 1994: 532). I submit that any evaluation process that includes teacher empowerment traverses more than one philosophy to emerge into a practical framework, mitigated by the local culture.

Contexts guiding the choice of a philosophy	**Considerations**	**Philosophy**	**Methodology**	**Methods**	**Data**	**Data analysis**
Indigenous discourses (*Ubuntu*) **Local realities:** e.g., shortage of computers **Computer illiteracy:** **Curriculum issues: e.g.,** Zadarh uses, timetabling, teachers' classroom strategies, etc. **The nature of subject** in Zadarh – Biology	**Accessing and incorporating participants' values** **Empowering** teachers with evaluation / training **Learning theories and nature of biology in Zadarh -** constructivist game + experiments **Individual participant interpretations** **Actors** Teachers; Students; Myself; Designers of Zadarh	**Qualitative** *Unquantifiable social interactions* **Developmental** *Teachers develop evaluation skills; conceptual understanding; computer skills* **Post-modern** *No formalities Sensitivity to school interests and capacity* **Constructivist** *Teachers' inputs towards the evaluation process and introduction of Zadarh*	**Action** *Teachers co-evaluators; training teachers to use & evaluate ECPs in their classes* **Class visits** *Observe teachers' practices, students' interactions with Zadarh and their teacher.* **Ethical considerations** *Permission from school authorities Teacher's convenience Coded records* **Interpretive** *Teacher's subjective and contextual interpretations recorded*	**Questionnaires;** **Interviews; (focus groups);** **Class observations**	**Interview scripts;** **Class notes;** **Video or audio records;** **Questionnaire responses**	Constant comparative; Discourse analysis

Figure 2: *Conceptualising the evaluation, mode of entry, and training process*

Post-modern evaluation

Firstly, the cocktail of Ubuntu-participative paradigm approach is postmodernist in creating an approach that is not bound by research traditions. The responsibility of valuing and introducing

Zadarh into school curricula lay with teachers (Nichols & Allen-Brown, 2001: 231; Yeaman, Hlynka, Anderson, Damarin, & Muffoletto, 2001: 254-256), and teachers benefited (Reeves & Hedberg, 2003: 271), without pre-sequenced progression (Dillard cited in Denzin, 2001: 29).

Developmental evaluation

Kong (2007: 69), Herrington (2002), as well as Reeves & Hedberg (2003: 275-274) argue for professional development through hands-on participation suitable for each individual teacher's level and needs. This was planned along the competencies in Figure 1. The process portrayed situated learning, interpretativism, constructivism, and action research as it happened in teachers' classrooms, and contributed towards alleviating 'external and internal value constraints' *(*Eisenhart & Howe, 1992: 660-661).

Constructivist evaluation

In a philosophical sense, we all process constructs or realities from interpreting experiences (Cobern, 1996: 304). Constructivism nurtured cognitive reflexivity, and engendered social transactions and negotiations, with teachers asking questions, which guided entry and training processes (Willis, 2000: 12), within the teachers' social norms (Jefferies, *et al.*, 2007: 113). A constructivist strategy allowed flexibility for teachers to influence their individual development (Kong, 2007: 69).

METHODOLOGY

Introduction

The methodology explains the plan of action and process (Crotty, 1998: 3). Bantu communities follow Ubuntu codes of conduct, in this case so important, considering the socio-cultural theory that *human action is mediated, and inseparable from the specifics of its cultural, historical and institutional context* (Vygotsky, 1978). For example, in Africa, *one first has to obtain permission from tribal or community* (Hewett, *et al*., 2003: 29). Ubuntu guided the following methodologies.

Ethical considerations

Among the Bantu, permission is better obtained through direct negotiations even if this follows a written request. Then 'Ubuntu' *inter alia* requires the principal to communicate and discuss this request with the teachers through social dialogue. Furthermore, it is important to state clearly how the findings would be used, and how teachers and the school benefit. People have realised that the information they provide has sometimes ended up published without their consent.

Developing the teachers because of their pivotal role as pedagogical agents of change is another ethical factor (National Research Foundation [NRF], 2004; Pedro *et al.,* 2004) that is also pertinent in Ubuntu and in disadvantaged communities, implying that the facilitator had to concurrently train participants (a process and outcome evaluation), which would contribute towards personal and social transformation of participants (Greene, 1994: 533; McKenney & Van den Akker, 2002: III, 407; Heinecke, Blasi, Milman & Washington*,* 1999).

Ethical considerations included consented preliminary surveys, to understand the teachers' needs and then plan and evaluate Zadarh with the teachers to infuse into the evaluation' their values and needs (e.g., training). This was easier because of my prior interactions (Huberman & Miles, 1994: 428-429; Myers, 2000: 3) during the Dinaledi project at CASME. These measures increased the 'Internal Value' of the activities and engendered mutual trust, and agreements

about roles or responsibilities of teachers (Eisenhart & Howe, 1992: 657 – 662; Heron, 1996: 159; Maykut & Morehouse, 1994:145-147; NRF, 2004; LeCompte *et al*., 1993: 322-349). An additional ethical issue concerned the Zadarh meeting the claimed benefits and fitting into curricula (Jefferies, *et al.*, 2007: 7, 10).

Action and interpretative evaluation

Pedro *et al.* (2004: 19) believe that a working practical example might motivate teachers to try out an innovation. According to Ottesen (2006:4 citing Ludvigsen), such practice should be planned with specific consideration of the historical and socio-cultural situation, noting Denzin's (2001: 25) point that there is an increase in resistance against modernist research (often perceived as control) and a desire for an interpretive practice that persons willingly submit to. Therefore, action considered Ubuntu and the historical effects of apartheid. For example, the experience of Bantu education had increased sensitivity to curriculum innovations. Not that Bantu education supported Ubuntu; it actually violated Ubuntu and seems to have led to the demand for people-centred curriculum development. So it was better to design the introduction of Zadarh with teachers, redress Bantu education damages, and to encourage teachers to articulate their needs in view of their interpretations of the new SA curriculum then code-named Curriculum 2005, which succeeded old curricula, including Bantu education. Teachers wanted, and it was necessary for them to understand the position of ECPs in Curriculum 2005 and how the evaluation and use of ECPs such as Zadarh helped them to achieve competencies to implement Curriculum 2005. Fortunately, Dinaledi, a government project, catered for the use of ICTs, including ECPs in science classrooms, and Curriculum 2005 requires teachers' to evaluate ECPs. Hence, Dinaledi provided computers to these schools.

On the basis of Pedro *et al.'s* (2004: 19) advice and ethical requirements, the preliminary knowledge about the teachers' competencies was used to plan their development. Furthermore, interpretive stances allowed teacher-centred individual interests regarding training (see for example Table 3). Based on the views on action research in Noffke (1995) and Stevenson (1995: 207), the following activities happened at each school, considering knowing as a subjective local event, (Reeves & Hedberg, 2003: 28):

First school visit

- Discussed the responses the teachers provided in the preliminary Dinaledi survey, especially regarding their competencies shown in Figure 1
- Observed Biology classes and computer uses and advised on possible improvements
- Introduced Zadarh, answered the questions about Zadarh and left it installed on school computers
- Showed teachers how Zadarh works and the possibilities of using Zadarh
- Planned timetabling for the subsequent evaluation with the school computer manager
- Taught teachers about 'evaluation' and introduced a preliminary evaluation plan for their input

Second school visit

1. Improved upon the evaluation plan using teachers' inputs, and planned subsequent evaluations with teachers including students involvement
2. Facilitated the teachers' evaluation – first with the teachers alone, and then with their students

CASME workshop or third school visit in some schools

- Discussed with teachers curriculum issues with regard to using Zadarh – how to include Zadarh into Biology lessons and timetabling
- Reviewed with the teachers, the use of and students' problems with Zadarh

- Individual teachers made requests for my further visits.

Discourse analysis

To start with*, interviews are situated in complex systems of discourse, where traditional, everyday performance, text and audience come together and inform one another* (Denzin, 2001: 26). In discussing the choice of philosophies, I hinted at designing emergent discourses that are a hybrid of formal Western philosophies performed within Ubuntu. That is, the applications of Western paradigms in a Bantu community inadvertently create new challenges and discourses, for both the facilitator and the Bantu participants to analyse as they try to find a common ground of understanding the evaluation process, as well the ECP and its use. Therefore, the emergent discourses and the processes that lead to their emergence require discourse analysis, as these cannot be predicted.

Discourse analysis is very important among Bantu, as Ubuntu draws meaning from and communicate through discourses, which Foucault (e.g., in Mphahlele, 1996) said include actions, hierarchy, emotions, and attitudes. For example, such discourses could be signs of acceptance or repertoire necessary for the subsequent activities. Additionally, Bantu often seek consensus to the extent that an individual's response could represent the collective community views, and so I had to note for pointers like a teacher using 'we' instead of 'I' when s/he answers questions.

Additionally, Minaidi & Hlapanis (2005: 246) identify language as a factor because English is dominant in ICT applications, and has bred new terminologies, which provoke or exacerbate misunderstandings. An example is the ‘mouse’, which in ordinary English is an animal. That, English was a ‘second language’ to the participants, required verification of instructions and questionnaires for technical or instrument validity (Denscombe, 1998: 213-214; Reeves & Hedberg, 2003: 34), sometimes requiring translation into vernacular, which in these areas were IsiXhosa and IsiZulu.

Discourse also related to the disadvantaged status of these schools in the possibility of exaggerating the value or accepting an ECP that is free of charge.

METHODS

The procedures triangulated questionnaires, interviews, and class visits in an interpretative dialogue (Greene, 1994: 532; British Educational Communication and Technology Agency, 2001; Merriam, 1998: 71; Denscombe, 1998: 109-112), to reveal the teachers’ understanding of proceedings, and what and how they benefited. I read questions where I sensed misunderstanding, and then interviewed about responses that were interesting or ambiguous. I photographed or video-recorded with consent.

Challenging tasks around problematic concepts in Zadarh (Armory, 2001), and questions during interviews, which nurture reflexivity (Willis, 2000: 12), formed the basis for dialogue that helped teachers' introspection, to analyse personal understanding of what or how they benefited. Using guidelines from Linn (2002: 40), Willis (2000: 9), and MacDonald & Farres (2003: 5I) interjections could be open-ended diagnostic questions or incomplete leading statements that scaffold to a more critical participant's thinking and reflection or included direct corrections to a misconception. Reflexive questions sought the teachers' knowledge, opinions, hypothetical predictions, or speculations. Examples included:

- How would Zadarh change your lessons?
- Does your teaching suit the use of a game?

- Do you have enough time to use ECPs?
- What factors prevent you from using ECPs?
- How has this evaluation helped you to improve your teaching strategies?
- What kind of support do you need in your efforts to use computers?

Although utopian, Denzin (2001: 24) refers to this approach as performative and conversational in that dialogue transforms *information into shared experiences,* and knowledge.

The first dialogues were about responses to the preliminary survey. The second dialogues happened during playing Zadarh, when I prompted participants for verbal predictions or descriptions about an activity they were performing (Gredler, 2001: 538). The second dialogue was also a training exercise, clarifying biology concepts and giving advice about computer skills as well as playing Zadarh. Dialogue was conducted often in isiXhosa or isiZulu.

The third dialogue sought participants' overall experiences with Zadarh and was held during the CASME workshop or in some schools in class.

DATA MANAGEMENT AND ANALYSIS

Ubuntu demanded an idiosyncratic constructivist and interpretive approach that includes my deeds in the data, and my opinions (Gay & Airasian, 2000: 204-211). All analyses were done in relation to participant benefits or problems within the framework of discourse analysis, but processed teachers' statements using the constant comparative method. The determination of recurring themes and patterns in participants' responses as suggested by Maykut & Morehouse (1994:126-144), Hitchcock & Hughes (1995: 295), and Denscombe (1998: 210) proceeded as follows:

- Statement on event / ideas and suggestions, some of them translated from vernacular
- General theme or unit of meaning, e.g., exciting
- Underlined or highlighted words or statements related to exciting and code them with a number (e.g., makes me feel good', 'not boring', 'makes me happy', all belonged to the general unit, 'exciting')
- Compared unit, e.g., compare 'exciting' against closely similar themes such as 'motivating'. These were combined if their meaning overlapped to form a new unit. Otherwise, each unit was refined where the two were definitely different. This step required setting rules of inclusion for each unit and yielded audit trails showing how it was developed.
- The rules of inclusion described the unit.

Themes emerged which I checked against the class observations and video records (especially to analyse discourses). I then derived generalisations from each unit.

FINDINGS: FACTORS THAT DIRECTLY AFFECTED ENTRY INTO A DISADVANTAGED SCHOOL

Introduction

This paper is about what one can expect when introducing or evaluating an ECP in disadvantaged schools. So, the outcomes of the evaluation are left out.

General school and classroom situations

Schools were found in two kinds of environments: 5 schools in rural villages and 18 in townships (predominantly low class Black residential areas). A chief attended an event in one of the village

schools. 96% of schools had line electricity, the one using solar panels for electricity. All of them had secure computer laboratories, which were found open on both occasions in only three schools.

Ethical issues of entry

I only managed to meet 5 principals or deputy principals out of the 23; the rest were reported to be attending meetings. However, they had delegated authority to the teacher Heads of Department, who then took me to the teacher in charge of computers, if it was not his/her responsibility. I was introduced to other teachers, where the project would be discussed. Principals and teachers were eager to state the problems facing the use of computers and in Biology.

Ubuntu was apparent in all the proceedings, such as the invitation of other teachers to participate. I.e., there were no cases where I dealt with a single teacher, concomitant with the communal Bantu nature to bring along others in such matters. Secondly, proceedings often changed into isiXhosa or isiZulu and that made participants more relaxed, accepting, and provided more inputs. A senior teacher in all cases convened meetings.

As fellow Bantu, and using ubuntu (antipositivist) methods of entry (local language and Ubuntu conduct being some of these), teachers consented to collaborative participation, and pointed out how they would prefer to be trained and about what. It was noteworthy that I was respected more for my age than for my qualifications or for where I worked. Ubuntu also meant adhering to school routines, which in 20 out of the 23 schools included meals fit for a visitor. In some schools, identifying with the DoE's, curriculum, or Dinaledi objectives supported my mission. A popular objective was how the project empowered teachers towards implementing the new curriculum.

Discussions would sometimes start by participants' national matters of concern or interests; on two occasions, by a critique of the national soccer team but mostly about the new curricula and the heavy workloads as well as needs for further training. Teachers appreciated obtaining Zadarh free of charge.

The process of evaluation

All teachers did not have the skills to evaluate Zadarh and many confused it with assessment. For example, they did not know the attributes to evaluate, and apparently had never been asked to do an evaluation of an ECP. Therefore, an overview and planning the evaluation were useful, especially as it helped teachers to scrutinise the way their students used Zadarh, to the extent that they were able to comment on the teaching style (the learning theory) applied in using Zadarh in their lessons. Unfortunately, 20 teachers felt that they would not have time to hold interviews with students and to analyse results, but could hand out questionnaires to students. Evaluations were punctuated by training in computer skills and references to Biology textbooks.

ADDITIONAL DATA FOR CONSIDERATION IN INTRODUCING, EVALUATING, AND USING AN ECP

Working out participant needs in relation to Zadarh

This is data from questionnaires applied to 26 teachers. Few teachers held degrees in teaching, and about a quarter had studied biology to Matric (Table 2).

Table 2: *A sample of qualifications of Grade 10-12 biology teachers (n=26). Key: % (n)*

Teaching qualification	None	Certificate	Diploma (E.g.,	Degree/HDE/ACE
	0%	**0%**	**65% (17)**	**35% (9)**
Highest level studying Biology	Matric	Certificate	Diploma	Degree
	23% (6)	**0%**	**54% (14)**	**23% (6)**
Number of years teaching Biology	0- 5	6-10	11-15	16 and over
	54% (14)	**35% (9)**	**12% (3)**	**0%**

Forty six percent (46%) of teachers had no training in computer skills, and institutions had trained only 35% (Table 3).

Table 3: Teacher's qualifications in computer skills

Never	Trained myself	Trained at an institution	Trained through a project	I am getting training now	Not interested	I want o be trained
46% (12)	15% (4)	35% (9)	4% (1)	15% (4)	0%	100%

Thirty eight per cent (38%) of teachers had never used computers to teach (although schools had the computers for over a year) and 35% had less than years' experience of using computers in teaching (Table 4). However the experience to teach meant providing some ECP to learners for revision or using presentation tools (e.g., Power Point).

Table 4: Teachers' experiences in using computers to teach

Never	Less than a year	Up to 5 years	6-10 years	11-15 years	Over 16 years
38% (10)	35% (9)	12% (3)	0%	04% (1)	0%

Status of computers and teachers' opinions about the use of computers

All computers were new in 20 out of the 23 schools, but 2 of the 23 schools had lost some of their computers to thieves. However, the 20 schools were not using the computers to teach, especially because they lacked technical support as well as computer skills. Overall, computers were very few in relation to the number of students, which was as high as 624. The DoE never allocated funds for computer maintenance, and the schools' fund was too small for maintaining the computers, as computer technicians were prohibitively expensive. Having just about 20 or less working computers for the whole school was problematic. Therefore, students had to play Zadarh in groups of five or six.

Access to computers

Access was mostly to teachers with permission from the computer laboratory managers appointed from the school staff: the majority having been mathematics and/or science teachers but without training in computer networking or using computers to teach.

Use of computers in schools

Teachers complained that teaching computer skills to students in the 3 of the 23 schools, which offered 'computer science' as a Matric subject, was prioritised although Dinaledi supplied computers for teaching sciences. These same 3 schools had bought physical science and mathematics programmes, which they were yet to use. The frequency of computer use by the students could not be established but in 19 schools, the observation that biology students had their first chance to enter a school computer laboratory via this evaluation implies that students did not have access to computers frequently.

I found 7 schools (out of the 23) with working e-mail and Internet for the principal. Shortages of e-mail and local networks (LAN) expertise, as well as lack of money to pay TELKOM for the telephone line and Internet services were major problems. TELKOM had disconnected many schools from the Internet due to non-payment of bills. I also found only 4 schools out of 23 where individual teachers, out of curiosity and interest, had set up the LANs in a working order. TELKOM had set up LANs in all the Dinaledi schools but did not train teachers on managing these LANs, and TELKOM retained management rights (through pass words). Schools were under contractual obligation not to allow non-TELKOM staff to do any repairs or changing computer and LAN settings. Faulty LANs meant installing Zadarh on each computer.

School computers and Zadarh

Basic computer skills, such as using a mouse that is fundamental to play Zadarh, were lacking among most teachers. For example, a teacher put a mouse on the screen, and another tried to move the ‘Zadarh’ icon to the ‘start’ Windows icon. Thus, training teachers included switching on the computer, logging into the computer, installing Zadarh, using a mouse, and playing Zadarh.

Compatibility of Zadarh with school computers

Zadarh was fully compatible and run well on computers supplied to the Dinaledi schools, but colours were poor and Zadarh was slow on older computers, even though Zadarh recommended such computer hardware and Windows 3.11.

Using Zadarh to teach

Teachers held varied views on when and how to use Zadarh, reflective of their teaching styles, which was mainly behaviourist (although Zadarh is constructivist). That is, I had to suggest and discuss how to use Zadarh effectively in their lessons. Furthermore, teachers viewed Zadarh as game not suitable for serious study. This view coupled with Zadarh requiring at least an hour before any tangible outcomes, relegated the students' use of Zadarh to after school periods of teaching. Unfortunately, teachers left school immediately after teaching and students rarely had a chance to play Zadarh. Nonetheless, playing Zadarh brought teachers and students together as they tried to help each other to solve problems.

DISCUSSION - *WHAT DOES INTRODUCING ZADARH INTO DISADVANTAGED SCHOOLS ENTAIL?*

Firstly, this was a case study of only 23 schools. More studies are required. The results were also biased in the use of teacher volunteers (Cates & Goodling, 1997: 30), excluding possible technophobes and those with very negative views about computers. The sample was also limited to Biology Grade 12 teachers, bearing in mind that computer managers were often mathematics and physical science teachers who were possibly more skilled in using computers. Thus, this was

a sample of teachers who wished to use computers in teaching but did not have the basic computer skills.

Secondly, results apparently show that the utilisation of computers has not progressed since 1996, because The Education Policy Unit, University of Western Cape (2000), during 1996-97, also found that teachers lacked basic computer skills. This together with poor understanding of concepts in Zadarh would undermine the teachers' abilities to use Zadarh in their teaching. Apparently, some teacher training institutions excluded basic computer skills; some teachers could not even handle a mouse. These were worse than elsewhere in Africa (e.g., Hewett, *et al.*, 2003: 5, 12). Teachers had never evaluated or used an ECP in teaching before, confirming my observations (University of Kwa-Zulu Natal from 2000 – 2006). While this evaluation provided teachers with some ECP use in class and evaluation skills, the revelation is alarming, and if extrapolated, requires SA to act immediately on training teachers in ECP use in teaching.

Training should involve teachers practically (Barbera, 2004, 13), to the extent that teachers are proficient in all the aspects of the ECP as summarised in Figure 1 (Whittier & Lara, 2006: 3-16). In my view, Figure 1 encompasses the complexity that concerns Whittier & Lara (2006: 3). However, the socially constructed approach (Ottesen, 2006: 277) was undermined by the teachers' ignorance of what they needed to know – social involvement where teachers were supposed to constructively participate in designing lessons with ECP use worked only after some training.

Another drawback in these schools was finance for training, computers and ECPs, which disadvantaged schools do not have. The 20 computers were certainly not enough, and none were received during this study, which lasted over a year, that the digital gap these schools suffer might persist for some time.

Besides taking care of the above, unlike in a purely Western and developed schools, an evaluator or innovator should prepare for a lengthy negotiation process to gain entry into a school, signposted by the recognition of local cultures and discourses (Wells & Wells, 2007). For example, Bantu still wish to share a meal regardless of one’s time constraints. The time spent is however worth it for long-term collaboration. I have in other occasions observed the disastrous effects of project facilitators rejecting that courtesy.

Furthermore, the qualitative approach seemed reveal more social dynamics or transactions (Myers, 2000:2) than the quantitative evaluation used by Adams (1998), as this provided deeper descriptions of local discourses and paradigms (LeCompte *et al.,* 1993: 322-349). However, the study shows that a collaborative evaluation, that gets teachers trained, can improve the success of entry and use of ECPs in teaching. The processes involved in introducing and ECP into a disadvantaged school include:

- Recognition of local discourses as alternative research agendas.
- Searching for compatibility between formal Western paradigms and local paradigms. Participative paradigms as are likely to be compatible with other local paradigms
- For the Bantu communities, imparting Ubuntu in the research process
- Being aware of historical influences
- Planning for development of participants
- Using reflexive questions and dialogue in interviews, with the option of translating them into vernacular
- Checking the ECP-computer compatibility. Most disadvantaged schools might not have the latest software or their computers could not have the capacity to store or run some ECPs

REFLECTION, LESSONS LEARNT, AND IMPLICATIONS FOR FUTURE ECP INNOVATIONS

Data shows that the success of ECPs in disadvantaged schools depends upon the understanding teachers have of Figure 1 competences. Data also says that introducing ECPs into schools is not a matter of taking ECPs and explaining a few things to teachers or giving workshops in remote centres. It requires collaborative evaluations with teachers at their schools, with unequivocal recognition of teachers' and school culture and needs. Teacher constructivist participation in the evaluation makes them part of curriculum development and exposes them to possibilities of using computers, but should be used after some introductory training.

Developing teachers through action training are difficult to plan and time because of varied teacher competencies, and the efforts they put into the exercise. The values they attached to the ECP or alternatively the extent to which the ECP solves their problems plays a role, but teachers could not be 'pushed'. While a push would gainsay the interpretative, developmental, and constructivist frameworks, it is important to note that Ubuntu courtesy and negotiation cannot be hastened. The above then begs the question of whether teachers have time for ECPs and training. I think that an ECP that yields outcomes in line with curricula objectives, and fits into the timetable of a school is likely to be adopted. One way is to design ECPs with episodes with designated curriculum outcomes that fit into school teaching periods.

CHALLENGES

Challenges that need attention to introduce and get teachers to use ECPs in disadvantaged schools include:

- Understanding the social, historical and economic situation
- Improving the teachers' conceptual understanding of content and learning approaches;
- Improving the teachers' abilities to evaluate ECPs;
- Improving the teachers' basic computer skills, and skills to use ECPs;
- Increasing the number of computers in schools so that ECPs can be used more frequently and effectively; and
- Developing ways of integrating ECPs into the school curricula, which requires the DoE and school administrators to be flexible with timetabling and with modes of teaching.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 49-59.

Adoption and usage of ICT in developing countries: Case of Ugandan firms

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ABSTRACT

Information and Communication Technology (ICT) is regarded as a driver and enabler of economic development is most countries including Uganda. The study examined the extent of adoption and usage of ICT on one hundred and ten firms in Uganda; and established benchmarks that can be utilized in future research and comparison between firms. The results revealed that the adoption and usage of ICT by firms in developing countries follow the same pattern as in developed countries, and they only differ in the level of usage and adoption. Firms do appreciate the contribution of ICT to their performance, but there are various barriers which require governments to adopt appropriate policies to address them.

Keywords: *ICT adoption and usage; ICT and Developing countries; ICT in Uganda; ICT and Ugandan firms; ICT usage in Africa*

1. INTRODUCTION

The adoption and usage of Information and Communication Technology (ICT) is changing business processes, and the way people live and work. New innovations as a result of ICT are continuing to emerge. Globally, in the year 2000, 539 million computers were being used with 410 million in USA, European Union and Asia, leaving 129 million in developing countries. The number of computer usage was projected to grow to one billion by the year 2005. Similarly, the Internet users were 315 million in 2000, and the number was estimated to grow to 716 million users by 2005, and the majority of these users were in developed countries (Ngplains 2002). The Internet usage rate in the developed world was 8 times that of the developing countries, and there were 22 million Internet users in Africa by 2004 (ITU 2004).

ICT has introduced what is known as the 'Networked economy', where successful businesses are linked with their suppliers, internal manufacturing processes, shippers and customers in real-time. Businesses are now able to move data and communicate with each other in real time. This has transformed the way businesses are being done. ICT has the capacity to cut costs of coordination, communication and information processing and many businesses have taken advantage of this (Brynjolfsson and Hitt 2000).

Uganda developed an ICT policy where it regards ICT as a driver and enabler of economic development. This paper is based on a study that was carried out in Uganda with the objective of examining the adoption and usage of ICT in the firms sector, with a focus on computers and the Internet. Specifically, to provide a benchmark that can be used in future research; information which can be used for comparison between firms; and information that can be used by policy makers to support the ICT sector. The paper starts by discussing ICT in Uganda's context; followed by a discussion of the data and methodology, results and lastly the conclusion.

2. GENERAL ICT INDICATORS IN UGANDA'S CONTEXT

As a result of good policies undertaken by the government, among which are the trade liberalization, privatization, civil service reform, financial sector reform, decentralization among many others in the last decade, Uganda has had an impressive economic performance with an average GDP growth of about 6% per annum. In 1996, as part of ICT policy reform process, the government liberalized the telecommunication sector and opened it for competition by licensing multiple players. There are now several cellular and mobile telephone networks, mobile radio communication, paging services, courier services, private radio and television stations, multi-purpose community tele-centres providing communication services of fax, telephone, e-mail and Internet, media services, computer services to name a few.

By 1996, Uganda's telephone density was as low as 0.25 lines per 100 people, and Kampala City had 2.8 lines per 100 people. The telephone density rose to 2.5 lines per 100 people by 2003 and to 6.5 lines per 100 people by 2006. The number of Internet Service providers increased from 2 in 1996 to 17 in 2006 (Uganda Communication Commission, 2005). By end of 2003, the Internet usage was 0.5 per 100 people, which is 125 Internet users (ITU 2004).

3. DATA AND METHODOLOGY

The 2003 survey was based on the information from the Uganda Business Register 2001/02 that indicated that, there were 160,883 businesses in Uganda with 87% of these businesses falling under the informal sector that is employing less than five people, and the remaining 13% in the formal sector.

Uganda like other developing countries, ICT usage is still at an infancy stage, in spite of Government's effort to promote it. A sample of 143 firms was purposively selected from a list of the topmost tax paying businesses in the year 2002, as they were most likely to have invested in ICT. The choice of the population was based on the fact that the diffusion of ICT and the adoption of advanced technology are associated with higher labour productivity, higher export intensity, and large size of firms, (Batelsman *et al* 1996; Baldwin and Deverty 1995; Gretton *et al* 2002). And in Uganda's case, the topmost tax paying firms were falling under this category.

The questionnaire was pre-tested and revised accordingly. The questionnaire included both open-ended questions and pre-coded questions in seven sections. The sections included: general information, computer usage, investment in ICT, IT department, Internet usage, ICT and firm performance, and information on how government can promote the adoption and usage of ICT. The questionnaires were administered and data was collected from 110 firms. The largest coverage was in Manufacturing (35%), followed by Wholesale and Retail trade (31%) Finance and Insurance 10%), Real estate and Business services (9%), Transport and Communication (8%), Construction (3%), Utilities (3%) and Hotel, Bars and Restaurants (1%). The data was then analyzed using Stata.

4. RESULTS AND DISCUSSION

The analysis covered general characteristics, ICT usage, E-commerce, Internet usage and connectivity, perception on the contribution of ICT to the firm, government policies, and barriers to ICT access and usage.

4.1 General characteristics of firms

The general characteristics covered age and ownership by firm size (see Table 1). The majority of the medium firms were foreign owned, while the large firms were mainly locally and jointly owned. When one considers firm age and ownership, 33 percent of foreign firms and 8 percent of the local firms were less than 10 years old; 27 percent of the foreign firms, 15 percent of the local firms and 17 percent of the joint venture firms were between 10 and 20 years old; 40 percent of the foreign firms, 77 percent of the local firms and 83 percent of the joint venture firms were more than 20 years old.

Table 1: *General Characteristics of firms (%)*

	Size of firms		
Characteristics	Small 6 - 20 people	Medium 21 – 100 people	Large > 100 people
Age			
< 10 years	24	49	27
10 – 20 years	29	38	33
> 20 years	4	37	59
Ownership			
Foreign	-	67	33
Local	23	23	54
Joint ventures	-	33	67

4.2 ICT usage

All the firms covered in the survey had computers and Internet access, though only 62 percent had a web presence on the Internet. This is an indication that size, age together with ownership is not discriminating factors in acquiring ICT in Uganda. A finding consistent with Dunne (1994), that young and old firms adopts ICT at more or less the same rate.

While all these firms had access to ICT, it had been acquired at different times. Table 2 presents the distribution of ICT usage and firm size. There is significant relationship (p-value = 0.005) between firm size and the duration of computer usage, which is in line with studies carried out elsewhere (OECD 2003; Gretton *et al*. 2002). The small firms are faced with limitation of investment capital, tend to be risk averse and conscious of uncertainties, and are more responsive to taxation. The results indicate that most small firms started adopting ICT in the last three years when the government started dropping some taxes. The findings above are in agreement with other studies (for example Baldwin and Diverty 1995; Baltelsman *et al* 1996; Gretton *et al* 2002) that established that the adoption of ICT increases with firm size; and larger firms tend to adopt ICT earlier than the smaller firms.

As for the Internet, there is also significant relationship (p-value = 0. 012) between firm size and the duration of Internet usage. This is in line with some studies (OECD, 2003; Knight and Pollard, 2004) that have established that larger firms due to their capability to have skilled managers and workforce, advanced business practices are more likely to adopt the Internet more quickly than other firms.

Table 2: *Distribution of ICT usage by firm size (%)*

	Firm size			
	Small 6- 20 persons	Medium 21 - 100 persons	Large >100 persons	Overall
Computer usage				
< 3 years	75.0	25.0	0.0	7.3
3 - 5 years	31.8	45.5	22.7	20.0
> 5 years	6.3	41.3	52.5	72.7
Internet usage				
< 3 years	33.3	39.4	27.3	30.0
3 - 5 years	10.7	50.0	39.3	25.5
> 5 years	8.2	36.7	55.1	44.6
Overall	16.4	40.9	42.7	100.0

Table 3 illustrate the distribution of ICT usage by the age of the firm. The table indicates that older firms tend to acquire ICT earlier than other categories of firms. Further analysis indicate that there is significant relationship between firm age and duration of computer and Internet usage (p-value = 0. 00 for computer, p-value = 0.06 for Internet).

Table 3: *Distribution of ICT usage by age of the firm (%)*

	Age of the firm			
	< 10 years	10 - 20 years	> 20 years	Overall
Computer usage				
< 3 years	100.0	0.0	0.0	7.3
3 - 5 years	72.7	22.7	4.6	20.0
> 5 years	16.3	23.8	60.0	72.7
Internet usage				
< 3 years	42.4	27.3	30.3	30.0
3 - 5 years	50.0	3.6	46.4	25.5
> 5 years	18.4	28.6	53.1	44.6
Overall	33.6	21.8	44.6	100.0

With respect to ownership, all the foreign and joint venture firms had computers for more than 5 years, while for the Internet 80 percent of foreign firms and 83 percent of the joint ventures had it for between 3 and 5 years. While firms with local ownership, 76 percent had computers and 7 percent had the Internet for more than 5 years, 15 percent and 38 percent, respectively between 3 and 5 years. Eight percent had computers and 54 percent had the Internet for less than 3 years. There is a strong significant relationship (p-value = 0.000) between ownership of the firm and the duration the institution has been using the Internet, but no significant relationship (p-value = 0.256) when it comes to computers. The findings are in line with studies carried out in other countries such as OECD (2003), that have established that foreign owned firms tend to adopt the Internet faster than local firms due to a number of reasons that include appreciation of the benefits of the Internet, and familiarity with the technology among others.

Figure 1 shows employee access to computers and Internet by employment category. Employees in the Administration and Finance have more access to computers and the Internet than other categories. While employees in Marketing/Sales have similar access to computers, they have less access to the Internet. The results tend to indicate that the marketing/sales employees are using the Internet to access information rather than as a business tool to support the marketing and sales functions.

With respect to usage of the computers, the employees in administration and the support staff use them mainly for word processing, while those in finance for accounting and those in production, marketing/sales use them for information processing. The secondary usage for these computers is communication and the Internet. The production department uses them also for inventory control and storage optimization. The ICT access and usage by employees in these firms is very low compared to other countries such as the OECD countries where the usage is more than eighty percent.

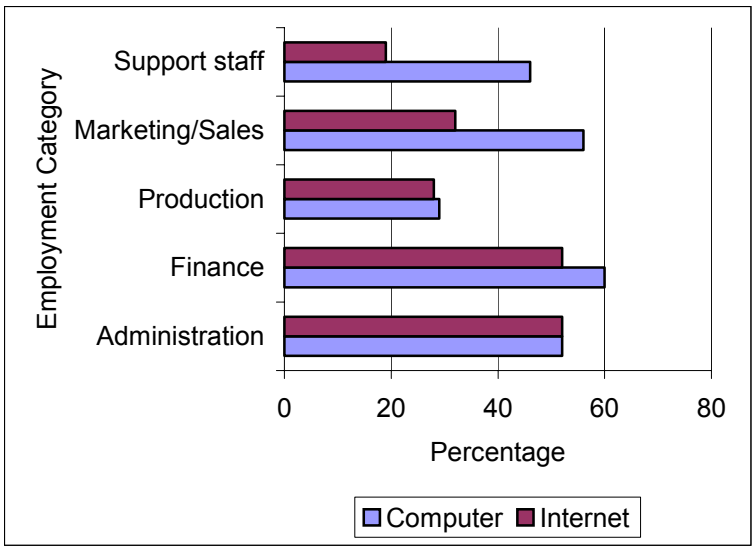

Figure 1: *Percentage of employees with access to ICT by employment category*

4.3 Internet usage and connectivity

The Internet is found in all firms that were covered during the survey, although only 61 percent of them had websites. Twenty seven percent of these firms were using their own website hosts, while 73 percent were using sites managed by third parties. Surprisingly, Figure 2 shows that the majority of medium and large firms were using high speed Internet connectivity technology of wireless and leased lines which can be adequately used to connect the websites to the Internet backbone. This pattern is not very much different from other developing countries. The low percentage of own websites is a possible indication of few ICT skilled professionals who can develop, administer and maintain the websites in the country.

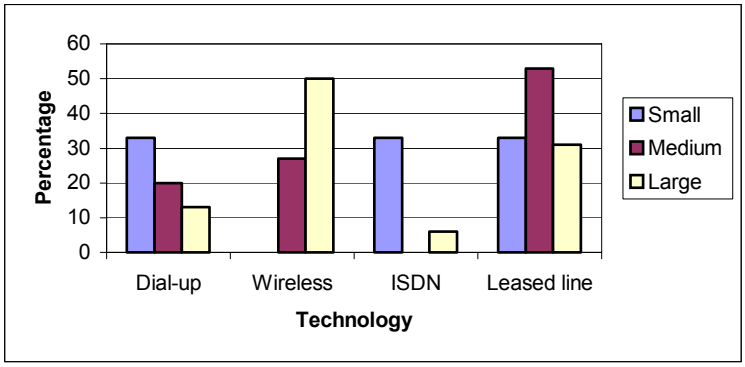

Figure 2*: Internet Connectivity technology*

The Internet is mainly used for communication, followed by surfing as depicted in Figure 3. The websites are mainly used for marketing, with the large firms also using them as symbols of status and to provide information, as illustrated in Figure 4.

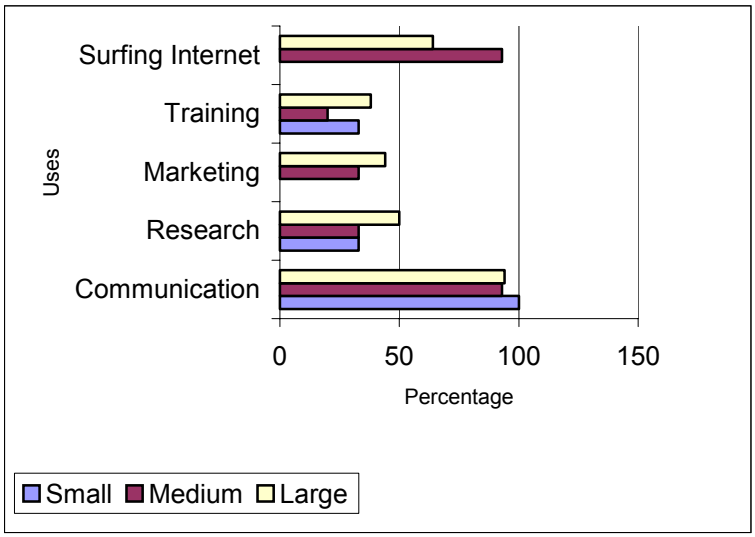

Figure 3: *Uses of the Internet by size*

4.4 E-Commerce

The number of secure web servers provide a good indicator about the infrastructure that can support E-commerce. Secure servers allow to transmit confidential information over the Internet for the purchase of goods and services. Only 17 percent of the firms had secure servers that could be used to transact business over the Internet, but none of these firms were using them to sell goods and services by the time of the survey. There were 27 percent of the firms that were using the Internet to purchase goods and services, though the transaction values were very small. This is an indication that e-commerce hardly exists in this country, though there are some promising signs that it may be adopted by some firms in future.

Figure 4 illustrates that the medium sized firms have adopted e-commerce better than the large firms, though still at a low level. The majority of medium sized firms are owned by foreigners, which emphasizes the point that foreign owned firms tend to adopt ICT faster than the local owned firms as discussed above.

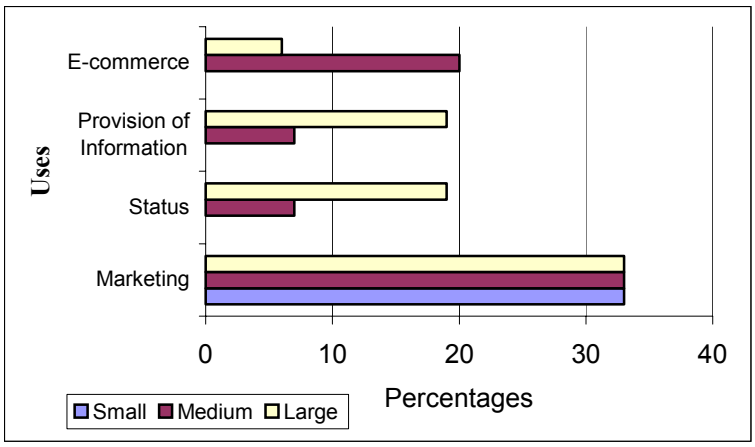

Figure 4*: Uses of the websites by size*

4.5 Perceptions on the contribution of ICT to the firm

With respect to the contributions of ICT to the firm, Table 4 illustrates the different perceptions. The majority of respondents strongly agree that ICT provides increased savings, increased efficiency, improved service delivery, low transaction costs, and improved market performance to the organization that invests in ICT. This observation is not different from studies carried out in other countries (OECD 2003).

Table 4*: Respondents' perception on the contribution of ICT to the organization (%)*

Contributions of ICT	*Strongly agree*	*Agree*	*Undecided*	*Disagree*	*Strongly Disagree*
Increased savings	52	36	12	-	-
Increased efficiency	81	19	-	-	-
Improved Service delivery	61	33	6	-	-
Low transaction costs	47	34	13	6	-
Improved market performance	38	38	21	3	-

4.6 Government policies

The government has introduced a number of policies on ICT in the past seven years. There are varying responses as indicated in Table 5. With respect to whether the liberalisation of the radio and TV spectrum in the country had created an improvement in the firm's market share, only 31 percent strongly agreed, and 44 percent agreed with the statement. There was a small percentage that had not benefited from this policy. This may have to do with the nature of products and services the firms were involved in.

Table 5*: Respondents' perceptions to policies related to performance of the organization (%)*

Government policies	*Strongly agree*	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*
Expanded coverage of radio and TV in the country having improved the firm's market share	31	44	9	6	9
Increased number of telecom operators has reduced the firm's operating costs	19	52	16	10	3
Increased number of telecom operators and ISPs has enabled firms to invest in the Internet	31	56	6	3	3
Availability of well trained ICT Personnel will encourage this firm to Invest in ICT	28	50	19	-	3

With respect to whether the increased number of Telecom operators had reduced the firm's operating costs, 52 percent were in agreement, with 19 percent strongly agreeing, and 16 percent undecided, implying that there were firms that had really benefited from this policy. There were also some firms that had not benefited from the policy, which may be due to the nature of business they were carrying out.

With respect to whether the increased number of Telecom operators and Internet service providers (ISPs) had enabled firms to invest in the Internet, 56 percent were in agreement, with 31 percent strongly agreeing, with a small number not agreeing and undecided. This is an indication that firms will easily invest in the Internet, when accessibility to the service is opened up, and there are several players in the Internet business.

With respect to whether the availability of well trained ICT personnel can encourage firms to invest in ICT, 50 percent were in agreement, 28 percent strongly agreed, and 19 percent were undecided. This indicates that the availability of ICT professionals in the country is an incentive for firms to invest in ICT. The above responses do indicate that government policies are working, and firms are realizing the benefits from these policies.

4.7 Barriers to ICT access and usage

The study examined several barriers to ICT access and usage. Table 6 presents the percentage of respondents and their perceptions on the various barriers. While the analysis of these perceived barriers is good for policy makers, it has to be interpreted with caution, as the answers depend on the respondent, and what he/she feels about the barrier in his/her present circumstances. For instance, when the firm has been able to employ good ICT professionals, this would not be a problem, as for another firm which wants to recruit these professionals, but they cannot afford to pay them. Other than the lack of perceived benefits to the firm, the other barriers were very important, and the majority of the respondents were in agreement. Therefore, there is need for Government to formulate policies that address these barriers.

Table 6: *Respondents' perception on barriers of computer and Internet usage in a firm (%)*

Barriers to ICT	*Strongly agree*	*Agree*	*Undecided*	*Disagree*	*Strongly Disagree*
Expensive hardware	23	44	-	33	-
Expensive software	22	56	11	11	-
Qualified personnel are expensive	22	45	-	33	-
Lack of perceived benefits to the firm		11	11	44	34
Taxes are too high on hardware and software	13	25	-	62	-
Lack of security on the Internet	22	33	12	33	-
The Internet connection fee is too high		44	22	22	12
VAT on Internet service is high		62	25	13	-

5. CONCLUSION

The results do reveal that while the developing countries are still lagging behind the developed countries, the adoption and usage of ICT follows the same pattern in all countries. They just differ in the levels of usage.

The usage of computers and Internet is high in medium and large firms, and especially firms owned by foreigners. The small firms which are mainly locally owned, have low usage due to the high cost of required investment, limited knowledge and skills, and being very responsive to taxation. The findings suggest that there is need to widen ICT training facilities for the local entrepreneurs to take advantage of opportunities associated with the adoption of ICTs; and to address taxation on the Internet services and other ICT consumables to lower the cost of acquisition.

The findings further indicate that the people do appreciate the contribution of ICT to the performance of their firms, but the various barriers such as high costs of hardware, software, Internet and ICT professionals among others are an hindrance to their progress. This requires government to develop policies that are geared towards addressing these barriers and promotion of ICT adoption and usage.

Note: This research was financed by the African Economic Research Consortium (AERC), Nairobi, Kenya.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 60-77.

Construct validation of ICT Indicators Measurement Scale (ICTIMS)

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ABSTRACT

This study aims to analyze psychometric features of a scale which was developed to measure indicators of Information and Communication Technologies (ICTs) at an undergraduate institution in Turkey. Issues forming successful ICT integration were identified according to competencies stated by UNESCO (2002). Besides, each competency sheltered further sub-components which were adapted from UNESCO (2002) and Odabasi et al. (2006). Questionnaire items for each factor were prepared and verified through expert panels. The questionnaire was administered to 359 education college students at a Turkish state university. Exploratory factor analysis eliminated 13 of 54 questions in the scale, identified 10 factors accounting for 51.557 % of the variance. The internal consistency was also high (α=.888). Then a confirmatory factor analysis was conducted which eliminated three more questions and revealed an ideal model fit. The model summary of the confirmatory factor analysis was provided along with implications and suggestions for further research.

Keywords*: ICT indicators; Teacher training; ICT Indicators Measurement Scale (ICTIMS)*

INTRODUCTION

Skills regarding information and communication technologies (ICTs) have gained utmost importance for education, for employment and for everyday life use in the 21st century. The ability to use ICTs with confidence and efficiency is demanded from most employers. As also reported by the Commission of the European Communities (2002), ICTs are used as tools for both learning activities and learning assistance, which place them into a well-established status in current education and training systems, that is, ICTs are crucial in the context of lifelong learning. This presents an enormous challenge to educators since they are expected to equip students with relevant, up-to-date and high-quality ICT experience before students emerge into the employment world (Gibson, O'Reilly, & Hughes, 2002). In this respect, ICT competencies of undergraduate students who will take the leading role in shaping the society of the future are to be investigated with scrutiny. According to a recent survey named Survey of European Universities Skills in ICT of Students and Staff ICT (SEUSISS), to which 13.000 students, staff and employers across Europe responded, ICTs were considered vital for future professional endeavors by the majority of participants (Haywood, 2003).

Researchers have studied several factors that could affect how individuals use ICTs in their personnel and professional endeavors. However, use of ICTs efficiently has been realized only recently. Up to the last decade, ICT supported instruction meant practitioners' conversion of conventional lecture notes to static documents that are made available on the web (Gibson et al., 2002). This is because the change imposed by ICTs is difficult to realize. ICTs present a dilemma for educational institutions for they require transforming new applications into current practices. Moreover, it is not easy to see through the short-term problems exerted by ICTs to understand how ICTs could transform education in the long-run (Richards, 2004).

Billig, Sherry and Havelock (2005) examine the factors that facilitate and support educators' uses of technology. Factors they mentioned could be applied to technology integration endeavors as

well. Based on the Billig (2002) study, which surveyed leaders of 17 organizations that could sustain educational innovations for a long time, Billig et al. (2005) claim that the followings are necessary for educational initiatives to be successful and sustainable: Strong leadership that promotes a shared vision, strong infrastructure that stress human autonomy, well-organized support structures for professional development, incentives for encouraging practitioners to work for the system and to remain in the system, visibility, credibility, strong and mutually beneficial partnerships, macro-culture development to promote contextual relevance, and sufficient funds from multiple sources. Billig et al. (2005) further list the factors associated with sustainability and institutionalization of innovative endeavors as (a) leadership and identifiable champions to sustain change, (b) infrastructure for technical support and collaborative learning, (c) resource allocation and stable funding, (d) supportive culture and climate, and (e) individual and system incentives, tangible evidence of success, visibility, and empowered networks.

Successful ICT integration is never realized out of a sudden. Teacher training in ICTs and through ICTs constitute a tiresome process from inception stages to maturity. Toledo (2005) scrutinized on three teacher education programs to investigate the stages of ICT integration that are experienced in educational institutions. A thorough triangulation of key informant and focus group interview data, and data from four survey instruments administered to faculty members, administrators, and key informants revealed a five-stage model of technology integration into the teacher training curriculum, namely, pre-integration, transition, development, expansion, and system-wide integration.

Jung (2005) examines four ICT use approaches found in teacher training, and suggests that ICTs can change the ways teacher teach. The first approach considers ICT use as the main training content, which leads teachers to learn how to use ICT tools in the classroom. That is, the approach emphasizes the development of basic ICT skills. The second approach considers ICT use as a part of teaching methods to facilitate teaching where teachers are provided with examples of ICT pedagogy integration in their training, and are allowed to reflect on examples and experiences provided by the curriculum. The third approach considers ICT as core technology for delivering teacher training, that is, ICT is used as the major way of providing teacher training. In the fourth approach, ICT is used to facilitate professional development and networking which could be very effective as long as constant and relevant support is provided. All approaches might have invaluable advantages if applied in an organized and efficient way.

In order to mediate the ICT integration process, teacher perspectives on integrating ICTs into instruction have been well-documented qualitatively through comprehensive studies like the Toledo (2005) study mentioned above. The study conducted by Hennessy, Ruthven, and Brindley (2005) also examined how teachers begin to integrate ICTs into mainstream classroom practice through several focus group interviews with teachers of core subjects like mathematics, science and English. Findings imply that teachers need to develop and endeavor new strategies for mediating ICT supported learning activities.

Smith and Robinson (2003) provide a different perspective for technology integration into curriculum, and suggest that collaborative cohorts be used for successful integration. The suggestion is for preK-12 schools; however, it seems plausible for most educational institutions. They propose creating an environment where teacher educators, pre-service education faculty students, and teachers can learn together through collaborative cohorts.

Since ICTs in teacher education constitute a dynamic field of study, which requires constant refreshment, there is always a need to measure up-to-date latent constructs of ICTs through valid and reliable tools including high quality indicators. Lin (2005) developed a questionnaire to determine technology integration factors that are considered important by teachers. The study offers a reliable measurement of indicators for the assessment of teachers' perception about

technology integration. Liu and Huang (2005) also investigated the concerns of teachers about technology integration through well-designed measurement tools. In Turkey, Akpinar (2003) developed and administered a scale to diagnose K-12 teachers' technology using behaviors. The current study has a different scope from these studies for it purports to develop a measurement tool for diagnosing the overall picture of an institution regarding internal and external ICT indicators from prospective teachers' points of view. Issues constituting successful ICT integration were determined according to four competencies stated by UNESCO (2002), namely (a) content and pedagogy issues, (b) collaboration and networking issues, (c) social and health issues, and (d) technical issues each sheltering further subtitles. Subcomponents of four competencies were determined according to UNESCO (2002) and Odabasi et al. (2006). Four competencies and their subcomponents are discussed below.

Content and Pedagogy is considered the most important aspect of infusing technology in the classroom (UNESCO, 2002). Teachers should be equipped with pedagogical competencies to integrate technology into the curriculum, so that they could efficiently create the vital link among their individual approach, the local context and the subject matter knowledge. Odabasi et al. (2006) identifies two subcomponents within this competency, namely, (a) teaching-learning method and (b) ICT in curriculum context. These competencies help teachers to demonstrate a thorough understanding of the opportunities of ICTs in curriculum context, and to implement and evaluate instruction in open and flexible environments (UNESCO, 2002).

Collaboration and Networking suggests that teachers be equipped with skills to facilitate collaboration and networking with both local and global communities, which expands learning beyond the classroom setting. This situation asks teachers to be open-minded and respectful for diversity, so that they could promote democratic learning. Odabasi et al. (2006) examines (a) professional development and (b) learning communities under this construct. These competencies help teachers to demonstrate an understanding of diverse instructional networks within and among communities, participate effectively in flexible learning environments, and prepare and provide equal learning opportunities for a diverse student body (UNESCO, 2002). Besides, professional development implies that teachers benefit from any opportunities to ameliorate their personal and professional competencies.

Social and Health *Issues* constitutes another set of competencies which asks teachers to understand social, moral, and legal issues surrounding ICTs. Odabasi et al. (2006) lists subcomponents of this construct as (a) health, (b) special needs, (c) ethics, and (d) policy. These issues suggest that teachers understand and apply moral and legal codes of practice, respect for intellectual property, plan and promote healthy use of ICTs for learners including handicapped individuals, and reflect upon and moderate the influence of ICTs on society (UNESCO, 2002).

Technical Issues constitute the technical competencies, issues regarding technical infrastructure, and provision of technical support throughout the curriculum (UNESCO, 2002). Odabasi et al. (2006) mentions four subcategories related to technical issues which are (a) infrastructure, (b) ease of use, (c) access, and (d) technical assistance. These competencies ask teachers to use and select form a variety of ICT resources to improve personal and individual effectiveness and update their skills in the light of new developments (UNESCO, 2002). The UNESCO description of technical issues implies the characteristics of professional development. However, the current study examines professional development issues under the title of collaboration and networking as suggested by Odabasi et al. (2006). The exact categorization of competencies is open to scrutiny through further research.

Above constructs place responsibilities not only upon teachers but also on students and administrative staff. It is not plausible to expect all above competencies from a K-12 teacher whose ICT competencies and endeavors will probably be affected by both internal and external

factors. Thus, while realizing a successful ICT integration in teacher training, some competencies mentioned here are considered interrelated with many other factors such as students and administrators. The measurement tool described in the following section clearly reflects some of these interrelations among shareholders of ICT integration and tries to address the following research question: What are the valid and reliable indicators to diagnose the overall ICT picture of an educational institution and its members from prospective teachers' perspectives?

METHODS AND PROCEDURES

Participants

The reference population was senior students of the Faculty of Education at Anadolu University, Turkey. There were 851 students enrolled in the faculty at the time of data collection (i.e., 1st and 2nd weeks of December 2006). Senior students were purposefully selected as they were teacher candidates who were about to complete their education and emerge into the employment world. Participation was realized on a voluntary basis. Researchers delivered 500 copies of the questionnaire 359 of which returned without missing values in critical variables. Number of returning questionnaires constituted 42.19 % of the senior student population. Data collection was mostly realized through randomly selecting from multiple senior classes. However, some departments had either very few students at the senior level or they offered senior courses within the same class. Thus, the current sample reflected the characteristics of an opportunity sample as well.

The profile of the participants is provided in Table 1.

Table 1*.Demographic backgrounds of participants*

DEPARTMENT		**AGE** (Mean: 21.96, SD: 1.93)					**TOTAL**
		20	21	22	23	>24	
	GENDER	***f***	***f***	***f***	***f***	***f***	
Foreign Language Education	Male	1	7	10	6	3	**27**
	Female	1	30	26	12	6	**75**
Computer Education	Male	0	5	15	3	2	**25**
	Female	2	4	2	1	0	**9**
Primary Education	Male	6	7	7	3	1	**24**
	Female	7	21	22	1	2	**53**
Special Education	Male	1	3	4	4	3	**15**
	Female	4	22	13	3	11	**53**
Pre-School Education	Male	1	0	1	0	1	**3**
	Female	25	0	16	1	4	**46**
Fine Arts Education	Male	0	2	3	2	5	**12**
	Female	1	5	5	3	3	**17**
TOTAL	**Male**	**9**	**24**	**40**	**18**	**15**	**106**
	Female	**40**	**82**	**84**	**21**	**26**	**253**

N=359

Since a detailed distribution of 11 departments is not needed for further parametric tests in the present study, frequencies of the department variable were summarized. Departments of English Language Teaching, French Language Teaching, and German Language Teaching were combined under the title of Foreign Language Education. Next, Departments of Primary School Education, Primary School Social Studies Teaching and Primary School Mathematics Teaching were combined under the title of Primary Education. Finally, Education of the Mentally Disabled and Education of the Hearing Impaired were combined under the title of Special Education.

Instrument

The instrument reported in the current study was developed in Turkish. A personal information form was administered to collect the independent variables needed for further analyses. Students' age, gender, department, family income, and PC and Internet experiences were elaborated through questions given on this part. While preparing the personal information form, the SEUSISS questionnaire was taken into account (Haywood, 2003). Based on the review of literature, particularly the studies of UNESCO (2002) and Odabasi et al. (2006), six to ten statements for each competencies and sub-competencies were prepared. Eight of the statements were adapted from Akpinar (2003) and three statements were adapted from Demiraslan and Usluel (2005). Statements were examined in the doctorate seminar course of the Department of Computer Education and Instructional Technologies at Anadolu University by the course instructor, who is an expert in the field, and eight PhD candidates. Modifications on the instrument were discussed in two sessions with the group on April 25 and May 9, 2006. Further expert opinions were provided by two academicians who had published test development articles in international peer-reviewed journals, one ICT faculty at Anadolu University, one measurement and evaluation instructor at Anadolu University, the chair of a human subjects committee at a Turkish state university, two PhD students of quantitative measurement and evaluation, and two PhD candidates at the Department of Computer Education and Instructional Technologies. These evaluations reduced the number of statements to 54. Fifteen of these statements were reverse coded so that students would not see a monotonous pattern to respond. Statements were prepared as Likert-Scale items. The frequency of a given statement was evaluated on 5-item scales: Never, rarely, sometimes, very often and always referred to 1, 2, 3, 4, and 5 respectively. The scale was named as the ICT Indicators Measurement Scale (ICTIMS).

Procedure

Written permissions from the rectorate and the human subjects committee of the institution were ready by December 1, 2006. The students were administered the survey during their normal class periods at the 10^{th} and 11^{th} weeks of the 2006 fall semester. The first author administered questionnaires in most classes and provided same type of instruction to all participants. Whenever this was not possible, classroom instructors were trained to administer the questionnaires. Completing the questionnaire took 15 to 20 minutes in all classes. The return rate of the questionnaires was slightly influenced by voluntary participation. After questionnaires with critical missing values, and those that were responded with an unreliable pattern (ie, rated all questions as 5 or 3), the return rate was calculated as 71.8 % (359 out of 500). By the end of the 11^{th} week of the semester (ie, December 15, 2006), the data collection procedure was completed.

Data Analysis

In order to investigate the categories of ICT indicators, an exploratory factor analysis was conducted through SPSS 14.0 for windows. Then, a confirmatory factor analysis was conducted through LISREL 8.51.

Factor analysis is used as a data reduction technique, which takes a large set of variables, and reduces or summarizes the data using a smaller set of components (Pallant, 2001). From a structural equation modeling (SEM) point of view, it is a modeling approach for studying latent constructs by using several observable and directly measurable indicators (Raykov & Marcoulides, 2006). Factor analysis is considered *exploratory* when the concern is with determining how many latent constructs are needed to explain the relationships among a given set of observed indicators. The analysis, on the other hand, is *confirmatory* when a preexisting structure of the relationships among observed and latent variables is tested (Raykov & Marcoulides, 2006). Exploratory factor analysis has been extensively used by researchers as a tool to determine the number of underlying dimensions in a dataset (Brkich, Jeffs, & Carles, 2002). However, it fails to take into account the measurement error (Brkich, et al. 2002; Raykov & Marcoulides, 2006; Rubio & Gillespie, 1995). Theoretically, confirmatory factor analysis is conducted to test a theory-driven model with observed variables. However, it is too difficult to specify a complete model before analyzing data since theories are poorly developed or even nonexistent (Raykow & Marcoulides, 2006). Thus, model generation is observed as a common situation in empirical research studies (Jöreskog & Sörbom, 1993; Marcoulides, 1989; Raykow & Marcoulides, 2006). The current study represents a model generating situation where an initial model is specified, unsatisfactory fit to the data is modified, and repeatedly tested till acceptable concurrence between the data and the model is obtained.

RESULTS

Before conducting the analysis, the suitability of data for factor analysis was assessed. The first concern is the sample size. Kass and Tinsley (1979) suggest having between 5 and 10 subjects per items of the scale up to a total of 300. If the number reaches up to 300, test parameters tend to be stable regardless of the subject to variable ratio. Field (2000) and Tabachnick and Fidell (1966) claim that it is plausible to have at least 300 cases for factor analysis. Finally, Comrey and Lee (1992) believe that 100 is poor sample size, 300 is good, and 1000 is excellent. Therefore, it can be said that the current data is suitable for factor analysis for it includes 359 participants. However, in structural equation modeling, sample size is a controversial issue (Tanaka, 1987). Precautions of the current study in terms of sample size are justified through conducting maximum likelihood (ML) as discussed in the following paragraphs.

First of all, Kaiser-Meyer-Oklin Measure of Sampling Adequacy was checked. This statistic is calculated for individual and multiple variables and represents the ratio of the squared correlation between variables to the squared partial correlation between variables (Field, 2000). The KMO value varies between 0 and 1. A value of 0 indicates that the sum of partial correlations is large relative to the sum of correlations. A value close to 1 indicates that patterns of correlations are compact, and so factor analysis will yield reliable factors. Kaiser (1974) suggests that values greater than 0.5 should be accepted. Pallant (2001) claims that the KMO statistic should be larger than 0.6. Hutcheson and Sofroniou (1999) suggest that values between 0.5 and 0.7 are normal, values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great, and values above 0.9 are superb. The initial solution of our factor analysis revealed a KMO value of 0.848 which is great according to Hutcheson and Sofroniou (1999). Finally, Bartlett's Test of Sphericity should reach a significance value to support the factorability of the correlation matrix obtained from the items. Bartlett's Test of Sphericity revealed an Approx. Chi-Square value of 6755.498 with a significance value of .0005, which meant that the factorability of our correlation matrix was proper.

The maximum likelihood (ML) analysis revealed the presence of 13 components with eigenvalues exceeding 1 (Kaiser, 1960), which explained 62.967 % of the total variance. In the current data, it was possible to apply principal component analysis which was popular and easy to interpret

(Pallant, 2001). However, in order to realize confirmative factor analysis as a next step, the assumption of multivariate normal distribution was given utmost importance. ML estimation is considered more robust to the effect of small sample sizes (Tanaka, 1987). It was also shown that ML estimates are least affected in comparison to alternative methods used for non-normal samples (Tanaka, 1984). Finally, ML provides a strong and more appropriate test to determine how many factors underlie the data (Kroonenberg & Lewis, 1982). Thus, items of the scale were examined through the ML extraction method.

Field (2000) suggests that loadings less than 0.4 be suppressed in the output. Besides, Pallant (2001) claims that if items load above 0.3, this is a strong loading which should not be deleted. Most items had loadings above 0.3, and variables with lesser values have been deleted from the analysis. Moreover, items with very close loadings in different components (ie, less than .01) were also suppressed from the analysis. The factor analysis was repeated revealing 10 factors. The analysis with the new set of items revealed a better KMO value (.878) along with an ideal Bartlett value ($p < .0005$) again as can be seen in Table 2.

Table 2. *KMO and Bartlett's Test*

Kaiser-Meyer-Oklin measure of sampling adequacy	.878
Bartlett's Test of Sphericity	
Approximate χ^2	7442.246
Df	990
Significance	.000

The Cronbach's Alpha (α) of the instrument was .888 after problematic statements with inappropriate loadings were suppressed from further analyses. The analysis explained 61.687 % of the total variance in the initial solution, and 51.557 % of the total variance after rotation. In fact, the higher the variability explained by the factor analysis, the stronger the factor structure of the scale is. However, values ranging from 40 % to 60 % are considered acceptable for social studies (Dunteman, 1989). Thus, the variance explained in the current study is considered appropriate. The results of the factor analysis regarding the total variance explained are provided in Table 3.

As mentioned above, the number of factors was determined as ten. The next step was to interpret them. To assist in this process, the factors should be 'rotated' (Pallant, 2001). Ten components were extracted and rotated. There are a number of different rotation techniques. In our example, Direct Oblimin, which serves as a method for oblique (nonorthogonal) rotation was chosen. Ten factors were labeled as the following: (1) Ease of use (eigenvalue: 10,173), (2) teaching – learning method (eigenvalue: 4,297), (3) ethics (eigenvalue: 3,504), (4) special needs (eigenvalue: 1,905), (5) infrastructure (eigenvalue: 1,616), (6) professional development (eigenvalue: 1,574), (7) access (eigenvalue: 1,338), (8) health (eigenvalue: 1,216), (9) policy (eigenvalue: 1,089) and (10) ICT in curriculum context (eigenvalue: 1,047).

Table 3. *Results of the factor analysis: Total variance explained*

Factor	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	10,173	22,606	22,606	9,556	21,236	21,236	5,141	11,424	11,424
2	4,297	9,548	32,154	3,827	8,504	29,740	4,121	9,157	20,581
3	3,504	7,787	39,941	2,634	5,854	35,593	2,685	5,966	26,546
4	1,905	4,234	44,175	1,773	3,939	39,532	2,409	5,352	31,899
5	1,616	3,592	47,768	1,358	3,017	42,549	2,137	4,749	36,648
6	1,574	3,497	51,265	1,124	2,498	45,047	1,700	3,778	40,426
7	1,338	2,974	54,239	0,895	1,990	47,037	1,569	3,486	43,912
8	1,216	2,702	56,941	0,820	1,822	48,859	1,372	3,048	46,960
9	1,089	2,420	59,361	0,649	1,442	50,301	1,096	2,435	49,395
10	1,047	2,326	61,687	0,565	1,256	51,557	0,973	2,162	51,557
11	0,995	2,212	63,899						
12	0,955	2,122	66,021						
13	0,890	1,979	68,000						
14	0,854	1,898	69,898						
15	0,805	1,788	71,687						

(Subsequent rows are omitted to save space)

Interestingly, only two predetermined factors, “learning communities” and “technical assistance”, were not revealed by the current analysis. Items included in each factor, internal consistency coefficients of factors, item means and standard deviations, component loadings and Direct Oblimin Rotation loadings are provided in table 4,

Table 4. *Means, standard deviations, internal consistency coefficients of factors, component and rotation loadings*

Items and Factors		Mean	SD	Component factor load	Direct Oblimin factor load
Factor 1: Ease of Use **(α=,810)**					
44	There are user manuals for technological devices I use.	1,955	1,077	,510	,768
49	Whenever I have problems with technological devices, there are warnings and user manuals to help me with what to do.	2,034	,997	,613	,680
45	I can find devices like scanner, printer and video camera whenever I want.	2,051	1,123	,531	,589
48	Whenever I have a problem in laboratories or technology classrooms, I get quick and efficient technical assistance.	2,392	1,065	,629	,493

Items and Factors		Mean	SD	Component factor load	Direct Oblimin factor load
43	There are warnings and explanations in technology classrooms which help me use the devices easily.	2,449	1,032	,577	,414
Factor II: Teaching – Learning Method **(α=,855)**					
18	Instructors serve as models about how to use computers salubriously.	2,045	1,048	,499	,699
19	Instructors create environments where we could use technology for communication and problem solving.	2,459	1,053	,585	,545
20	Instructors model us in using technology for instructional endeavors.	2,790	1,039	,586	,503
22	Instructors use computer software during classes.	2,494	1,075	,566	,453
17	Instructors use technology to realize class activities.	3,101	,937	,513	,400
25	Instructors select and use technologies according to our needs.	2,909	1,032	,557	,362
Factor III: Ethics **(α=,747)**					
11	(reverse coded) I can help my friends with their assignments even though we are asked to study individually.	3,510	,978	,550	,688
10	(reverse coded) I can get help from my friends with my assignments even though we are asked to study individually.	3,717	,998	,430	,634
5	(reverse coded) Students share their assignments and use each other's ideas.	3,503	1,317	,652	,622
12	(reverse coded) There are instances where students use similar assignments for different classes.	4,123	,981	,551	,513
4	(reverse coded) Students use Internet resources without acknowledging the resource.	3,474	1,160	,501	,433
Factor IV: Special Needs **(α=,855)**					
52	There are instructional materials suitable for handicapped students.	1,867	,986	,591	,898
51	Classrooms are suitable for handicapped students.	1,856	1,066	,587	,845
53	There are sufficient personnel responsible for the problems of handicapped students.	1,913	,959	,573	,649
50	Tables and chairs we use are suitable to use computers salubriously.	2,339	1,147	,584	,509
Factor V: Infrastructure **(α=,824)**					
47	Internet speed is sufficient in our campus.	2,972	1,221	,482	,766
37	Computers are fast enough to use for instructional activities.	2,562	1,171	,521	,529
46	I can use Internet on campus whenever I want.	2,941	1,279	,497	,503
40	There are sufficient opportunities to improve my technology knowledge	2,483	1,105	,661	,361

Items and Factors		Mean	SD	Component factor load	Direct Oblimin factor load
41	Classrooms, lighting, air condition and arrangement are suitable for instruction.	3,130	1,083	,512	,343
54	There are sufficient licensed software programs.	2,526	1,067	,503	,343
39	Sufficient technology training is provided	2,291	,982	,658	,321
Factor VI: Professional Development (ie, obsolescence) **(α=709)**					
23	(reverse coded) Instructors do not use course materials except for the blackboard and chalks.	3,545	1,182	,526	-,838
24	(reverse coded) Instructors do not need computer assisted instruction in teaching most subjects.	3,703	1,126	,569	-,741
15	(reverse coded) Instructors lecture through traditional methods since they are not proficient in technology	3,290	,999	,536	-,381
Factor VII: Access **(α=,819)**					
35	There are sufficient computer laboratories.	1,958	1,091	,589	-,910
36	There are sufficient computers for us.	1,867	1,087	,594	-,885
42	Technology classrooms and laboratories are available whenever I need.	2,365	1,148	,586	-,382
Factor VIII: Health **(α=,777)**					
7	(reverse coded) I know students who have insomnia stemming from excessive computer use.	3,941	1,221	,605	-,824
6	(reverse coded) I know students who have physical problems stemming from excessive computer use (e.g. pain, posture problems, spasms, cramps)	4,017	1,114	,604	-,747
Factor IX: Policy **(α=,689)**					
34	Administrators ask our opinions for their innovative applications.	1,875	1,031	,579	,677
33	We are informed about the administration's prospective technological endeavors.	2,437	1,169	,476	,650
Factor X: ICT in curriculum context **(α=,743)**					
27	Instructors use Internet resources for teaching – learning endeavors.	3,138	1,031	,487	,697
28	Instructors give assignments that lead us to use Internet resources.	3,473	1,053	,365	,672
26	Instructors try to use motivating instructional technologies.	2,751	,999	,599	,334
29	Instructors announce the course materials and technology they are going to use in their classes.	2,561	1,098	,508	,329

After the exploratory factor analysis, items revealed by the analysis were further processed through LISREL 8.51 (Jöreskog & Sörbom, 2001) to conduct a confirmatory factor analysis. The solution with 10 latent and 41 observed variables suggested in Table 4 was examined. A chi-square value (χ^2) of 1711.31 with a corresponding df value of 734 was found ($p<.0001$). The ratio

of df to χ^2 value was 2.333 which was acceptable, but slightly above the ideal ratio (ie, 2). The Akaike information criterion (AIC) which takes into account the measure of fit along with the model complexity was checked next (Akaike, 1987). Generally, models with lower values of AIC and CAIC are considered better means of data description than models with higher indexes (Raykov & Marcoulides, 2006). Even though the model CAIC (2588.98) was smaller than the saturated CAIC (5950.20) as desired, model AIC (1965.31) was larger than the saturated AIC (1722.00), which was problematic. The root mean square error of approximation (RMSEA) was .06 which was marginally above the acceptable value (ie, .05). In fact, some researchers suggest that a RMSEA value of .08 and below represents a reasonable fit (Browne & Cudeck, 1993). However, the current study looks for a more conservative and robust fit at a level of .05 or below. Besides, the most current resources suggest that RMSEA be smaller than .05 to have a pertinent model (Raykov & Marcoulides, 2006).

Goodness of fit indices were not higher than the suggested ideal value .90 (Bentler & Bonett, 1980). More specifically, non-normed fit index (NNFI) was .83, comparative fit index (CFI) was .85, and incremental fit index (IFI) was .85. Particularly, the CFI is considered to show a good fit when it is .90 or higher (Bentler, 1995). Thus, modifications suggested by the program were conducted as follows:

Paths to question 42 from infrastructure, ease of use, and special needs were suggested. The measurement tool was examined and it was observed that the suggestions indicated a plausible path. Thus, one-way paths from infrastructure, ease of use, and special needs were drawn to question 42. The program was run again and the ratio of df to χ^2 value was improved to 2.25. When this problematic question was removed from the scale, the ratio was improved to 2.23 and RMSEA value was improved to .058. Thus, question 42 was removed from the scale. Better questions measuring access, ease of use, infrastructure and special needs independent from each other were necessary.

Question 47 also seemed problematic and deleted from the instrument since it had relationships with teaching-learning method, access, policy and ICT in curriculum context. The analysis after this deletion revealed a χ^2 of 1387.46 with a corresponding df of 657. The df to χ^2 ratio was almost ideal (ie, 2.11). Question 50 was removed from the measurement tool as well, since it had relationships with ease of use, infrastructure and special need simultaneously. The final model revealed a χ^2 of 1297.79 with a corresponding df of 620. The df to χ^2 ratio was reduced to 2.09.

After above modifications, non-normed fit index (NNFI) increased to .87, comparative fit index (CFI) increased to .88 and incremental fit index (IFI) became .89. Further deletions did not improve χ^2 any further. Thus, as suggested by the program, an error covariance between question 27 and 28 was added. This modification revealed a χ^2 of 1230.94 with a corresponding df of 619. The df to χ^2 ratio was appropriate (ie, 1.989). Finally, an error covariance between questions 25 and 26 was added as suggested by the program. This final modification revealed a χ^2 of 1193.89 with a corresponding df of 618. The df to χ^2 ratio decreased to 1.93.

When modifications were completed, the RMSEA was .05 as desired. Most goodness of fit indices were ideal as well (NNFI: .89; CFI: .90; IFI: .90.). In brief, after the confirmatory factor analysis, 42nd, 47th and 50th questions were removed. Besides, error covariances between 27th and 28th questions and between 25th and 26th questions were added. None of t values below the critical value at a probability level of .01 was taken into account (2.576). Latent variables, observed variables, standardized solutions and t values are reported in Table 5. Besides, Figure 1 illustrates the results of the confirmatory factor analysis.

Table 5. *Variables, t values, standardized solutions and error variances*

Latent Variable	Observed Variables	t-value of the Path	Standardized Solution	Error Variance
Ease of Use (α=,810)	Question 43	11,96	0,60	0,64
	Question 44	13,41	0,66	0,56
	Question 45	12,76	0,64	0,60
	Question 48	15,43	0,74	0,46
	Question 49	16,57	0,77	0,40
Teaching – Learning Method (α=,855)	Question 17	12,75	0,63	0,61
	Question 18	11,83	0,59	0,65
	Question 19	16,84	0,77	0,41
	Question 20	17,90	0,80	0,35
	Question 22	14,84	0,70	0,50
	Question 25	14,80	0,70	0,51
Ethics (α=,747)	Question 4	9,93	0,54	0,71
	Question 5	13,17	0,68	0,53
	Question 10	10,80	0,58	0,66
	Question 11	13,11	0,68	0,54
	Question 12	11,14	0,60	0,65
Special Needs (α=,866)	Question 51	19,40	0,85	0,27
	Question 52	21,27	0,91	0,18
	Question 53	15,94	0,74	0,45
Infrastructure (α=,794)	Question 54	11,11	0,57	0,67
	Question 37	11,41	0,58	0,66
	Question 39	13,89	0,68	0,53
	Question 40	16,79	0,78	0,38
	Question 41	10,65	0,55	0,70
	Question 46	10,62	0,55	0,70
Professional Development (α=709)	Question 15	9,75	0,53	0,71
	Question 23	14,49	0,76	0,42
	Question 24	14,27	0,75	0,44
Access (α=,898)	Question 35	20,39	0,92	0,16
	Question 36	19,57	0,89	0,21
Health (α=,777)	Question 6	13,62	0,78	0,40
	Question 7	14,03	0,80	0,35
Policy (α=,689)	Question 33	11,46	0,63	0,61
	Question 34	14,74	0,84	0,30
ICT in Curriculum Context (α=,743)	Question 26	16,92	0,79	0,37
	Question 27	12,57	0,63	0,60
	Question 28	6,76	0,37	0,86
	Question 29	11,47	0,58	0,66

The final version of the scale consisted of 38 items with an ideal overall alpha (α=.874). There are reverse coded items as also specified in Table 4, which should be processed with caution by practitioners. Besides, some components have only two items. Further studies might add new items to these constructs to further develop the instrument. The maximum possible score of the scale is 190 and the minimum score is 38. The mean of the sample was 105.131 with a standard deviation of 17.234. Skewness (.068) and kurtosis values (-.270) were within the limits of a normally distributed sample (Huck, 2000). Besides, both Kolmogorov-Smirnov and Shapiro-Wilk Tests of Normality revealed that the distribution was normal (Kolmogorov-Smirnov statistic: .028, p=.200; Shapiro-Wilk statistic: .997; p=.789). Descriptives of the sample are provided in Table 6.

Table 6. *Descriptives of the sample group*

		Statistic	Std. Error
Mean		105,131	0,91
95% Confidence Interval for Mean	Lower Bound	103,342	
	Upper Bound	106,92	
5% Trimmed Mean		105,042	
Median		105	
Variance		297,023	
Std. Deviation		17,234	
Minimum		61	
Maximum		152	
Range		91	
Interquartile Range		24	
Skewness		0,068	0,129
Kurtosis		-0,27	0,257

This section provided statistical analyses conducted to increase the validity and reliability of the ICTIMS whose results reflected the characteristics of a normal distribution. The authors suggest that total scores of the scale be used after reverse coded items are processed. Individual explorations for each factor could also be conducted to see aspects of ICT integration that need immediate action. Since further confirmatory analyses to investigate second-order relationships were not yet conducted, and since the relationships among sub-competencies of UNESCO (2002) were not investigated through pertinent structural equation models, it is suggested that total scores calculated for part of the individual factors not used.

DISCUSSION

The current study sets out to generate a measurement tool for investigating indicators of information and communication technologies. Authors had 12 factors and more than a hundred statements at the inception of the development process, and completed the instrument through expert panels, and exploratory and confirmatory factor analyses which identified 10 predetermined factors indicated by a total of 38 questions.

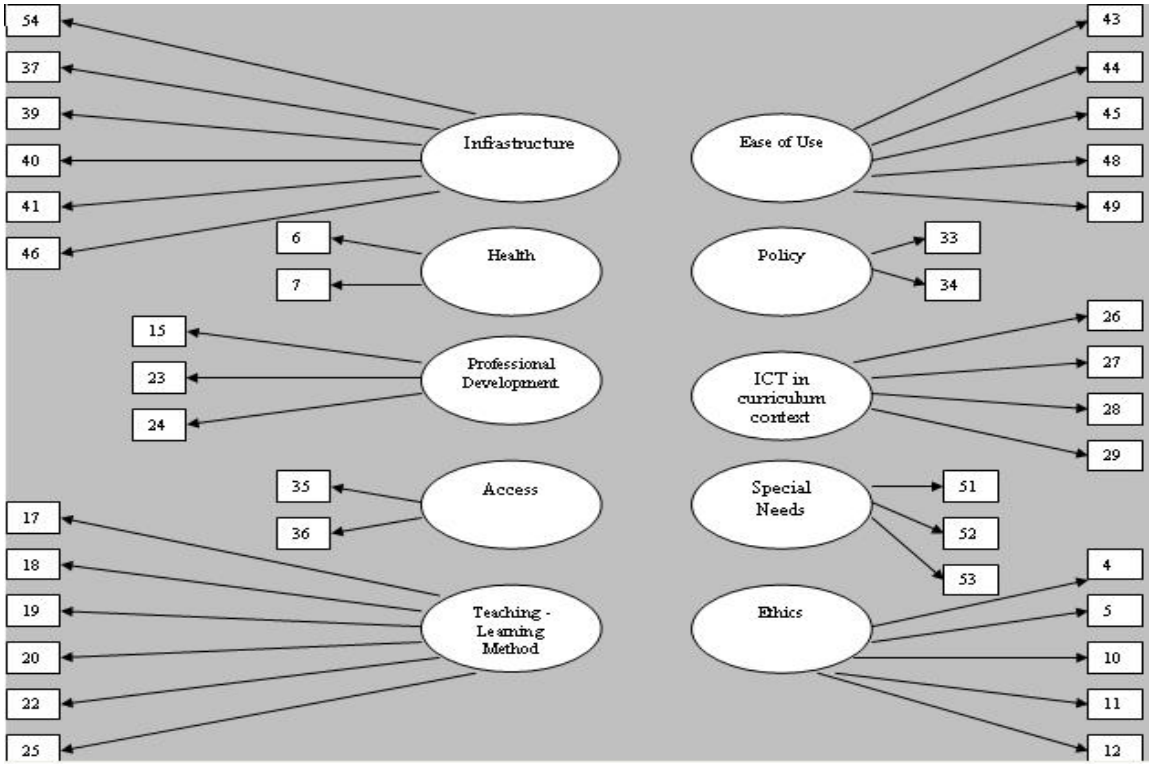

Figure 1. *Summary of the confirmatory factor analysis*

Items of technical assistance were somewhat merged with indicators of access, ease of use and infrastructure. This was not an extraordinary situation since these subcategories all belonged to the construct of technical issues as mentioned in the literature review. Moreover, none of the items addressing learning communities had appropriate loadings to be included in the final version of the scale. Perhaps, items of learning community were shadowed by those of professional development. This was an expected situation as well, since both professional development and learning communities are examined as subcategories of the same construct (i.e., collaboration and networking). New questions could be added to the scale to address technical assistance and learning communities more effectively. An interesting controversy to bear in mind is that professional development is mentioned under the construct of technical issues by UNESCO (2002). If this approach is taken for granted, one might suggest that the current study did not reveal factors related to collaboration and networking. Naming factors in accordance with observed variables is open to further discussion and scrutiny.

Some privileged studies conducted through structural equation modeling in the literature tend to conduct factor analysis on the first subset of a large sample, and SEM on a second subset (Creed & Machin, 2003; Inglés, Hidalgo, & Méndez, 2005). However, it is also acceptable to conduct both analyses on the same data as done by Brkich et al. (2002). The analysis conducted with a single sample in the current study demonstrates first-order relationships between sub-categories of UNESCO (2002)'s four competencies and observed variables. Further analyses with new samples could be conducted to see the relationships between four competencies and

subcategories, and between subcategories and observed variables, which can reveal second-order relationships. Moreover, through administering the current scale across different populations, the tool might be developed further, so that structural equation models can be suggested among reliably measured constructs.

As mentioned before, the reference population of the study was senior students of the Faculty of Education at Anadolu University, Turkey. The scale should be used with larger samples across different faculties aside from the education faculty to develop its construct validity and generalize the results to a larger reference population. For example, Akpinar (2003) reported differences in technology using behaviors of K-12 teachers within and outside classroom in accordance with the program they graduated from. Since the current data were collected from an opportunity sample which was a single Turkish state university, generalizations to other state universities based on the current dataset could only be suggestive rather than definitive. Besides, the ICTIMS investigate ICT indicators from senior students' points of view. A parallel form of the questionnaire could be developed for instructors to scrutinize their perspectives in terms of content and pedagogy, collaboration and networking, social and health issues, and technical issues.

The authors of the current study prepare to administer the ICTIMS across senior students of all education faculties in Turkey, which will lead to scrutinized knowledge on the ICT situation of educational faculties and prospective teachers. Besides, collaboration among European universities within the scope of a joint project like SEUSISS (Haywood, 2003) might lead practitioners to invaluable information about the ICT situation across European universities.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 78-88.

Researching a participatory design for learning process in an intercultural context

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ABSTRACT

The School of Education, University of Nottingham (UoN), UK and Beiwai:Online, Beijing Foreign Studies University (BFSU) Beijing, China have been engaged on a collaborative project to develop a generic module for the training of online tutors as part of the eChina-UK programme. Participatory design approaches have been used within this project to allow potential users of the module to play an important role in the design process. Academics, technologists and tutors from China and UK worked together in small groups over nine months to produce the module materials. Reflective accounts, audio recordings of face to face (F2F) group working and interviews have been used to explore the design process. This paper describes the participatory design approach in this project and explores an activity theory based analysis approach that is used to identify some of the factors that affected the design process.

Keywords*: participatory design; activity theory; tutor training; intercultural*

INTRODUCTION

This paper provides an introduction to research into the process of participatory design of online materials for the training of online tutors: etutor training. A collaboration between the School of Education, University of Nottingham (UoN), UK and Beiwai Online, Beijing Foreign Studies University (BFSU) Beijing, China set out to develop an etutor training module for use initially within BFSU, but which was intended to be developed eventually as a set of generic materials for use across the Higher Education sector. Participative design approaches that involve a wide range of professionals, i.e. technologists, academics and etutors have been adopted to support a shared dialogue between the cultures to produce effective etutor training materials. There is much rhetoric about the importance and the value of including potential users in the design of online materials and experience of this process indicates that it is complex and time consuming. However it was felt that the development of the tutor training module would benefit greatly from an involvement of some of the Chinese tutors who would be potentially completing the tutor training module. It was also felt important to develop an understanding of the participatory design process to inform ways of working within the collaborative project and to share this more widely. The research reported here explores the cross cultural interactions among the groups of people involved in the design process. The paper begins by contextualising the research by describing the project, the structure of the tutor training module and the participatory design approach used to develop the materials for the module. An activity theory approach has been used to support the analysis of the data and the paper provides an analysis of two cases of group activity within the project to illuminate the value of this research approach.

THE CONTEXT

The School of Education, UoN, UK and Beiwai Online, BFSU, Beijing, China were engaged in a collaborative project to develop an online Masters in English Language Teaching for teachers at tertiary level from 2004 - 6. Details of these Higher Education Funding Council for England (HEFCE) funded developments and the wider eChina-UK programme of which this project was only one part can be found on http://www.echinauk.org . As part of the UoN-BFSU collaboration and as a result of a user needs analysis of potential tutors for the Masters course it became clear that a 'new' approach to tutor training was needed. This resulted in further collaboration by the partners to develop a generic module for the training of online tutors as part of the eChina-UK programme., funded by the institution themselves together with HEFCE.

TUTOR TRAINING IN CHINA

The approach to tutor training that exists in China supports the learning and teaching activities in the course and this has been the approach taken at Beiwai:Online for their current programmes. This tutor training programme like many in China involves face-to-face residential training in orienting the tutor to the nature of the course and their role. At Beiwai:Online there is also an online experiential component to the training which involves an exploration of the materials including an experience of using a discussion forum. The focus of such training is on the orientation of the tutor to the types of activities in which the students are engaged. For example, one tutor training activity involves the tutor in planning a face to face tutorial and another involves how to assess student assignments. These approaches present models of effective practice, which the tutors then follow as part of a course assignment on which they receive feedback. However, a good etutor needs more than this. The challenge is one of helping them understand the concept of "etutoring" fully by developing their understanding of effective pedagogy and strategies for supporting online learners. This needs a new approach to the tutor training curriculum. It also needs a new approach to the design of the tutor training materials to ensure the materials developed are influenced by the real needs of the potential learners. This was the approach adopted by the project described in this paper.

TUTOR NEEDS

Ten Chinese tutors who were representative of the potential tutors for the online MA EELT volunteered to participate in the design of the etutor training module. These tutors all had an MA degree, had between 2- 4 years online tutoring experience and were from a representative number of regions/cities. Each tutor was asked to complete a questionnaire and an individual interview in order to develop an understanding of their backgrounds and to gather their perceptions of the nature of key etutor skills. This raised 2 key issues:

- Low retention on online courses was felt to be partly due to learner isolation.
- They expressed a need for professional development that would support research into practice

They identified the following skills needed by online tutors:

- Computer literacy: An online tutor needs high levels of skill in using a computer and the internet.
- Communication: An online tutor needs to be an effective communicator with their online learners and to encourage effective communication between learners as well.

- Interpersonal relationships: An online tutor needs to know how to build effective interpersonal relationship and trust. This was a major concern for these tutors.
- Supporting new ways of working: An online tutor needs to support the learner in new ways of working, for example learner centred approaches mean learners need to learn how to develop a more autonomous approach to their learning.
- Knowing how to motivate learners: Online tutors need to understand how to motivate learners to complete the work.

THE eTUTOR TRAINING MODULE CURRICULUM

The eTutor training module within this project was designed to last for between 10 and 15 weeks and is a mixture of self study and online group work. The structure of the module is described below. The whole module is designed to be completed online, but would benefit from some F2F working in Units 1, 3 and 5.

Unit 1 Introduction (1 - 3 weeks) Mode: F2F/Online

In this unit, tutors have the opportunity to get to know each other and to reflect on their current practice by considering eLearning pedagogy and intercultural working. They are also introduced to the module structure.

Unit 2 Experiential learning (3 - 4 weeks) Mode: Online

This unit contains eLearning content from the modules on which the tutors will be acting as tutors. Materials and examples from the MA eELT module have been used initially, but this can be supplemented or replaced by examples from local courses when used at other institutions. Tutors act as learners in this unit and reflect on the kind of support they need from their tutors and establish a better understanding of the tutor's role. Note that most tutors have little experience as online learners themselves and this unit is designed to provide an intensive experience of this.

Unit 3 Personal development planning (1 week) Mode: F2F/Online

This is a reflective unit and serves as a transition from what they already understand to more advanced training. Tutors need to decide upon a personal development plan (PDP) which sets out the areas they will focus on in Unit 4.

Unit 4 Advanced training (4-6 weeks) Mode: Online

Five sub-areas are identified within this unit: Empathy, Cognitive aspects, Methodology, Assessment, Community building. Some of the content and activities are compulsory and others are optional. Tutors focus on the areas they have identified in the PDP in unit 3.

Unit 5 Further reflection/Assessment (1 week) Mode F2F/Online

Trainee tutors complete a portfolio outlining their achievements as well as their future training needs. This serves as a transition to their working as an online tutor..

Pilot versions of units 1 and 2 were set up in the open source online learning environment Moodle. These contained lttle interactive material and were basically text and video based serving as a benchmark of current practice for the project tutors - these were to be subsequently revised for the final version of the etutor training module. The volunteer project tutors were required to complete these units as a preparation for developing materials for units 3 and 4. The online learning experience was expected to help the project tutors reflect on the roles and needs of the learner and tutor in some detail to help them to think critically and creatively about the nature of the training materials that would be needed in Unit 4. These project tutors were to work

collaboratively with academics and learning designers and technicians and the participatory design approach is described in the next section of this paper.

THE PARTICIPATORY DESIGN APPROACH

Participatory design (PD) originated in Scandinavia (Schuler & Namioka, 1993) in the 1970s. It started in the field of computer software design, but similar approaches have been used in other fields as well (Silva & Breuleux, 1994). Participatory curriculum development (PCD) in higher education has been promoted by Taylor (2006)

> *"today, particularly with an increasing interest in experiential and learner centred education, learners are encouraged to take responsibility for their own learning. At the same time, there has been some recognition that teachers and trainers should have an input into what they teach as well as how they teach it. Still, curriculum development has tended to remain the responsibility of a few, an elite group located at the top of a hierarchy. The idea of other stakeholders having a clearly identified role in curriculum development is rather uncommon."*

This idea of involving different stakeholders in curriculum development serves the purpose of enabling the users of a curriculum to take responsibility for their own learning experience, through participating in the design. Axup (2006) points out that PD has a very strong advantage:

> *"Co-designing with real users in realistic situations and environments helps improve the quality of feedback users provide. Frequent iteration between users and designers reduces misconceptions designers make (in part due to insufficient domain experience)."*

Understanding user needs, their preferences, their problems and confusions can only be achieved by frequent and profound communication between designers and users. In PD the intention is that the role of the expert "is changed from that of an expert to that of an equal participant who happens to have expertise" (Silva & Breuleux, 1994:103). Learning designers need to listen to the users' voice and not just take for granted what users may like and have to know. There is a need "for designers to take work practice seriously—to see the current ways that work is done as an evolved solution to a complex work situation that the designer only partially understands " (Greenbaum and Kyng 1991, in Winograd & Kuhn, 2006). Users' work experiences should have an important role to play in the design and should be highly valued. However, Axup (2006) also points out that there are several pitfalls of PD:

- Participants are usually not trained designers. Consequently they can produce poor designs or feel uncomfortable doing unfamiliar design activities.
- If participants are asked to start from scratch, it will be problematic. They work better with some scaffolding to direct their design ideas.
- Users may not be willing to devote time to help build technologies which other people profit from. A key challenge is determining how to interest or motivate participants to help build a product they may not use, and which may take be years from production.
- Using a small sample of participants runs the risk of one user being an outlier with unrepresentative concerns. These participants can provide useful challenges to the design, but they should not drive it.'

The PD process itself has tended not to be the focus of research and it was the intention within this project to develop an understanding of what happens during the PD process. An activity theory approach was used to frame the research and the data analysis and this is the subject of the next section of the paper.

ACTIVITY THEORY

Activity theory (Leont'ev 1978; Vygotsky 1978) was used as a framework to analyze the ways individuals work within the project as part of the PD process to design the tutor training module materials. Activity theory is increasingly being applied to aspects of technology-supported learning because of its emphasis on the mediation of tools and social factors on human activity. It has been used in the study of Human-Computer Interactions (Nardi 1996) in research into online collaborative behaviour and distributed learning (Andreassen 2000; Russell 2002) and for supporting the eLearning design process (Jonassen et al 1999).

Activity theory argues that an activity is composed of a subject, a person or a group engaged in the activity, and an object (the objective of the activity), mediated by a tool. The mediation can occur through the use of many different types of tools, e.g. material tools as well as psychological tools, including culture, ways of thinking and language. eLearning tools might be an online discussion forum, an online or paper notebook or the study approaches that support effective learning. An activity system (Engeström 1987) shown in Figure 1 is a way of visualizing the total configuration of an activity.

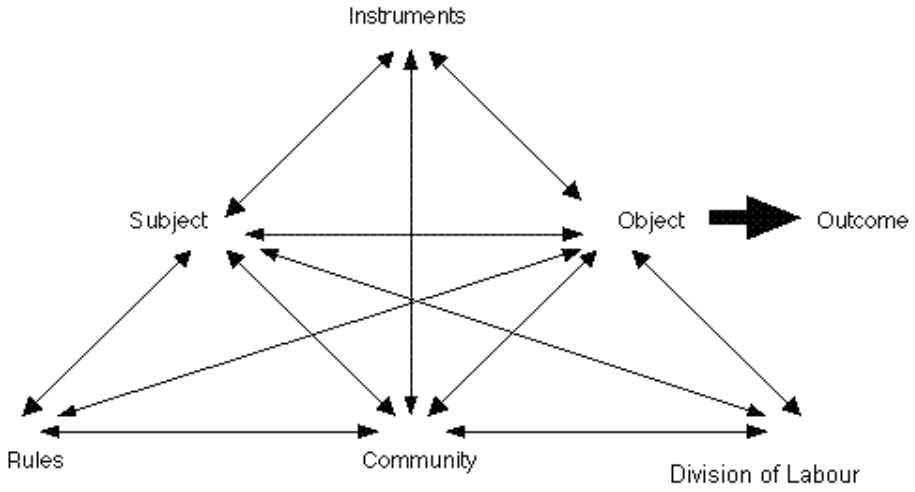

Figure 1: Model of a human activity system (Adapted from Engeström, 1987)

Consider the model applied to the development of the etutor training module. The object of this work is to facilitate the project tutor with necessary skills and awareness so that they can collaborate in the development of the materials. The outcomes include the intended ones for the tutors such as ownership of the learning process and successful activity completion i.e. development of materials as well as knowledge, understanding and skills and associated ones such as skills development. Unintended outcomes such as possible dissatisfaction, non-engagement can have a negative impact on the process. The instruments may include communication tools such as email, discussion fora, which may be used to support the development of understanding and encourage engagement. The community consists of the project tutors, the academics and the learning designers/technicians who are supporting them in developing the materials. The division of labour determines the roles taken on by the individuals in the PD process. Finally, the rules regulate the use of time, the online behaviours, the measurement of outcomes, and the criteria for rewards (or awards).

Two cases within the project are described to illustrate the ways the activity system approach is being used as the framework for data analysis and presentation.

TWO CASE STUDIES

In this project, the tutors and academics were divided into five home groups covering the five themes of the module, namely empathy, methodology, cognitive aspects, feedback/assessment and community building. As mentioned earlier all the project tutors were involved in 3 weeks working online completing the induction unit, unit 1 and the experiential orientation unit, unit 2. This was followed by a four day F2F workshop in Beijing where they started participating in the design process for unit 4 and group working was audio recorded. This workshop was followed by a 4 month period of online collaboration within home groups in order to prepare materials for their particular theme. During this time each individual was asked to complete a monthly reflection on the participatory process. At the end of this period they were also interviewed at a second F2F 3 day workshop in Beijing. In this study, two home groups (named Group A and Group B) have been selected and their reflections on their online experience and their monthly reflection over a four-month period are analyzed to show the impact on the tutors within the PD process. The results are summarized below.

Reflections on the initial induction and orientation online experience

Prior to the project none of the project tutors had been online learners although they all had at least 2 years experience of online tutoring - they were trained to be online tutors because they had classroom teaching experience. They felt that the experiential learning within the project gave them an opportunity to understand online learning and view this from a learner's perspective. In their reflections, they mentioned that they didn't have enough time to complete the expected activities and they lacked motivation. The project deliberately chose not to provide effective tutor support during the online induction in order for each tutor to experience what it felt like to be poorly supported - they unsurprisingly all felt that the contact between themselves and the course tutors running the online induction was inadequate They expressed feelings of loneliness and isolation and wanted more communication .They were critical of the eLearning exemplar materials in unit 2 as they felt that these should be more interactive and stimulating. They however felt that their experience and their reflection on this were useful and helpful in terms of developing a better understanding of the need of their online learners. They were developing an empathy for their students as well a new perspective on their own roles, responsibilities and needs as tutors.

Reflections on the PD approach in practice

The project tutors were potential online tutors for the MA eELT. Their participation was intended to ensure the training materials met the needs of tutors being trained within the module – as they were centrally involved in the design process. However not only were they involved in designing something for future tutor training, they were in fact being trained by participating in the design process itself. Their monthly reflections and the interview revealed how they felt during the process and what influenced their understanding of eLearning and teaching. The result of the use of the activity system approach to analyse the behaviours of the two groups is shown in table 1, which provides a comparison between the two groups using the activity system components as a framework. If we consider designing the material as an activity, we may report the activity system within these two groups in the following table:

Table 1: *Activity system*

Activity system component	Group A	Group B
Objective	To develop 3 online activities - the following covers the design of first activity	To develop 3 online activities - the following covers the design of first activity
Subjects	The three members (all female) in this group were all Chinese.	The two tutors (one female and one male) were Chinese and the coordinator (male) was British.
Tools	Skype, emails, paper, PowerPoint, Word etc	Emails, paper, PowerPoint, Word etc.
Rules & Regulations	At the workshop it was agreed that each participant would organise one activity each. The coordinator was to lead on the first activity. The group met online in Skype once a week. Agreed necessary readings and reviewed work that was been drafted before each meeting.	At the workshop a design had been agreed for the first activity that involved creating a number of video clips. The group were to use the F2F workshops to develop an overall design and then share the provision of content for this in between these meetings The group set up deadlines for submitting scripts by email attachment for videos to the coordinator.
Division of Labour	All members contributed equally in this group. The ideas are discussed before they are finalized. The coordinator's role was to organize online discussion every week and summarize ideas after it.	All members contributed equally in this group. However the coordinator acted as an editor of all the contributions and finalises the learning design.
Community	Due to the frequent online interactions, the members in this group are not only work partners but also close friends.	The two male members had strong viewpoints.. The female member acted as a bridge to help them understand each others perspective. Though the group were productive their relationship remained professional.
Outcome	The overall structure of the unit was completed and three online activities within this were partially produced in this first period of development	The overall structure for the unit was completed and one complete online activity was produced in this first period of development

From table 1, it is clear that there were differences in the ways of working and the outcomes between the groups. The following explores some of these differences in more detail as a means of exploring the potential of the activity theory approach to the analysis as well as revealing the nature of the PD process within the two groups.

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Division of labour

Group A: This group worked collaboratively, i.e. all the major content and ideas for presentation were whole group decisions. They achieved this by synchronous online discussion through

Skype. The coordinator took responsibility for putting ideas into PowerPoint files and sending them around to the group members for reviewing and further development. When asked how they managed to achieve the final outcome, they all thought that the regular online meetings were critical. This meant that they needed to be well-prepared for the discussion and so increased involvement and motivation. The pressure created by this approach is greater than when email is used as these can be ignored or simply forgotten due to work or family priorities.

Group B: This group worked more cooperatively i.e. they agreed tasks and worked on them separately rather than working on them collaboratively. From April to June, the two Chinese tutors produced the agreed video scripts that were important for the completion of the first activity the group had designed. These were sent to their UK coordinator who then edited these and added his own. He then liaised with the technical developers in the UK to ensure the activity was programmed and completed. In the mean time email communication was infrequent once the agreed task were completed and the coordinator spent time designing an online tool and another activity by himself for use across the whole module as well as within the unit. This coordinator was also the project manager and took responsibility for leading the project conceptually and the activity that was developed was as a result of this wider working. However this did mean that the group were not involved in these developments and it also meant that time spent with the group was limited. “There has been little collaboration this month. I have just got on with developing the unit…. not the best approach but deadlines needed to be met and I had to lead the module and our unit with its conceptual direction.” (B1) He chose to move things on to meet deadlines and this approach did not allow time for debating and discussion.

Community

Group A: This group thought that they were “very flexible” (A1,A2, A3) in their approach. The theme was new to all of them but they were happy to read background materials to develop their understanding in order to produce effective materials. The group were all of similar age and personality. They described each other as very considerate. A2 is a new mother so A1 and A3 were very supportive. They chose the time for online discussion that was suitable for A2 and they also took more of the workload so that she could cope. A2 on the other hand was very active in providing new ideas and feedback. A3 was very busy but would try her best to meet with the others online. She said that she “delayed other work but stuck to the timetable set up by the group because I didn’t want to let anyone down when discussing online”(A3). She wanted to contribute and managed to do so by working very hard. The atmosphere in this group was described as very friendly and the participants described themselves as becoming ‘close friends’. As A3 reflected “we not only talk about the project, but also show much concern about each other’s life. In this way, we try to support each other mentally to continue working hard on this project.” There was frequent communication among the group and this was quite open and informative. A2 and A3 had no chance to work with the technologists directly as these were all in UK, A1, the coordinator worked in the UK during this period and reported to the other two members all the suggestions and questions the technologists made each time she had a meeting with them. In this way, A2 and A3 were always informed about the progress.

Group B: As we can see from the table, the two male members are very strong minded people. B2 reflected on what happened in the workshop and reported that “It seemed to me that both B1 and B3 were trying to persuade the other with his own ideas, both were strong people. I felt if I wouldn’t do some coordination work, the two would certainly break up and quarrel.” In the end, B2 acted as a bridge and B1 conceded to take a different approach to ensure B3 (the Chinese tutor) felt his ideas were being valued. They all followed B3’s approach in their planning. It is important to point out at this moment that the language used for discussion in Group B was English and in Group A this was Chinese. Language was felt to be an obstacle for communication within the

project, some of the Chinese tutors felt it was difficult to get ideas across when using English in spite of their relatively high language competence - they were teacher's of English. When B2 acted as bridge she ended up using Chinese to talk to B3 so that she could understand B3's perspective better and help B1 to understand it. For Group B, the only communication method was via email in spite of being an online tutor B3 had not used instant messaging softwaresuch as Skype and this was not addressed in the first workshop. B1 felt "it takes a few days to get a reply". They in fact had relatively few email exchanges. Activity one had in fact been fully designed at the face to face workshop and a PowerPoint prototype had been developed. In effect the technical developers took this and developed the final online activity from this work. However this left the other members of the group uninvolved in any group working. B1 liaised with the developers to ensure the deadline for completion of the activity was met and organising this and other project work meant that he was hesitant to start developing anything new. B2 also felt B1 was busy and she said "B1 is responsible for the coordination work and busy getting the videos done, I just visited the Moodle websites, waiting for further instructions." B2 seems to be a little passive as she waited for further instructions, but she would visit the websites which means she was willing to do more. However, B1 has "a feeling that my group will be waiting for me to move things on and I can't really do any more than I am doing and in fact at present there seems little that they can do – this needs thinking about during the Beijing workshop (the later meeting) – rethinking ways of working." The coordinator realized that their way of working was problematic and a new approach needed to be adopted so that the group members can be involved more.

Reflections on the influence of the project involvement on the tutors

B2 in her reflection said that this experience had been helpful in her actual teaching. "One of the group members B3 has interviewed some of his students for the development of the teaching material, and this kind of first-hand information has been very helpful in my teaching. …when I transferred similar ideas to my students, I got such unexpectedly positive responses from my students." Niether of the project tutors B2 and B3 had thought about the theme they were working on before the project and didn't realize it was closely related to online teaching. From the participation, they felt they had understood the theme better and had broadened their view in this area.

A3 started to look at her teaching practice in a more critical way. "I think the textbook I am using now for the online teaching is not suitable. Because there is little difference between those used in classroom teaching. In my opinion, online teaching materials should be designed by integrating online activities into the course. These online activities will be achieved in the online learning community, which should be assessed and serves as an integral part of online learning." Both A2 and A3 said that they had benefited from the process of designing the activities for the module. This was because they had the opportunity to talk to their colleagues so that they had a better understanding of the concerns and problems other tutors have. They also thought that their creativity had been improved and that this would influence their future teaching.

If we summarize the key differences between these two groups into the activity system triangle, it looks as shown in Figure 2.

This shows that the activity system approach to analysis can be useful as a way of presenting the dynamics operating within an activity. It also signals issues such as ways of working and communication, interpersonal relationship and language etc that might need addressing to ensure improved participation. Participatory design processes are complex and this approach provides a means of presenting this complexity illuminating the interplay of factors that shape group working.

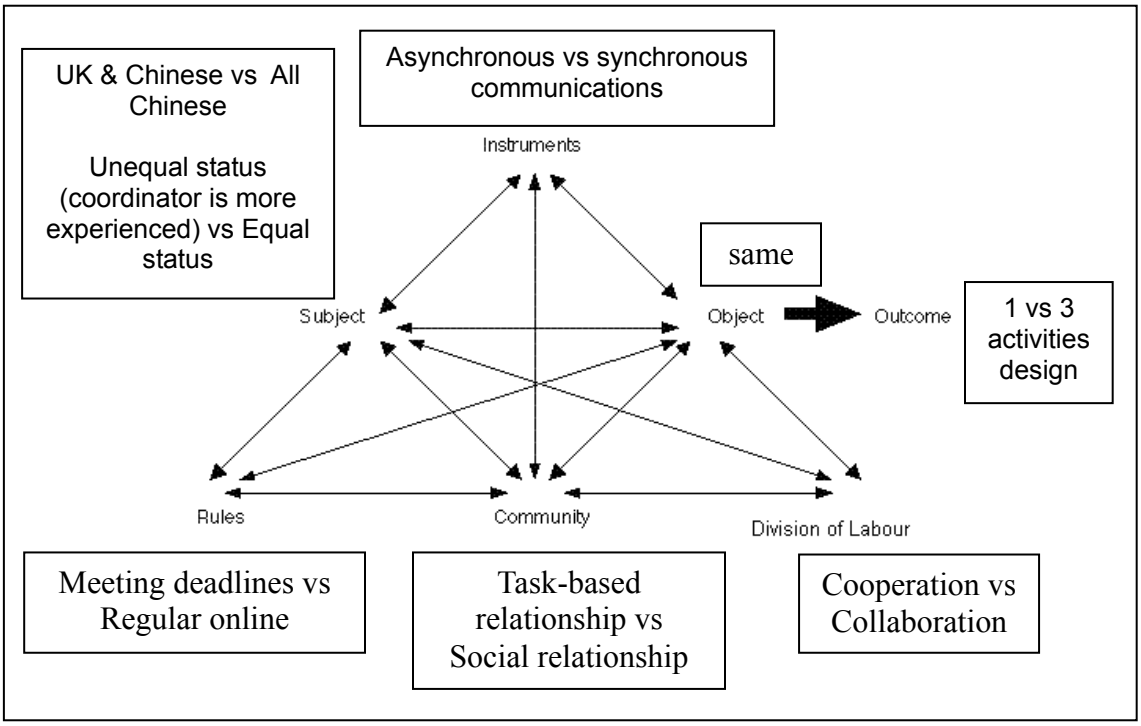

***Figure 2**: Key differences between groups*

CONCLUSION

Activity theory appears to be a useful tool in supporting the analysis of the participatory design process. It helps the researcher frame questions to explore during the research and through the data analysis. Further work needs to be completed within the project described and it is hoped that this will lead to the identification of factors that support effective collaborative design as well as provide an indication of the value of such a process for the participants. The paper has been written at a time in the project when the tutors have just begun the second phase of developments.

The lessons learnt from the analysis described above have been shared within the project and the home groups have planned to revise their ways of working, for example, synchronous communication is now the preferred and intended approach for online collaborative communications. This is already an indication of the value of this type of comparative analysis within the complex project described in this paper. In the next four months, the tutors will continue to work with academics and technologists to produce more materials for the module and further data will be collected and the research approach explored more fully.

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The innovative elements in non-formal education of Bangladesh: Perspective of income generating programmes for poverty alleviation

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ABSTRACT

This paper attempts to explore the innovative elements of non-formal education of Bangladesh in terms of its contribution towards poverty alleviation through income generating programmes. A survey of the beneficiaries, focus group discussions, and documentary review are used as research methods. This study selects one NGO through examining relevant NGOs in term of non-formal education linked income generating programmes and then finds out the innovative elements of that NGO by in-depth study. It shows that most of the NGOs have programmes for socio-economic development but a very few of them have innovative elements in non-formal education linked income generating programmes for poverty alleviation.

INTRODUCTION AND BACKGROUND

Attacking poverty has become an international concern for placing in the paradigm of 'education and learning for sustainable development' in consideration of the reality that almost half of the world's population live in poverty. The world has deep poverty amidst plenty (World Bank, 2000). Based on the recognition that formal education programme has failed to become adequately responsive to the needs, particularly of the poorer/disadvantaged sections of people, non-formal education programme has evolved in various form as a strategic intervention for poverty alleviation.

In recent years, non-formal education has become an important phenomenon in developing countries like Bangladesh where many international, national and local NGOs are providing non-formal education for increasing income generating programmes for the poor and disadvantaged groups. The general objective of this paper is to identify and examine innovative aspects of non-formal education programme having demonstrated potentials and scope for poverty alleviation through income generation. Specifically, the paper has sought to identify the scope and the role of non-formal education contributing to income generation; to identify innovative approaches of non-formal education linked to income generation; to assess the impact of pilot /experimental income generation programme under non-formal education as a useful contribution to human resource development; and to make recommendation for policy formulation to build up essential links between non-formal education and income generation programmes for poverty alleviation.

Bangladesh is classified as one of the poorest countries of the world. Data published by UNESCO rank Bangladesh in the thirty-first position out of thirty-five countries for which GDP data could be given. The national literacy rate has increased significantly but 34% adult people are still illiterate (Bangladesh Bureau of Statistics, 2002). The labour force, with the growth of population, will continue to grow for about 50 years more till the population becomes stationery. It is estimated that the labour force will grow from 55 million to 100 million over the next 20 years. The country has 6.6 million child labour force (aged 5-14), but in reality the number may be higher. Over 4 million of these children work in agriculture in rural areas and in informal sector in urban areas. The poverty line (daily intake of 2122 K. Cal a day) reveals that 36% people live

below the poverty line. Thirty seven percent are rated most vulnerable, and forty six vulnerable (Bangladesh Bureau of Statistics, 2000). The present trend of the socioeconomic conditions in Bangladesh in terms of literacy rate, population growth, per capita income, and employment situation are improving but inequitable distribution of resources (e. g., income, land) deteriorate the situation. Twenty percent people has only 8.7 percent share of total income while the highest 20% people has 42.8 percent share of total income (The World Bank, 2000) and 84% people acquired small farm 0.05-2.49 acre land (Planning Commission, 1998).

As in many other countries of the world, non-formal education programmes have been organized in Bangladesh, first, by NGOs and subsequently by the Government at a larger scale. Although there are many NGOs, large and small, engaged in non-formal education not all programmes are well conceived. Also, many of these non-formal education programmes are not specifically designed to address the crucial issues of income generation to improve the quality of life of the targeted population, while some directly address the poor or disadvantaged groups. Some NGOs are relatively new in the field and their emergence has been prompted by foreign funding channeled through government projects or directly by the foreign NGOs with Bangladesh Government approval. A good number of NGOs have vast experience as they have been working for many years. Some NGOs follow traditional approaches and some have been trying to evolve new approaches. It is worth exploring those programmes which have innovative interventions linking non-formal education with poverty alleviation. For such programmes it is important to identify their strengths, weaknesses, replication prospects, sustainability and acceptability in the community.

In spite of the outstanding growth towards universal basic and primary education there are still many left outs of the system. They constitute drop-outs of the enrolled students and non-enrolled, mostly among the rural poor. Besides the non-formal education programme operated by NGO-small and big-the government has administered a member of big non-formal education projects nationwide. The thrust of the government project has been toward promoting literacy aimed at the goal ‘Education For All’. Some of the government projects have been implemented by NGOs, as partner (contracted) agencies, although supervised and monitored by designated government staff.

Non-formal education operates alongside the formal education system. It is flexible in terms of curriculum, organization and Management, responsive to the needs of special groups of learners and is inclusive of all who wish to learn. Continuing education combines under non-formal education in a limited way literacy with life improvement skills in consideration of practical needs of different population groups. There are many barriers to non-formal education and livelihood skill training, as far as the goal of alleviation of poverty is concerned. The barriers are at the level of the illiterate poor and also in the nature of non-formal education programmes and quality of management. Identification of appropriate model to alleviate poverty of the people is an important area of in-depth investigation and it is a major concern of the Government, NGOs and the development partners. The Government of Bangladesh undertook several projects such as Integrated Non-Formal Education, Non-formal Education Project– 1, Project– 2, Project– 3, Project– 4, Post-Literacy and Continuing Education Pilot Project to address illiteracy (DNFE, 1999) and in a very limited way, the poverty issues. The Government has been planning to undertake Post-Literacy and Continuing Education for Human Development Project with the financial support of World Bank, Asian Development Bank (ADB), Norwegian Assistance for Development (NORAD) and Swedish International Development Assistance (SIDA). The most recent thrust of non-formal education project, named post-literacy and continuing education for human development is on skills training and income generation for poverty alleviation.

METHODOLOGY

Selection of innovative project

In consideration of the objectives of the study, a particular agency was to be selected for in-depth investigation and analysis. This required adopting a procedure so that the selection could the proper. First, the study collected and reviewed the NGO directory published by the Association for Development Agency in Bangladesh (ADAB, 2001), which is an apex body and a forum of all NGOs engaged in development, and the Directory of Education Programmes of the NGOs published by the Campaign for Popular Education (CAMPE, 1995) which is a forum of NGOs engaged in educational activities. The team examined the activities / programmes of the NGOs and in this process more than one hundred agencies – local, regional, and national operating non-formal education and income generation programme were preliminarily selected. At the second stage, the study team sought to identify non-formal education focused on income generation programme and linked to poverty alleviation. The process resulted in identification of 12 agencies with some relevant information for the study purpose. The selected organizations were then approached to provide further information on non-formal education and income generation programme and also relevant documents. An interview schedule-cum-checklist was used at this stage and direct contact was established with these agencies to collect information. The main areas of information sought from these organizations included:

- innovative elements of non-formal education linked to income generation programme, and the importance given to the programme,
- goals and objectives of the programmes
- information on non-formal education and income generation programme components
- impact of non-formal education linked income generation programme on target population

A total of eight organizations provided all information we sought. The study team then thoroughly examined the information received from eights organizations. From these two organizations were selected:

- Bangladesh Association for Community Education (BACE), and
- Centre for Mass Education in Science (CMES)

The two organizations appeared to have comparable elements that the study could take interest in.

Final selection of the innovative project (organization)

The study team carefully examined the above two organizations by using the following indicators: (a) target groups; (b) benefits planned for the target groups; (c) coverage; (d) goals and objectives; (e) how innovative; (f) how closely non-formal education is linked with income generating programme; and (g) how much importance is given to non-formal education- income generation programme linkage. The study team, at this stage, also assessed the level of cooperation that the authority of the above two agencies at both head quarter and field level were ready to offer to the study team. Thus the team finally selected CMES for the case study.

Data of the study and sources of data

The study was based on both secondary and primary data. Secondary data were obtained from available reports and documents of Government organizations, NGOs, international agencies, which supported planning, development and financing of non-formal education for linking with income generation programme. Primary data were collected from different groups of respondents taken from the selected NGO. Different method i.e. interview, observation, focused group

discussion and informal discussions, were used to collect information. Use of different sources helped us to validate data, as data from one source could be checked by data from another source.

The whole process of data collection, therefore, included the following activities:

H01 collected documents and reports relevant for the study;
H02 reviewed available relevant documents;
H03 prepared a list of leading NGOs involved in non-formal education and skill training;
H04 selected one innovative non-formal education project involving income generation programme through income generating activities;
H05 designed interview schedules, checklist and observation guidelines; and
H06 carried out filed survey to collect both quantitative and qualitative information relevant for the study;

Interview and focused group discussion

The study team conducted interviews and focused group discussions with the following groups:

- providers at the headquarters (interview)
- providers at the field level (interview)
- students studying at the centres (focused group discussion)
- graduates of the programmes (focused group discussion)
- parents of the students (interview)

Field study

Besides looking into the available documents on the CMES activities, field study was carried out dating March 21 – April 8, 2002.

CENTRE FOR MASS EDUCATION IN SCIENCE (CMES) – A CASE STUDY

Major thrust and target groups

Established in 1978, CMES is solely dedicated to the disadvantaged population groups, and is based on an assumption that exposing the mass people to science and technology would bring about a significant positive change in the level of their living and would contribute to national development. In its programmatic interventions, CMES has sought to arrange an appropriate education for the common mass encouraging them to be used to science and technology in thoughts and practices. In other words, education and practices that help to bring appropriate technology within the grip of disadvantaged people in particular for their empowerment has been the major thrust of CMES.

The target groups in direct focus of CMES are (CMES, 1999):

- children and adolescents who have no access to primary schools;
- children and adolescents who drop-out from the primary schools; and
- adolescent's who have had some primary education but want to acquire livelihood education.

Features of CMES system

- CMES, an enthusiastic organization, implements non-formal education for the disadvantaged boys and girls through very joyful and family environment. It offers basic education as well as employment opportunity to the learners. As a result not only the particular learners but also their families and community get benefits from the programme.

Together with education and learning having concentration on science and technology through its Basic School System (BSS), CMES has got other supportive programmes, which includes skill training, health and environment, credit scheme, cultural activities, social actions, curriculum development and public awareness programme. A mixture of all these make CMES a unique and innovative organization in Bangladesh.

- The innovative approach to human resource development, particularly for disadvantaged adolescent girls and boys is practically very useful. It has got a design of continuing education program offering diverse options through integrated education, skill training and profitable work-practice. The first stage in the process of transforming poor illiterate/out-of-school groups into productive human resource is the Basic School System, as it is called. This system has evolved through experience over a number of years at field level work and has been replicated and is serving now 20,000 students at a time. The focus is on increasing the chances for both wage employment and self-employment of the poor leading to poverty alleviation.

- Basic School System offers an integrated package, which makes education a supportive force to simultaneous income generation. It arranges for a life-oriented education curriculum compatible to mainstream primary and early high school education (up to an approximate 8^{th} grade level), along with training and profitable practice of appropriate technology. The system includes home to home interventions in health and environment. A distinct supportive programme called Adolescent Girls' Program (AGP) empowers the girls to shake off discriminations and stereotypes and to participate in the education and technology-oriented livelihood improvement programmes equally with boys. All the components of this integrated programme serve to reinforce each other. Literacy education draws its subject matters from livelihood practices while the latter derive scientific basis from the education curriculum. The school-day is divided into an inner campus (class room) and outer campus (practices) situations providing a lot of options. The latter takes place at market level, responding to the local demands for products and services that can be marketed by the Basic Education System. The marketing arrangement offers opportunity to the learners for earning income, which facilitates further practices in production and enhancement of skills.

- Basic School System particularly seeks to establish closeness of education to the life-environment on the one hand, and the practice of rural technology on the other, leading to immediate income generation and enhancement of life opportunities. In keeping with the needs of adolescent boys and girls (young adults); CMES has included community-based programmes at different levels of education. The learning system of Basic School System encourages the learners to use the local reading materials and resources. Students' evaluation criteria seek to assess competency level. It conducts three tests in a year like the government school system, but the tests are conducted very carefully followed by assessment of practice skills. After completing their education in Basic School System the students can get them admitted to technical centre and Advanced Basic School and move through different sessions of continuing education.

- CMES wants the parents to participate in the programmes, gets them in the parents' meeting and thereby facilitates community involvement. In 2001, three thousand and nineteen such meetings were held where the target was 3429.

- CMES encourages financial participation of the students. It allows the students to have a feeling of ownership of Basic School System. Each student deposits Tk. 2 per month that is kept in a bank of the Unit. By June 2002 the total amount deposited under this programme was Tk. 958,497, which is a substantial amount.

- Productive trades of CMES include carpentry, welding, computer-compose, repairing of tools and machineries, tailoring and garments, dyeing, block printing, nursery, mushroom cultivation, masonry sericulture, poultry, leather works and sanitary latrine manufacturing. Necessary supports like teachers and teaching/training materials are provided by CMES. Community and national demands as well as availability of local resources and learners' capacity are considered. Thus CMES involves its learners in different simple technology based production. The products include chalk, candle, soap, tie-dye, ball pen, and metal products. Other activities for income earning includes home-gardening, construction works, appropriate paper technology, book binding, decorative candle making and craft works by using jute fabrics. In 2001, students produced 971,728 pieces of chalk, 194,261 pieces of ball pen, 2944,005 pieces of candle, 32,466 pieces of soap, 135,137 saplings in home gardening and a good number of other products. The students' trainees earn money and contribute to their family income, while they learn.
- CMES also offer different short training courses for target groups and staffs of other organization. This is an effort to diffuse the education and training on science and technology. To ensure quality education and to develop its own staff, CMES provides regular training to its personnel.
- Home to home work as outer campus education is an important component of CMES programmes. As a change agent at the level of community, CMES takes up some activities like promotion of the improved chula (oven), compost fertilizer use, sanitary latrine use, tree plantation, vaccination, tube well repair, etc., which improve the condition of living of the target community population The students learn practical knowledge through this kind of outer campus education.
- Gender programmes include organization of gender convention, couple programme for awareness raising, peer assisted education, social action, management of credit programme and entrepreneurial training. Under the Adolescent Girls' Programme the adolescent girls get awareness on gender equity, rights, reproductive health, and livelihood skills.

The importance and use of mass education in science is brought to the attention of various materials for a particularly professional community interested in the promotion of non-formal education and income generation programme for poverty alleviation. Different dissemination initiatives in this regard are regular publication of the lessons, special publication, audio visual presentation, organization of seminars and exhibitions.

Unit level organization

Field Units: Each unit of system works through 15-30 Basic Schools, 2-4 Advanced Basic Schools and one Rural Technology Centre.

Five or six Basic schools serve as feeder to one Advanced Basic School (ABS). This is a primary level school with a difference. Seven or eight ABS serve as feeder to Rural Technology Centre (RTC). Rural Technology Centre is a higher and diversified school having emphasis on technical skill training. The general organizational setup is shown in the figure (please see figure).

The General Patterns of Component Functioning

The following are the general patterns of the functional system at CMES:

- Basic and primary education is delivered by following a learner centred approaches such that the students are active agents in not only learning, but also applying the competencies in the livelihood practices.
- Technology skill training, which involves application of general education and science education, is carried on to production of goods and services for the sale at the local market.
- Home to home work on health and environment constitutes a part of school routine – putting education into immediate practice for the enhancement of quality of life.

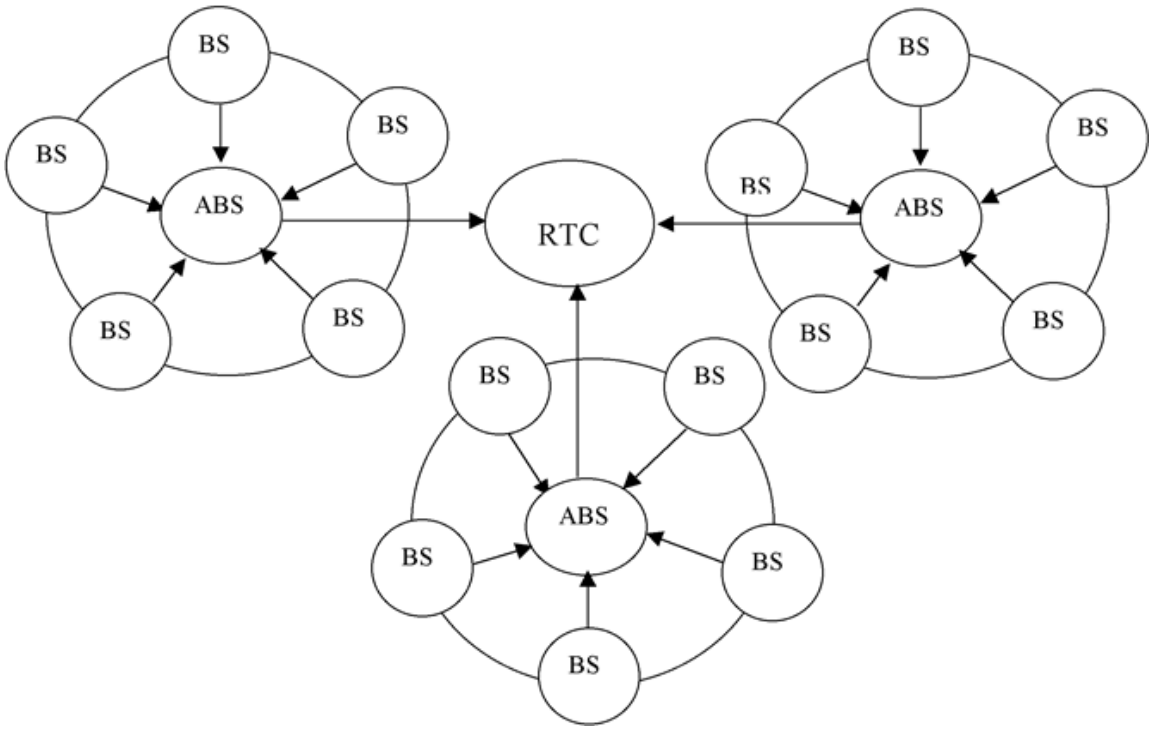

Figure 1: *Unit level organizational set up*

Implementation approach

The CMES education and training is designed and administered over 5 grades (levels), each taking one years in general. The five levels are: i) Angkur (Germinating), ii) Bikash (Developing), iii) Agrassar I (Advanced I), iv) Agrassar II (Advanced II), and v) Agrassar III (Advanced III). Angkur and Bikash levels are imparted to students in basic school and Advanced Basic School, while Advanced I, Advanced II, and Advanced III are imparted in Advanced Basic School and Rural Technology Centre. The way education and training is organized according to level and type of institution.

The Angkur level education is intended to ensure reading, writing and numercy skills while imparting basic knowledge of health, and environment. Angkur also offers opportunities to learn at least one technological skill directly relevant to income generation. The Bikash level gives

emphasis on the use of literacy and numeracy in real life situation, knowing the environment and acquiring technology skill. Bikash also offers opportunities to learn two or more technological skills directly relevant to income generation. Agrassar (Advanced) I, II, III cover primary level syllabus of the formal education system and advanced technological skills directly relevant to income generation. Rural Technology Centre offers advanced courses as well as combination of flexible courses on technical know-how.

Total number of basic school, advanced basic school and rural technology centre in CMES system

CMES operates its programmes through 20 Field Units in various parts of the country comprising. These units work through eight Rural Technology Centres, fifty nine Advanced School Systems and three hundred and eighteen Basic Schools. The total students in all the schools are 20,000 at a time. All the Rural Technology Centres have, in addition to general education and skill training, Adolescent Girls' Programme. The number of adolescents involved in programs related to income generation activities is more than 10,000. There are 3 field training centres and a central training centre and several special laboratories to support the CMES programmes.

Unique features and innovative elements of CMES

CMES offer non-formal education at three levels in a hierarchy but in an integrated pattern. The levels are: (i) Basic School, (ii) Advanced Basic School, and (iii) Rural Technology Centre. Basic School serves as a feeder to Advanced Basic School and similarly Advanced Basic School to Rural Technology Centre. Basic and Advanced School Curricula are designed to fit to the requirements of trade training at Rural Technology Centre. Combined together, the non-formal education system levels address the needs of the poor target groups. The most note worthy feature of the system is the conceptual coherence and practical integration between education and skill training with the aim of transforming the target groups into productive human resource for eventual elimination of poverty.

Application of non-formal education including skill training is directed at producing services and goods, marketing of the products, add allowing some income for the learners while they participate in education/training. All the components of the system make an integrated package for the young people enabling them to effectively participate in production and market mechanism.

The activities organized at the field level institution, that is, CMES Field Unit are of the following categories:

- Non-formal education combined with livelihood skill training and income generation for the target groups;
- Gender empowerment programme for adolescent girls, as they have special needs and problems, which need specific attention;
- Research and development on appropriate technology and their adaptation to micro-enterprises for the disadvantaged young men and women.

The CMES education system arranges for life oriented education curriculum compatible to mainstream primary and junior secondary (up to 8^{th} grade), along with training and profitable practice of appropriate technology.

The Adolescent Girls' Programme makes the young women conscious of their rights and empowers them to stand up against all superstitions and discrimination and to participate in education and technology based income generating activities.

The organization of activities as 'inner campus activities' (classroom activities) and 'outer campus activities' (practices of skills in work setting) establishes close link between education in classroom and the practical life in the world of work. The outer campus training takes place at market level as if students are producers or employees, get daily wages for the works, or go to the markets to sell the products.

Marketing system of CMES provides scope for the students to become familiar with the challenges and realities at the market situation. This also provides an income to the students and the schools, and encourages the students to further enhance their skills through practice. The Rural Technology Centre serves not only as learning centre, but also as main education resource centre, technology centre and management centre for the field unit.

Programmes of Advanced Basic School and Rural Technology Centre capitalize on the basic education and offer a number of livelihood skills. The livelihood skills are utilized in producing a wide variety of consumable and marketable goods based primarily on locally manageable resources. The system has a provision of very limited micro-credit to the graduates (producers) and the participants of Adolescents Girl Programme of CMES. That the credit programme meets the demand of only a very small percentage of CMES target groups is explained by limited availability of such credit fund.

The innovative elements in CMES education may be presented as the following:

- It brings education closer to home environment, both spatially and attitudinally, through interfacing with the real life of works.
- The same closeness involves the families in education and work, and eliminates the alienations between formalisms of schools and realities of life.
- All the important indicators and competencies of a quality education are given proper weight, and these come in a natural way, the students being active agents. Students create teaching aids through their own practical activities and through the presentation of the same.
- The three components mentioned earlier are organized and managed such that one supports or enriches the other e.g. general curriculum draws its examples and exercises from real life skill practices and home to home interventions, whereas the latter finds the required academic basis from the former. The school is virtually extended from the classroom to the world of work outside.
- Education is not treated here only as a preparation for the next level of academic structure. Rather it is made interesting and useful in itself, a matter of joy and pride, a thing of immediate benefit to themselves and the families. People are more ready to accept some opportunity-costs in such a situation.
- The girls are placed in an active role as much as the boys, within all the components. Gender issues are directly addressed so much so that this has given rise to a follow-up programme for the empowerment of adolescent girls.

In overall terms, CMES education system makes significant contribution to enrolment, retention and quality performance especially in its relevance to improving the quality of living.

OVERALL FINDINGS ON NON-FORMAL EDUCATION – INCOME GENERATION PROGRAMME TOWARD POVERTY ALLEVIATION

Quality of education and training

Discussions with the graduates reveal that the level of skills acquired by them was very good in reading, writing, numeracy and life skills. The levels of skills on trades, however, varied among

the graduates. Some were found to have acquired satisfactory level of skill and they were engaged in helping the fellow students. The centre lacks sophisticated machines.

Impact of the non-formal education - skill training

Immediate benefits gained by the graduates are basic education and skill training on a number of simple trades and on one particular advanced trade. In addition, the important qualitative contribution of the programme is reflected in the high degree of consciousness of the graduates about the importance of education, health and nutrition, and keen interest in gainful self-employment or entrepreneurship.

The impact of employment and income is relatively pronounced in case of Rural Technology Centre graduates. Learners graduating from Rural Technology Centre are fewer compared to those who complete 'Ankur' and 'Bikash' in Basic School and Advanced Basic School. Twenty one graduates interviewed in this study have an average earning of Taka 1700 per month, which is a good amount in rural areas of Bangladesh.

Most of the graduates are either employed or self employed. The employed graduates are determined to start self-employment and they are saving money for the purpose. They have been trying and face problems to get loan from CMES and other sources to start their own business.

As the parents of the CMES graduates report, they have been amply benefited. The benefits they mention are:

- graduates are contributing to family income;
- family members are more aware about the importance of education;
- living condition of family has improved;
- members of family now have increased social awareness;
- members are not worried about the future of children who could not avail general education, from the formal schools. They have got alternative opportunity at CMES;
- graduates help younger children in their families to get education; they can do coaching.

Benefit to community

The benefits of CMES for the community include:

- reduction in unemployment
- reduction in crimes
- delay of girls' marriage
- empowerment of girls
- improvement in overall social environment

Income generation and poverty alleviation through credit

The prevailing micro-credit facility in the regular economic system is often not available to landless families and people living below poverty line. The available marketing facility for the products of loan recipients is very poor. In the study area, the only source of credit is CMES. Because of fund constraints, however, the number of beneficiaries of CMES credit is small. The credit amount is also small. Those who could avail the limited facility have started self-employment and they have been able to raise their family income. Case records included in this report as illustrations bear testimony to this.

Areas of skills training as desired

The graduates identified the types or areas of education and skills that would be useful to the target people. The skills appropriate for training in future to help the target group come out of poverty situation are: motor driving; motor mechanics; welding; electric repairing; TV, radio and refrigerator repairing; sewing and embroidery; livestock; piciculture; vegetable growing; and nursery

Specific lessons learned about non-formal education as an approach to poverty alleviation

The lessons that emerge from the present study could be definitely considered in future planning of non-formal education linked to skill training at a national scale as an approach to poverty alleviation. The approach will have higher chances of being effective provided sufficient attention is given to strengthening of to other approaches to modify the structural conditions that work against the poor in their efforts to change the situation.

Lesson 1: Integrated approach to continuing education
Basic literacy with post-literacy with the limited objective to retain literacy is not sufficiently attractive to the poor and, therefore, cannot combat poverty problem of the poorest people. Poverty can be eliminated through gainful wage employment and self-employment. Gainful employment is possible if graduates can rightly identify marketable skills and acquire those skills, which have demand in the local market. Thus the hypothesis that integrated approach is necessary to ensure that continuing education leads to gainful employment.

Lesson 2: Important components and quality aspects within continuing education phase
To identify marketable skills, local barriers, and other problems associated with self-employment, appropriate market research and market analysis by using sufficient and relevant data must be carried out. Locality specific conditions must be placed in this analysis. Available indigenous experiences should also be taken into consideration.

Training should be carried out following well-thought out curricula and syllabus prepared by persons having appropriate conceptual insights, practical knowledge about the skills together with persons having wide-spread knowledge of market mechanisms. The trainers and resource persons should have extensive expertise to work upon the individual poor's motivational level and social and cultural predicaments. They should also be well-oriented about the poverty scenario, the complexity of factors involved in poverty alleviation efforts and the interacting processes between individual and the larger social contextual elements in poverty.

The trained people must have access to raw materials, essential equipment and marketing know-how. During the training the learners must have the opportunities to be involved in practical work and the poor learners should be supported to earn by marketing their products.

After completion of continuing education with an emphasis on vocational training, a probation period of 3 to 4 months would be very useful for the trainees to gain confidence about their capacity and enhance the chances for their acceptance in employment market situation. This would be useful also for building-up motivation and capability to start self-employment.

Access to loans is another important component of the integrated system and a mechanism needs to be evolved so that the individuals interested in self-employment have easy access to loans on soft terms. This is very importance for any continuing education programme education
A special programme to encourage young women and mobilize the local community for marking a congenial atmosphere (in terms of norms and facilities to support) might be integrated within the non-formal education program. The present programme suffered for the fact that these aspects were not built into the non-formal education programme.

Lesson 3: Program relevance as an antidote against lack of interest and low participation
Learners are keen to learn skills as long as they clearly perceive the potential economic benefits, opportunity cost to their advantage, and if they can choose the skills of their choice using their own judgment. Potential learners should have access to information regarding skills, products, markets, capital requirements, rate of returns and future prospects so that they can make the right choice.

IMPLICATIONS OF THE PROGRAMME EXPERIENCES

The programme experiences have implications for future actions at two levels. The first one is about designing and implementing non-formal education programmes focused on income generation activities targeting the poor in particular, and the second one is getting broad based policy to strengthen non-formal education for transforming the unschooled and early dropout population groups (living in the poverty) into productive human resource conscious and capable to change their economic and social status. The implications are therefore described below under two titles.

A. Non-formal education –income generation programme for poverty alleviation

1. Conventional non-formal education programme work with a limited interest in literacy. When extended to cover continuing education, non-formal education programme has to have a particular emphasis on imparting skills which can generate employment and income.
2. As the scope of wage employment for non-formal education completers may be limited in a rapidly changing market situation with the continual adoption of new technology, appropriate income generation programme has to be kept in view in a given locality. This has to be done with full understanding of the possibility to use and improve the indigenous technology, and the importance of encouraging self-employment/entrepreneurship of the non-formal education/continuing education graduates.
3. With the growth of economy and expansion of wage employment market the pattern of continuing education can be upgraded to ensure skills development appropriate for the target group to have wage employment with a reasonable income level.
4. Non-formal education with employment skills training has to be combined with training for other life skills such as healthful and hygienic living, safe living in home and work environments, safeguarding the basic rights as human being within family and community.
5. Organization and management of continuing education (non-formal education), programmes have to be in fulfillment of the personal and social (normative) interest of the people, who are potential participants in the programmes.
6. The programme characteristics have to be sufficiently motivating and stimulating for the participants that the latter can clearly perceive and experience the prospect of earning and improving their standard of living.
7. The programme participants (target group) being the poorest segment of population will find it attractive to have some earning, even if it is in small amount, during the period of their education/training.
8. Programmatic initiative for employable skill learning, that is preparation for engagement in income generation activities, is effective when the first part in the preparation consists of an understanding of the role of science in daily life situation, and the other part has the

practical experience that the use of technology and learning new skill can give concrete benefits for better living.

9. When the issues of women improvement are in focus of non-formal education- income generation programme and pursuit of non-conventional trades is needed for poverty alleviation, the character of the non-formal education porgramme shall have to be such that women gain the courage and confidence to overpower the cultural prejudice and negative attitude in the society restricting women's access to new knowledge and participation in new activity.

10. Programme managers, monitors, supervisors, teachers/trainers, that is , all categories of personnel involved in implementation have to have sufficient preparation for playing their role effectively while making a link between non-formal education and promotion of income generation programme toward poverty alleviation. An understanding of the dynamics of individual and societal situations in interplay with poverty has to be an important part of this preparation.

11. The programmatic non-formal education intervention has to promote participation especially of local government institution and other community based agencies and subsequently gains strength from community participation, in planning, implementation, and monitoring and impact assessment.

12. Non-formal education programme for enabling individuals and groups to get out of the poverty situation has to have institutional linkage with other programmes and service agencies, which are relevant to fulfilling the needs and aspirations of the non-formal education graduates.

B. Macro level policy support to establish an environment conducive to non-formal education for poverty alleviation

The following are the important elements of policy consideration:

13. The national education policy and plan of action have to give adequate allowance for the development of non-formal education in both government and non-government sectors and also in private sector with emphasis on science and technology to be applicable in bringing about a positive change in life situation. This will be in consistency with the Dakar Framework for 'Education For All' goals.

14. Clear and adequate information about non-formal education policy, goals, programme objectives, strategies, key players, targeted groups and new opportunities are to be regularly disseminated through different media and mechanisms and be made accessible to all concerned groups/agencies. This should crate an overall positive social climate.

15. Successful micro initiatives as experiments or pilot programmes have to be scaled up and replicated with necessary adaptations to varying situations and supports from national government authorities and other development partners are necessary in this regard. National budgetary allocation is an appropriate measure and should be a part of the poverty reduction strategy of the national government.

16. All sectors concerned with human development and economic growth are to recognize the importance and the obligation to support non-formal education in the national interest. Two approaches are necessary in this regard. Those who are directly engaged in non-formal education and poverty alleviation projects/programmes can act together in some forum to share and disseminate experience and information. Secondly, the national development planning authority and the specialized agencies, which are to support the national development planning process (e.g. research agencies authorities responsible for collection, compilation and analysis of date in carious sectors), can stress the point

that the different sectors of development relevant to poverty reduction should draw upon the strengths of non-formal education for preparing human resource to carry forward their sectoral programmes. As such, these development sectors (for example, industries, commerce, transport, public heath and so on) are to support the non-formal education programmes. Authorities responsible for implementing micro finance system, in particular, has to assume responsibility to support the non-formal education programme by making funds available to the graduates of non-formal education programme and to those institutions which can run income generation programme by using the output (graduates) of non-formal education.

CONCLUSION AND RECOMMENDATIONS

The foregoing analysis of CMES Programme and other observations that come along are drawn upon to make the following recommendations presented in two categories. One is about the post-literacy and continuing education to have special relevance to income generating programme for poverty alleviation, and the other on the role of the national authority (DNFE in the case of Bangladesh) to promote post-literacy and continuing education human resource development including research issues.

Post-literacy and continuing education under non-formal education

1. A national policy should guide continuing education programme to contain science and technology orientation, while the educational competence level will be comparable with that of formal education to be integrated with skill training and practices allowing opportunities for production of marketable goods. The programme will contain all necessary ingredients -- curriculum contents, teaching-training approach, materials and equipment etc. which will give employment attractiveness from the very beginning of implementation process.
2. Technical-vocational skill training component has to allow supervised practice training within the education training centres. This will require national commitment and a bold move to make necessary resources available as a part of the overall development policy and programmes for poverty alleviation through human resource development and promotion of small enterprises. The major thrusts will on making the large youth population group in poverty informed, conscious and productive manpower of the country.
3. Adolescents and youths should be given particular attention as they have special needs and potentials.
4. The learners should get practice learning opportunity through work-settings in the market situation; and to make it possible, the training centres should be required to establish linkage with production and business enterprises.
5. The learners should be given exposure to and experience in the dynamics of marketing, while they are in the learning centres for skill learning and are engaged in production of useful commodities.
6. Skill training component should offer a range of possibilities in terms of trade and skill level.
7. Instructors to engage in training are required to have adequate technical competence, ability to teach skills, knowledge about the poverty situation, understanding of the need for linking education and skill learning to income generating programme and poverty alleviation.

8. Teachers/Instructors should be locally recruited and specially trained for their job.
9. Learners should be given option to select the trades for their skill acquisition. They should be given orientation on the prospect of the trades in the market.
10. Trades having no market demand should not be offered.
11. Continuing education programme should be monitored and assessed with particular consideration given to the process and outcomes in the light of poverty alleviation objective.
12. Continuing education programme management should establish a database for learners and a follow-up system for the graduates moving into the market situation for employment.
13. Education and skill learning through non-formal education has to be accredited by the authority as a necessary part of the education system.
14. Every learner should be given information on the skills, job market, future prospect, so that he/she can take decision based on analysis and own assessment.
15. The curricula and syllabuses should be prepared by experts having practical, as well as sufficient theoretical expertise and familiarity with practical work setting.
16. Trainees and graduates should be informed in advance about the capital required to start self-employment in any trade.
17. For the graduates to have access to credit facility, concerned organizations should either introduce credit programs or makes arrangements with credit giving agencies.

Role of national authority

18. The national authority designated to promote non-formal education /continuing education has to work based on clear guidelines, which can be formulated with the participation of all stakeholder groups. The authority should set standards corresponding to grades/skills and the requirements to be fulfilled for standards at various levels of continuing education keeping in view the poverty alleviation objective.
19. NGOs interested and engaged in continuing education should be supported by the national authority to work in fulfillment of definite standard(s), Supervision and monitoring system should seek to ensure compliance with the standard(s).
20. The national authority should facilitate linking of NGOs with relevant government bodies for the latter's support to the farmer. Similarly linkage should also be established with business community.
21. The national authority should organize sharing of experiences/learning of continuing education programmes and their contributions among the stakeholder groups for feedback and follow-up actions.

ACKNOWLEDGEMENT

The authors are grateful to UNESCO, Bangkok for providing financial support for the study.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 105-114.

Effectiveness of video as an instructional medium in teaching rural children agricultural and environmental sciences

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ABSTRACT

The study was conducted to determine the effectiveness of video in comparison with selected instructional media for teaching primary school pupils Agriculture and Environmental Sciences. It examined also the effect of gender and grade on the performance of the pupils taught with four instructional media. 240 pupils from 3 rural primary schools in Badagry Local government Area of Lagos State, Nigeria, were taught three topics drawn from Agriculture and Environmental sciences. The non-randomized quasi-pretest posttest experimental design was used in finding out which of the pupils in the four experimental groups – video, realia, charts and No instructional media performed best. The study revealed that the pupils taught with the video performed equally as well as those taught with real objects (Realia). While both groups performed significantly better than those taught with chart and without instructional medium. There was no significant difference in performance based on the gender. With regards to grade (Primary 5 and 6), only the group taught without instructional medium had a significant difference. The pupils in Primary 6 did better than those in Primary 5. The study concludes that video is as effective as the traditional teacher in teaching Primary school children Agriculture and Environmental issues. This confirms the assertion of many researchers of the potential of using video as an instructional medium in teaching varying subjects to adults, youths and children in the formal school system. The advantages far outweigh the disadvantages. The four methods that can be used by the teacher were recommended. An organisational structure in each state and video equipment needed for effective take off of the video programme in Primary schools in Nigeria were suggested.

Keywords: *Video, Instructional Medium; Teaching, Children; Agricultural science and Environmental science.*

INTRODUCTION

Video is a potential window that can expose the minds and heart of many rural African children to modern Agricultural practices and Environmental concepts, far more than the traditional classroom teacher can achieve. Children and youths are so enthralled with home video films that they are described as video crazy (Akpabio, 2004). Their interest in watching home video films can be exploited in the formal school system in teaching Agricultural and Environmental practices in vivid and entertaining manner.

Enlightened and middle class parents would want to encourage their wards to migrate to the cities, to escape the poverty circle in the rural community in order to make quick money. This fuels the loss of agro-labour force. There are fewer young farmers and increasingly older farmers in the rural community. Agriculture is becoming less attractive to youths. Modern agricultural practices presented to children in an exciting manner through video could reverse this attitudinal tendency of the rural people on the long run.

In addition, conservation of soil and forest resources in the environment is not a priority concern for resource-poor farmers. Rural people are less bordered about Ozone layer depletion,

desertification and depletion of forest resources due to “cut and burn” farm practices. Their main concern is on economic empowerment and improvement of the social infrastructure such as good primary health care and roads. A vivid motion picture through video of the long-term effect of their present bad practices could touch the soul of the children to convince their parents to adopt better farm practices that will sustain the resources for the incoming generation. Besides, the children and youths are likely to deviate from their parents’ bad practices and take to environmentally sustainable/friendly behaviour.

There is a strong need for an alternative technique of teaching the children if the Millennium Development Goal of better environment and education for all in 2015 will be attained. In addition, the sustainability of the agricultural labour force, rural – urban migration, food insecurity and massive youth unemployment are worrisome issues that evoke serious concerns and calls for urgent action to empower the youths early through educative, informative and entertaining agricultural/environmental video programmes. It is expected to improve on the current level of adult literacy put at 57 percent, incidence of poverty at 54.4 percent and life expectancy at 54 percent (CBN 2004).

The primary school age (6 – 11) of children in Nigeria is 15 - 17 percent of the 140 million citizens of Nigeria. There is a 2.5 percent annual growth rate, 3 percent of GDP (US$493.2) budget on education, 62 percent net primary school enrolment/attendance and a teacher – pupil ratio of 1:85 in public primary schools and 1:35 in private schools. The National Policy on Education specifies that the curriculum of the Primary School (Basic 2– 6) shall include among others agriculture. The curriculum objectives are to arouse and sustain pupil’s interest in the art of farming, enable them acquire elementary knowledge and manipulative skills in agriculture. It is also to prepare them for further studies and career opportunities in Agriculture and to appreciate the environment in a scientific way. Consequently, topics on the environment and farming were organized into units spread over the 6-year primary school period. It is stipulated that “a special attribute of the primary Agriculture core curriculum is its practical orientation right from the first year of school till it peaks at 100 percent practical work in year five, leaving year six for field work. (NERDC 1991). This is a beautiful document. But most primary school teachers are not even aware of it, neither has it been put into practice. This is the bane of Nigeria-good policy, poor execution. These objectives may never be achieved due to poor governance in Nigeria and gross ineptitude among educational administrators.

The Universal Basic Education programme received a boost with an interest free loan facility of US$105 million from the World Bank disbursed to twenty states and Federal Capital Territory. In addition, Educational Trust Fund (ETF) disbursed $27.9million to state primary school boards for construction of new classroom blocks. (CBN, 2004). These funds are largely misappropriated. Primary school teachers are not well motivated. Poor salaries that come 3 – 6 months late are a regular occurrence. There are inadequate instructional materials, charts, models, realia, specimen and equipment. Dilapidating structures with leaking roofs, hot uncomfortable classroom with children sitting on the floor is observed in some cases. Teachers are poorly trained. They lack zeal and commitment. They are uninspiring, unimaginative and do just the much to earn their poor wages. The teachers face great challenges. They teach large classes (50 –100 students), use inadequate instructional media in a poor environment and inferior classroom condition. There is excessive paper work. Parents’ indifference is negatively impacting on the teacher’s efficiency. These challenges hinder effective teaching (Awake, 2001). The teacher and the school environment make learning fun. But these are in short supply in most primary schools in Nigeria. The load can be taken off the chest of the teachers with the introduction of video in the primary school system. The children can be engaged having fun and learning at the same time.

Video is a powerful tool for instruction in the classroom. By means of it children could learn about lands and people they can never visit and how they cope with their environment. Children ‘travel’

to mega cities with skyscrapers and polar ice caps, to mountain peaks and ocean depths. It enables the children to peer into the intriguing worlds of both atom and stars. One watches documentary of what has happened on the other side of the globe. Video enhances comprehension and retention. Real life activities – illustration, demonstration and specimens in agriculture and the environment are brought to the pupils in the classroom in a neat and exciting package. Learning experiences that would have cost much (in terms of field trips) could be recorded with a video camera and shown on a television through VHS or VCD at much less cost. Environment issues such as effect of erosion, bush burning, pesticides poisoning, HIV/AIDS, forest degradation, global warming and climatic changes could be taught through video. The beauty of video is that it can be watched repeatedly as often as it is required. (Spencer, 1991; Ahmad, 1990; Adedoyin and Torimiro, 1999).

Many studies have found no statistical difference in learning due to the presentation medium, whether it is face-to-face in a classroom teaching-learning process or face-to-screen in a distance education setting. What makes a course good or poor is a consequence of how well it is designed, delivered, and conducted. Dannenberg and Capell (1997) conducted a study on the effectiveness of Just-In-Time Lecture technology via video as a delivery mechanism. They found no significant difference in the achievement of students taught in the classroom and those taught through video. The students that received instruction through video complained of not been able to ask questions immediately. The delayed feedback-feed forward mechanism in distance learning through video or any other electronic medium is a major drawback. In the study, reference was made to a three-year study involving 200,000 students and 800 public schools. One hundred and nineteen were significant in favour of television –taught students and 44 in favour of the teacher-taught students. Most of the comparisons showed no significant difference. Another study on the comparison in achievement in seven different courses between students taught with closed circuit television and conventional manner showed no significant difference in 29 out of 32 cases.

Kumar, Sharm and Vyas (2003) carried out a study on the use of array of electronic media technology by counselors in distance learning in Turkey. It showed that out of 12 electronic media used, videocassette was ranked third behind telephone and computer. Moore and Kearsly (1996) posited that comparing the achievement of learners (as measured by grades, test scores, retention and job performance) who were taught at a distance;face-to-screen and those taught in face-to-face classes is a line of research going back more than 50 years. The usual finding in this two environment, regardless of the nature of the content, the educational levels of students or the media involved are:

- Classroom instruction is the optimum delivery method.
- Distance Education can be as effective as classroom instruction.
- Absence of face-to-face is not in itself detrimental to the learning process.
- What makes a course good or poor is a consequence of how well it is designed, delivered and conducted, not whether it is face-to-face or face-to-screen.

From the fore-going, many researchers have attested to the effectiveness and advantages of using video as a medium of instruction. It is low cost. Returns on investment are attractive. Its flexibility, convenience and availability are quite good. Students generally are favourably disposed to it. Group discussion which aids social skills among students is enhanced.(Isiaka, 2000; Dopemu, 1990; Ahmed, 1990; Talabi, 1989).

The study focused on the effectiveness of video in comparison with chart and live specimen (realia). The effectiveness was determined by the performance of pupils taught certain subject matter. The relationship between gender and class on the performance of pupils was established.

METHODOLOGY

Non-randomized quasi-pretest and posttest experimental design was used in conducting the study. This design involves administering an achievement test to the pupils before and after teaching the topics. The study was conducted in Badagry Local Government Area of Lagos State. One primary school each was selected from Topo, Ikoga-Zebbe and Arandagun. The three typical rural primary schools were purposively selected and stratified random sampling technique was used to select the 240 pupils involved in the experiment. The pupils were stratified along gender-male/female and class-primary 5 and 6. In the rural setting both gender are actively involved in agriculture. On the other hand, primary 6 pupils should have a year's experience over the primary 5 pupils. In each school, 20 pupils were placed in each of the treatment groups: video, chart, realia and no instructional media group. This means that 20 pupils each were taught with video, charts, realia and the control group (no instructional media)

The achievement test used to determine the performance of the pupils consists of 30 multiple choice questions with 4 options on the three topics – construction of vegetable bed, simple farm tools and soil conservation. The topics were taken from the primary school Agriculture curriculum. The video clip on the three topics were produced locally and edited for its suitability for teaching children.

The socio-cultural and psycho-cognitive status of the children was put into consideration in producing the video. The video group was taught with the video alone without the intervention of the teacher. The realia group was taught by the teacher with the real objects and demonstration of the practice. The teacher taught the chart group with charts containing diagrams, drawing and pictures of the concept taught. The no instructional media group was taught using lecture method without any instructional material. An interval of three hours was given between pretest and posttest.

Analysis of variance was used in comparing the performance of all four groups. T test statistical analysis was used to compare the performance of male and female; primary five and six pupils. Scores of each pupil before instruction and after instruction were computed. Difference between pre and posttest (the net gain) was calculated. The percentage means net gain for each experimental groups male and females, and primary five and six were computed separately.

RESULT AND DISCUSSION

The ages of the pupils range from 10 and 16 years with mean age at 14.75 years. Ideally the ages of the pupils of primary five and six should be between 10 and 11 years with mean at 10.5 years (FRN, 2004). Pupils in rural areas start primary school later than their urban counterparts. Thus older pupils are found in rural schools.

Performance of the pupils in each treatment group in the achievement tests

The mean net gain score, which is the difference between the pretest and the posttest, was computed for the four treatment groups. The video group is slightly higher than the Realia group (56.75 and 56 % respectively). The chart group scored 44 percent while the No instructional media group scored 36.75 percent. This result in table 1 confirms the assertion of Isiaka (2000), Dopemu (1990), Ahmad (1990) and Talabi (1989) that video can be effective in teaching both adult and children varying subject matter. Since the information in the video clip is as real as life, it is not surprising that the performance of the video group is slightly higher than the Realia group.

The chart group had 44 percent, coming 3rd while the No instructional media group had 36.75 percent in 4th position. It is noted that in all the groups, the posttest score was relatively high with the least score of 62.45 percent by the No instructional media group.

Table 1: *Mean Net gain score of the pupils' performance in the achievement test*

Instructional media	Pretest score in %	Posttest score in %	Netgain score	Ranking
Video	25.3	82.05	56.75	1st
Realia	24.9	80.9	56	2nd
Chart	25.1	69.1	44	3rd
No instructional media	25.4	62.45	36.75	4th

Table 2 shows that the F cal of 19.4 is greater than the F tab of 2.76 at alpha 0.05. This implies that there is a significant difference amongst the four mean net gain scores of the pupils taught with varying instructional media.

Table 2: *Test of Significance using analysis of variance (ANOVA) of the mean net gain scores of the four treatment groups*

Sources of variance	Sum of square	Degree of freedom	Variance estimate	F cal	F tab	Remarks
Between group	225.25	3	75.08			There is significant difference
Within group	294.3	236	3.87	19.4	2.76	
Total	347.5					

The result in table 3 shows that video, Realia and the chart groups performed significantly better than the no instructional media group. The Realia and the video groups did significantly better than the chart group while the video group performed equally well as the Realia group.

The conclusion from the study is that video as an instructional media is as effective as the realia in the teaching-learning process in primary schools. The use of realia, video and charts is more effective in teaching the subject matter than not using any instructional material. The inadequacy with lecture method particularly for primary school children has been brought to the fore (Orukotan and Oladipo 1994; and Oke and Oshodi, 2000). It is expedient for the primary school teacher to make use of instructional media in passing information to the pupils. Asoga-Alliu (2002) confirmed that the use of realia (real object/practices) in teaching is most effective. A strong case can be argued for the use of video since it presents scenes, activities, demonstration and objects of the subject matter as real life. Bamidele (1996) and Benedict (1995) both confirmed this fact from the study conducted using video to teach secondary school students.

Table 3: *Least significant difference table*

Treatment with	Percentage mean net gain	LSD at 5%
Video (V)	56.75	
Realia (R)	56	3.125
Chart (C)	44	
No instructional media (NIM)	36.75	

Establishing significance with LSD at 5% (3.125)

V-NIM	56.75-36.75	20	Significant
R-NIM	56-36.75	19.25	Significant
C-NIM	44-36.75	7.25	Significant
VI-C	56.75-44	12.75	Significant
V-R	56.75-56	0.75	Not Significant
R-C	56-44	12	Significant

Gender and class difference in pupils' performance among the treatment groups

There was no significant difference in performance between male and female pupils within each treatment groups as shown in table 4. Similarly, no significant difference in performance was found between primary 5 and primary 6 pupils within video, Realia and chart groups except the group taught without instructional media. The pupils in primary 6 performed better than those in primary 5. This implies that gender difference does not affect the performance of the pupils no matter the method used in teaching (Amoo, 1990) but class difference does, particularly where no instructional media is used in teaching the pupils. (Haruna, et al 1998 and Isiaka and Dacosta, 2001).

Table 4: *Comparative performance of pupils based on gender and class difference*

	N	Video		Realia		Chart		No Instructional medium	
		Score	t-calc.	Score	t-calc	Score	t-calc	Score	t-calc
Male	130	57.05 n=32 SDV=1.07		56.25 n=33 SDV=37		43.75 n=32 SDV=1.45		36.54 n=33 SDV=1.57	
Vs			1.346 (NSD)		0.99 (NSD)		0.92 (NSD)		1.6526 (NSD)
Female	110	56.83 n=28 **SDV= 1.04**		55.95 n=27 SDV=1.26		44.03 n=28 SDV=1.34		37.08 n=28 SDV=1.67	
Total	240	60		60		60		60	
Primary 6	125	57.54 n=30 SDV=0.85		56.1 n=32 SDV=1.07		44.25 n=31 SDV=1.28		38.54 n=32 SDV=1.75	
Vs			0.893 (NSD)		1.325 (NSD)		1.288 (NSD)		10.24 (SD)
Primary 5	115	56.85 n=30 **SDV=0.94**		55.75 n=30 **SDV=1.05**		44.87 n=29 SDV=1.41		35.14 n=28 SDV=1.57	
TOTAL	240	60		60		60		60	

Tabulated value at alpha 0.05=2.068: Degree of freedom= 58
NSD = No significant difference
SD = Significant difference
SDV = Standard deviation
n = Number of pupils in each treatment group
N = Total number of pupils in each variable (male/female and Pri. 6 & 5)
tcalc = Calculated t value.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, it is concluded that the use of video (in the absence of the teacher) in teaching primary school pupils is as effective as when the teacher uses the real objects in teaching Agricultural and Environmental Sciences. The use of video is more effective than the use of charts and when no instructional media is used.

In view of the challenges primary school teachers are facing in Nigeria and the weak political will of the Government to address the worrisome issues, it is suggested that the Parent Teachers Association in each school should go into partnership with the Primary School Management Board,the state agency that oversees the running of primary schools in each state and procure necessary funds to put the video infrastructure in place. The structure includes both institutional organizations and video equipment. The video equipment recommended is a television and video player/recorder and locally produced video CD on Agricultural and Environmental issues to be

located in each school. Documentaries on Agriculture and Environment could be dubbed from local television broadcast and satellite stations (Adewoyin 1998).

The Primary School Management Board should establish a unit, which could be called VIDEO RESOURCE CENTRE with the organizational structure shown in figure 1.

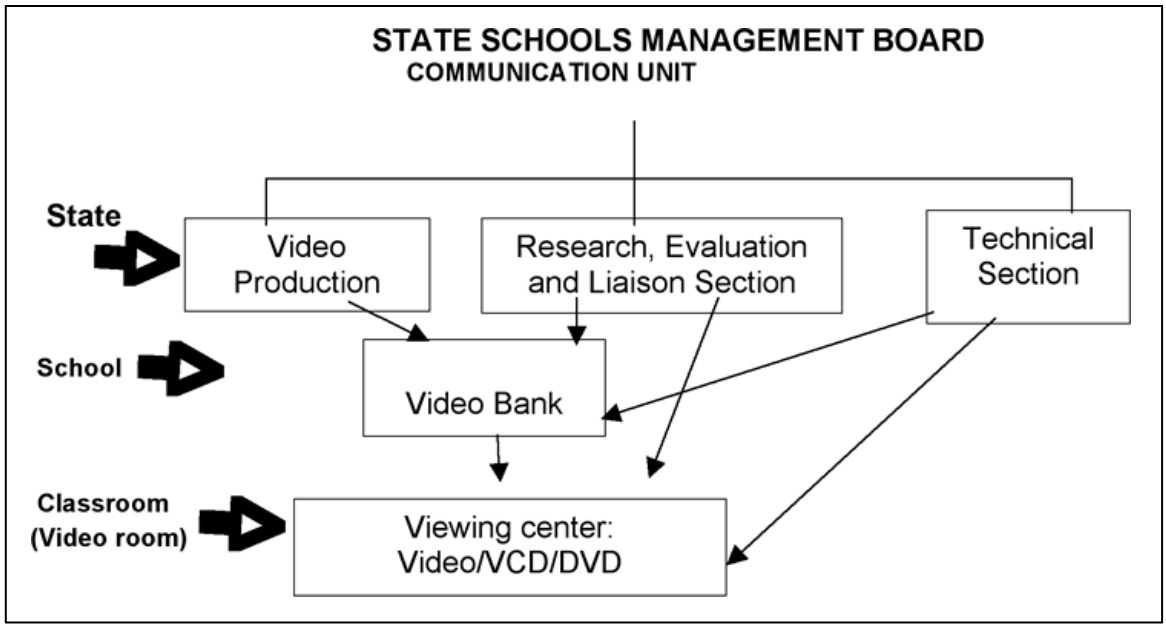

Figure 1: *Proposed organogram of a video resource center*

There should be a communication unit in each of the states' Primary School Management Board. The unit should consist of three sections: video production section, research, evaluation and liaison section and technical section.

The video production section should be responsible for the production of instructional packages in agriculture and environment specifically for primary school children. Relevant video clips from various sources are procured and edited to make them suitable for the children. The video clips are multiplied and distributed to the schools. The research evaluation and liaison section should be mainly involved in conducting research on various issues on the effect, response on the video instruction and comments of the teachers, pupils, parents and the production team. Linkage is established with stakeholders in the educational system- Non-governmental organizations, teachers, parents, and so on.

The technical unit is involved with the repairs and servicing of all video apparatus in all the viewing centers. Selected people, teachers and pupils are trained in operating the video equipment and to handle minor repairs and routine maintenance. Personnel in this section, also deal with the preservation and handling of the video clips of each school's video bank.

At the school, a technician maintains the video bank, which contains relevant video clips. The clips are classified; labeled and stored in a conducive, dust free and dry room. The technicians

locate the video clip needed and issue them to the teachers for use in the classroom or video room.

Rhodes and Pufahi (2004), described four ways foreign language video programmes is used in the classroom in United States of America's elementary schools. These could be adopted with modification in primary schools in Nigeria. They include:

- A classroom teacher who learns the language along with the students, uses the video-based program as the foreign language curriculum.
- The video-based program is used as the foreign language curriculum by a classroom teacher and is reinforced on a weekly basis by a foreign language teacher or aid that speaks the language.
- The video-based program is used by a language teacher as a supplement to the foreign language curriculum.
- The video-based program is used by a language teacher as the foreign language curriculum.

The adoption of any of these four methods is dependent on the technical competence of the teachers in Agriculture and Environmental Sciences. With low level of motivation, huge paper work, low competence of primary school teachers in Agriculture and inadequate number of teachers to teach the subject matter the first option is readily feasible in primary school system in Nigeria. The teachers will be as excited as the pupils in learning side-by-side via the video programs.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 115-121.

Teaching history using a Virtual Reality Modelling Language model of Erechtheum

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ABSTRACT

The aim of this paper is to present a Virtual Reality Modelling Language VRML exploration of the Erechtheum in Athens. It addresses the 4th grade students and it constitutes a teaching approach trough the use of various representations created with VRML language. The design principles of the applications are described in detail as well as the technical characteristics of the application. A pilot evaluation of the teaching approach is also presented and the results indicate a strong positive impact on students' performance. The application also aims to emphasize the significant advantages of VRML as an efficient way of offering ICT course materials to students.

Keywords: *3D STRATA Studio; 3D CAD; VRML; history; Erechtheum.*

INTRODUCTION

Education has been influenced by the changes in the area of Information and Communication Technologies (ICT). The arguments for and against ICT are powerful and have triggered off a great interest in the issue of ICT induction in education. As a result a huge number of articles has been published which study this issue through a number of perspectives and provide the ground for further research. Some applications of ICT in education are the induction of movement techniques, movements with graphics, and simulations, the development of visual experiments, speedy exploration of data and observations storing, the development of multiple reconstructions etc. The greatest contribution however, of ICT in the educational process is the potential of modelling and simulating phenomena and procedures that facilitate scientific research and the exploration of the real world (Borkowski, 2002), in contrast to the procedure of simply acquiring knowledge out of a book manual.

According to Brant et.al, (1991) modelling is a computing process which includes a manageable and interactive environment and it corresponds to a real phenomenon or a theoretical system (Akpan, 2001). ICT provide also the tools that help students decide easily about the results of natural processes, interact with the software applications, carry out their own explorations on an individual or collective level etc.

ICT introduction in education establishes a dual relationship between the ICT and the learning theories and the teaching practice, since it reframes the teaching methodology of sciences through the use of ICT while it also brings up the crucial issue of teaching thinking skills through the use of ICT in the framework of a constructive learning environment. ICT contribute to the student's participation into the learning process and the invention of ways, which facilitate the active construction of his knowledge structure, as well as the understanding of this process. The fundamental principle of constructivism (e.g (Reiser 2001, Strijbos et.al 2004) is the active initiative and the control of learning by the learner, the personal construction of knowledge, that is

the self-control of learning (de Charms, 1983; Deci & Ryan, 1985) and ICT can give a shift towards that direction. The implementation of Information and Communication Technologies (ICT) can offer to both students and educators alike, quick access to historical sources, libraries and museums. Through the so-called “discovery learning”, they may also participate in research or problem-solving activities which help acquire a wider and broader perspective of History. One of the ways of utilising ICT is through VRML.

Recently, an increasing number of educators have access to virtual reality. Through the Virtual Reality Modelling Language (VRML), teachers and students can have a direct access to 3D learning environments on the Internet. VRML gives teachers the opportunity to enhance their students’ knowledge, while simulated spaces can help students visualise information in new and realistic ways, give abstract concepts a realistic flavour and encourage cross-cultural, global communities.

Corporate VRML today tends to be focused primarily on enterprise and entertainment which do not usually contribute towards educational goals. As a response to this issue, an educational world for the Erechtheum has been developed, in an attempt to encourage a wide use of these simulations in traditional subject areas.

THE CONCEPT

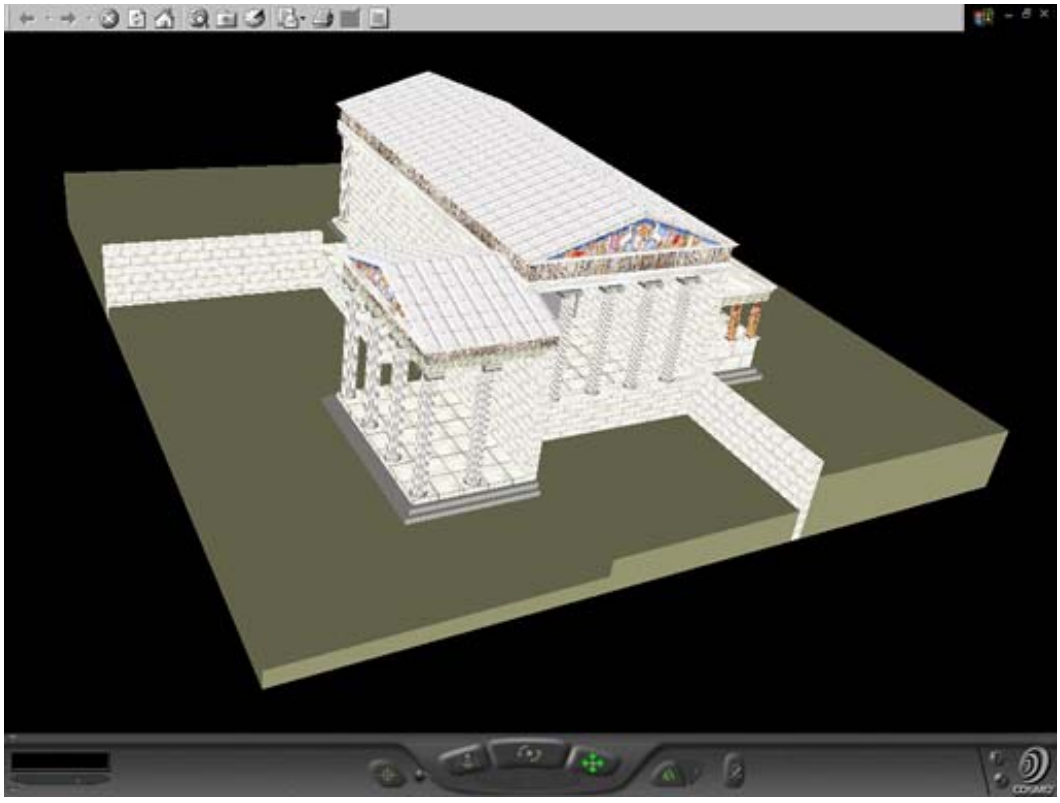

***Figure1:**. Erechtheum using VRML*

We have developed a virtual reality environment illustrating an Ancient Greek Temple. We chose the Erechtheum as our case study, which, due to its structural complexity, gives us the

opportunity to fully explore the capabilities of VRML, such as complex shapes(IndexedFaceSet) application of textures (on simple and complex shapes) grouping of objects, various co-ordinate systems etc.

In Figure1 we present the parts of Erechtheum and using the Cortona Client Software Program (http://www.download.com/Cortona-VRML-Client/3000-12777_4-10359613.html) students could explore the different parts of Erechtheum.

THE DESIGN PRINCIPLES OF THE APPLICATION

The organization and layout of the various structural components in space were based on the following design principles:

- In order to simplify the location of the position of objects, the origin (0,0,0) of the root coordinate system is placed at the centre of the main temple and at an elevation which corresponds to the lowest level of the ground. Furthermore, we used the following drawing (Figure2) in order to calculate the coordinates of a number of objects designed.

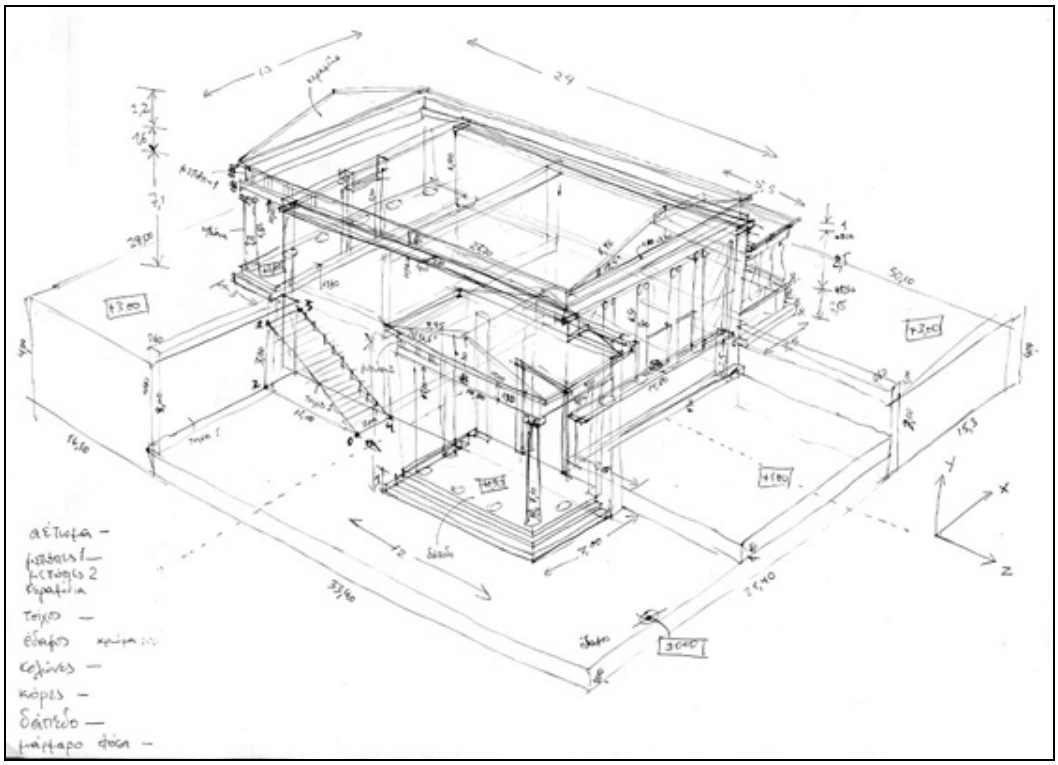

Figure 2: *Drafts used to determine the position in space of the different objects*

- We used scale of 1:10 relative to real-life dimensions (this was done as the use of real dimensions caused a problem in the output of the environment through the browser).
- We created groups of objects and placed in space (relative placing of objects in the local coordinate system, aggregate placing in the root coordinate system).

- We installed the object (Caryatids), following prior construction on 3D CAD, with small adjustments on the VRML code.
- We used a number of textures (eg marble, floor, wall) developed almost solely for the purposes of this project (e.g. columns, statues, metopes and pediments). The application of textures is achieved through the use of a suitable scale so that a seemingly real picture is created, based on the object and its position in space.(see Appendix B)
- During the design of the environment (description in VRML), some simplifications and assumptions were made. These include: the pediments and metopes have adopted elements present on the Parthenon (as the equivalent information for the Erechtheum is unknown), the real dimensions have not been adhered to exactly etc.

THE DESCRIPTION OF THE ENVIRONMENT

We created source code in VRML using the editor VrmlPad, the Cosmo Player Plug in and Photoshop for the creation of textures (Figure3) .

The environment as a whole is made up from the following structural components:

- Ground: Shows significant irregularities. It is made up of 6 boxes of varying sizes (4 coloured boxes for the creation of the ground irregularities and 2 boxes with a “wall” texture for the creation of two retaining walls for ground support).
- Floors: Made up of thin boxes (0.30m) with a floor texture, variable scaling (depending on the size) for improved output. In particular, two shapes IndexedFaceSet were implemented for the ramp on the exterior of the structure, namely a vertical triangle and a parallelogram for the inclined surface.
- Walls: These are made up of boxes of thickness 0.60m with a “Wall” texture, each of which contains on its upper surface one narrow box of thickness 10cm and marble texture. The textures can be adjusted by different scaling such that uniformity is achieved. The interior divider is essentially a box with a colour texture.
- Columns: These are of two types which differ in height. The first type is used on the front and rear of the temple and the second is used on the side (north). The columns form a group of objects (cylinders and one box) which can perform relative translational and rotational motions so that they can accurately be placed in position. Having formed the group as a whole, it is then moved to the root coordinate system so that it can be placed in the building.

Roof: The following components are analysed:

- Metopes: These are boxes forming horizontal plates. The middle one is larger in height and portrays the metopes (metopes1, metopes2), while the rest-using marble texture-are slender and protrude slightly along the perimeter.
- Tiles: These are made up of very thin boxes which can be translated and rotated to the desired angle so that they are in accordance with the pediments. Their texture is marble tiles (Keram2).
- Pediments: These are essentially triangles constructed using IndexedFaceSet, and the texture (aetoma) is achieved through the Texture Coordinates.
- Statues: For the creation of the Caryatid, the 3D STRATA Studio programme was implemented, which created the body of the statue in IndexFaceSet version. Following this, the two bases (upper and lower) were added and the image of the statue as texture. This object was used 6 times in total, each time in the appropriate position, as an external object (inline).

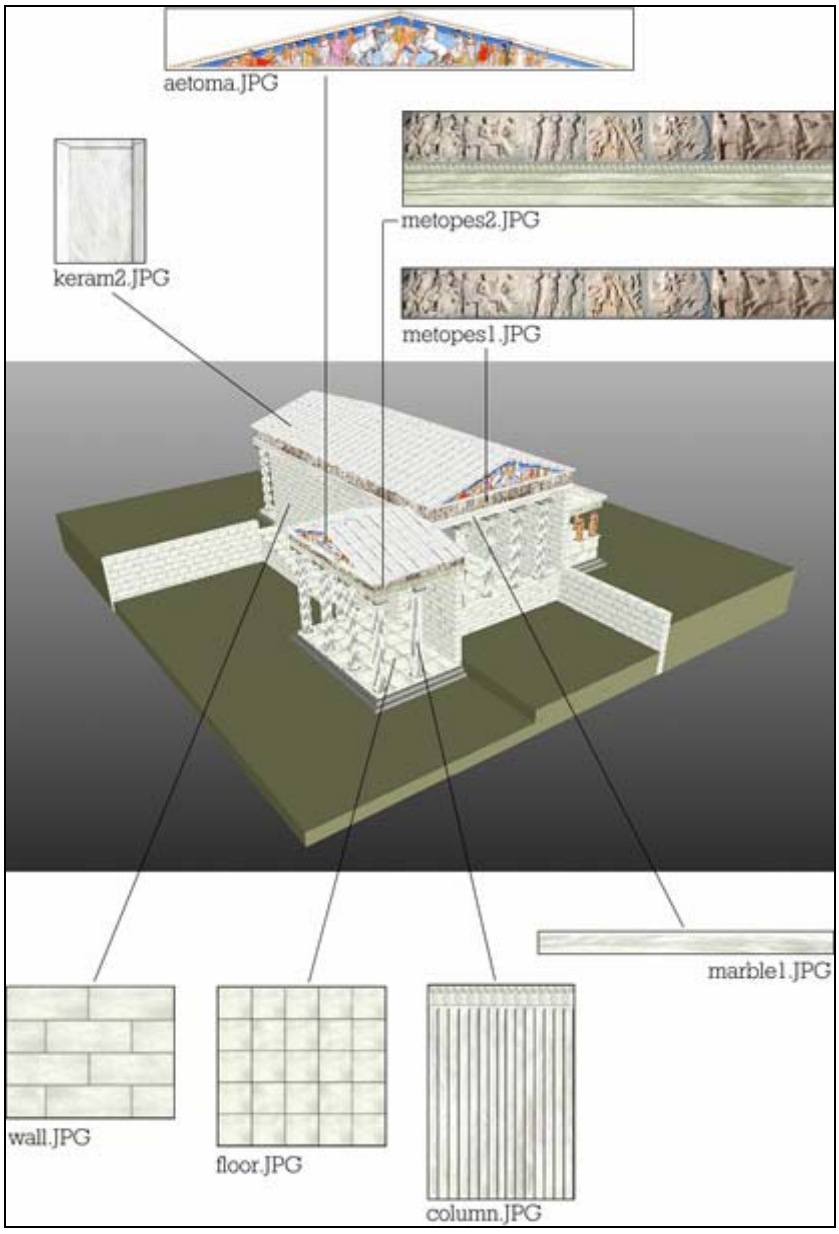

Figure3: *Textures*

METHODOLOGY OF RESEARCH

Aim

The aim of the research was to examine the role of VRML software at students' cognitive achievement in the framework of the teaching and learning process.

The Sample

For the research, we have used two classes (Grade 4) from a Primary School of Athens. Both classes consisted of 25 students with approximately equal distribution of boys and girls.

The process

One of the classes – which was characterized as the control group - was taught the concepts of Erechtheum, applying the constructivist approach through the use of the relevant school textbook. Students were motivated by the teacher to think about Erechtheum and they were involved in the different phases of constructivist approach to learning and teaching (Engage, Explore, Explain, Elaborate and Evaluate) (Bybee, 1997). The main differences of the teaching process for the two groups concerned the way of the implementation of the above mentioned phases.

Students of the control group were exposed to pictures of the Erechtheum, they were asked to describe in brief what is, who was the creator, what is the main issue they think makes that to be famous e.t.c.. Next, students were taught the different parts of the Erechtheum using the text book, they explore the parts of it using the pictures provided by the book and they discussed with the teacher the architecture of the Erechtheum as well as aspects like the materials used to construct that, the colors used etc. The experimental class was taught concepts through the use of the school textbook but teachers also demonstrated the software and students exploited the Erechtheum with the aid of the teacher.

Students were motivated to go through the Erechtheum using the buttons provided by the software and during that exploration we noticed that a type of dialogue was developed concerning the status, the dresses at that time, the geometry of the space and the techniques of the sculpture. For the experimental and the control classes the teaching units were equivalent but the experimental unit devoted two more teaching hours for the demonstration of the VRML application. Before starting teaching a common pre-checking test was given to all of the students in both classes in order to estimate the students' cognitive level about issues relative to Erechtheum. After the end of the teaching process a common post test was given to all of the students.

Finally, teachers were encouraged to discuss about the experiences they had in their teaching and to identify effective teaching and learning which had occurred, as well as problems which had noticed.

RESULTS AND CONCLUSIONS

The students' cognitive achievement (at the initial test) average in the two classes was M=1,7 SD=0,3 for the control class and M=1,8, SD=0,5 for the experimental class(maximum grade is 6). Analysis of co-variation ANCOVA for the two groups and the pre- and the post-test yielded the following results: The F ratio that refers to the relations between groups of the research design (two groups and two tests) is 10,542 with p significance less than the 0,001 level. Thus, we accept that the interaction is highly significant. After the teaching process,the cognitive achievement average for the control group increases from M=1,7 to M=3,8 whereas as the experimental group is concerned, it increases from M=1,8 to M=4,9.The difference between the averages for each class is statistically significant. For the control group t=-5,446 with significance level $p<0.001$ and for the experimental group t=-8,489 with $p<0.001$. From the results, there is strong evidence that simulated spaces help students visualize information in new ways and give abstract concepts concrete form.

Questions concerning the architecture and the geometry of space were found to be more difficult for the control group while students of the experimental group seemed to be more familiar with issues concerning the positions of the status, the distance between the, and the different geometric creatures of the Erechtheum. This project may be developed further using collaborative learning tools (such as CMAP) so that students are able to cooperate and explore relevant architectural issues, historical sources etc.(work in progress). Further research (in process) will be focused on using this application to investigate issues like : “How do students perceive the learning course in relation to the use of VRML environments?”, “Does approach to learning change over the duration of the course due to the use of VRML?” and “What metacognitive development takes place in the course due to VRML?”.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 122-131,

Can the Internet in tertiary education in Africa contribute to social and economic development?

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ABSTRACT

Poor Internet connectivity is one of the serious underlying causes of the digital divide between developing and industrialized countries, and is hampering the transition to the global information society. The recent emergence of national and regional research and education data communication networks in parts of the developing world have shown large benefits arising from collaboration amongst tertiary education institutes. Africa is currently the most underserved continent in terms of information and communication technologies. Collaboration amongst tertiary education institutes in Africa is essential to make them key players in the enhancement of information and communication technologies for society.

Keywords: *Tertiary education, ICT, development, research & education networks, Internet.*

INTRODUCTION

Technological advancements, global telecommunication and automation have greatly contributed to economic growth in the world over the past decades. However, not all regions, countries and people in the world have benefited equally from the opportunities that information and communication technologies (ICT) offer. Especially rich industrialized countries and several countries in transition have profited from the information age and attained high economic growth figures. The advantages of the information era have been significantly less for developing countries, which generally lack favourable conditions for deployment of new technologies. This difference in access to ICT between the poor and the rich is referred to as the digital divide.

ICT is considered one of the key factors behind sustainable development, not only as a means for automation of work processes in business and industry, as a tool for education and scientific collaboration, and a platform for technological innovation, but also for communication and access to information. It thus contributes to democratic empowerment and poverty reduction (Potter et al. 1999:137). Poverty, poor access to education and lack of public investment capital are commonly believed to be the main causes of the digital divide, however, other causes may be of influence. A basic understanding of the mechanisms of the implementation and the role of ICT in society is necessary to reduce this digital divide, bearing in mind the local circumstances, differences and cultural contexts. This paper focuses on Africa, the most underserved continent in terms of ICT.

Many African countries have defined governmental policies to support ICT, in the past few years. Numerous ICT-initiatives and projects are taking place simultaneously in African countries, supported by the World Bank, the European Commission, the United Nations and many other donors (Hawkins 2005, Steiner et al. 2005).

The United Nations Millennium Declaration (UNMD 2000) contains a commitment to “ensure that benefits of new technologies, especially information and communication technologies” …”are available to all”. In the “Declaration of Principals” for the World Summit on the Information Society (WSIS), held in Geneva in 2003, goals were set for developing “…a people-centred, inclusive and

development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life.." (WSIS 2003)

The role of education in bridging the digital divide is crucial. In this paper I will describe the key role of tertiary education in the quest for good Internet access to improve information and communication flows, that can contribute to social and economic development.

INTERNET IN AFRICA

Africa's population of approximately 933 million inhabitants represents 14% of the total world population. The estimated number of Internet users[1] in Africa in 2007, is 33 million, which represents 3.6 % of the Internet users in the world. Excluding South Africa (and the North African countries of Morocco, Algeria, Tunisia and Egypt, which have higher Internet usage figures), the penetration of Internet in Sub-Saharan African countries is an average of 2%. Yet, Internet use is growing fast in Africa: more than 600% for the whole of Africa, over the period from 2000 to 2007. This can be compared with the total world Internet usage growth, which was just over 200% in the same period. (Internet World Stats 2007a). The number of Internet users in a country can be considered a "digital indicator" of the adoption of ICT in society, and the integration into the global networked economy.

Table 1: *Population per country, number of Internet users and penetration: percentage of Internet users relative to the total population: (source Internet World Stats 2007a and 2007b)*

	Population in 2007	Internet users, most recent data[2]	Penetration
Total World	6.574.666.417	1.114.274.426	16.9%
USA	301.967.681	211.108.086	69.9%
China	1.317.431.495	162.000.000	12.3%
Netherlands	16.447.682	12.060.000	73.3%
Total North Africa	153.156.098	12.805.000	8.4%
South Africa	49.660.502	5.100.000	10.3%
SSA	736.925.602	15.871.800	2%

E-READINESS AND DIGITAL INFRASTRUCTURE

The integration into the global networked economy of a country can be assessed by computing "e-readiness" (Bui et al. 2003; Ifinedo 2005). Eight factors are used to evaluate the e-readiness of a country: digital infrastructure, macro economy, ability to invest, knowledgeable citizens, competitiveness, access to skilled workforce, culture, cost of living and pricing, according to Bui et al. (2003).

When considering the e-readiness factor of digital infrastructure, it is clear that building a physical telecommunication infrastructure in Africa will require high investments. Low population density

and large distances between urban centres are unfavourable conditions for the expansion of a continent-spanning communication infrastructure. In such circumstances there is no promise of quick revenues for private investors in country-wide telecommunication infrastructures.

Nevertheless, several studies have shown that lack of financial means for investments are not the main reasons for the absence of a regional Internet infrastructure, as might have been expected. A study of the availability of optical fibre connections on the African continent was carried out in 2004-2005. It was sponsored by the World Bank and the Canadian International Development Research Centre (IDRC), covering the south eastern countries, and was implemented by the Southern Africa Regional Universities Association (Muchanga 2005). This revealed the existence of thousands of kilometres of private high capacity transmission over optical fibre cabling, owned by power utility companies, and other pipeline operators. However, closed governmental policies and regional regulations in many countries have until now prevented the use of this valuable infrastructure for public communication purposes (Pehrson & Ngwira 2006:5).

The real problem that holds back the use of Internet is the high cost for Internet connectivity for end-users in Africa. An African consumer pays, on average, 240 times as much for the same Internet connection as someone in the Netherlands. The high pricing is an obstacle for the deployment of Internet in Africa. The main challenge, therefore, is to bring the costs down.

CAUSES OF THE HIGH PRICE OF INTERNET

It is important to understand the market mechanisms that contribute to the excessively high prices for Internet connections in Africa. Internet infrastructure in African countries is dominated by private telecommunication companies and some monopolistic state companies. In Sub-Saharan countries, access to the rest of the global Internet is exclusively through wireless satellite connectivity termed VSAT, or through submarine optical cable. VSAT dishes connect via a satellite directly to dishes in the US or Europe, and subsequently with the large Internet exchanges in the world, located in e.g. Amsterdam, London, Paris or New York.

A submarine cabling system, called SAT-3/WASC/SAFE was completed in 2002, and has landing points in eight African countries, situated mainly along the west coast (Senegal, Ivory Coast, Ghana, Benin, Nigeria, Cameroun, Gabon and South Africa), and it also connects to Spain, Portugal, India and Malaysia. Most landlocked countries in Africa (with exception of Mali and Burkina Faso) and countries on the east coast are currently not connected to this submarine cabling system.

The VSAT wireless Internet connection appears to be an adequate alternative for Internet in places that cannot access the submarine system. A dish can be easily purchased and installed anywhere. Almost every university in Sub-Saharan Africa is already connected to the Internet via VSAT (Hawkins, 2005).

The downside of VSAT connection is the high price, the inferior connectivity quality and lower bandwidth[3], as compared to optical cable, plus the fact that no local infrastructure is being built. It is estimated that Africa spends 400 million US $ per year on VSAT connections, mainly to international, not African, companies (Drouot, 2005).

Let us consider a case when two users at, for example, the Cape Coast University in Ghana send an email to each other, using email addresses from American providers such as hotmail.com (MicroSoft Corporation) or yahoo.com (Yahoo). While both persons are located on the same campus, the email travels through the VSAT, 4 x 36000 km: to the satellite and through the

exchange point in, for example, Amsterdam, back to the satellite, and again to the campus. The whole travel of the email usually takes only a few seconds, but it represents a disinvestment in terms of building up local capital. The Internet providers and satellite owners are international companies. All the budgets spent on VSAT – connections flow away from Africa, instead of being reinvested in local infrastructure.

Glass (optical) fibre is the best medium for data transport, and is much more sustainable than satellite wireless, but it requires high initial investments. One optical fibre pair (dark fibre) can nowadays carry 80 Gbps of data, which is 80.000 times the capacity of an Internet connection for an average university in Africa. In each glass fibre duct hundreds of fibre pairs are bundled together, giving a total connectivity of Terabits (1000 Gigabits) per second for one single duct. Nevertheless, the return on investment of optical cable infrastructure is often too risky for private investors.

One of the main goals of the SAT-3/WASC/SAFE cable was the reduction of connectivity costs to the Internet, for the participating nations (Jensen 2006). However, the lowering in price did not happen, because the connection was shared by a closed consortium of dominant telephone companies and telecom state monopolies (Gedye 2006). There was, unfortunately, no Open Access Model or governmental policy or enforcement regulation to break the monopolistic market position of the members, and thus lower the Internet prices (Drouot, 2005).

The east coast of Africa is currently completing its EASSy cable, the East African Submarine cable System, which is expected to be operational in 2007, and runs from Port Sudan (Sudan) in the north to Durban (South Africa). This will complete the fibre loop surrounding Africa, by connecting Djibouti, Somalia, Eritrea, Ethiopia, Kenya, Tanzania, Madagascar and Mozambique (Olawo, 2005).

The submarine cabling systems are a positive step forward in bringing Africa “on-line”, but additional infrastructure is required to connect the inland regions and landlocked countries to the landing points.

As shown by several studies, including the SARUA fibre study (Muchanga, 2005), power utility companies commonly use optical fibre for the operation of their core business; so many investments in expensive infrastructure are already done. This electricity fibre infrastructure might easily be shared by other companies, such as Internet providers, or public user consortia, without affecting the electricity business, and without technical or market constraints. The use of the infrastructure by several (competing) business partners, is not only common in the rest of the world, it is even enforced by Open Access policies and regulations in many countries to prevent monopolies (e.g. the OPTA and the NMA in the Netherlands, Independent Regulators Group (IRG) and the European Regulators Group (ERG) for the European Union).

THE IMPORTANCE OF INTERNET IN TERTIARY EDUCATION

The importance of ICT and Internet in tertiary education is generally recognized. The Internet represents the world’s largest knowledge data base. This information is easily accessible through powerful search engines. The Internet can substitute for expensive hardcopy libraries, and provide access to resources of scientific publications and scholarly information, when students have daily access to computers and the Internet with sufficient bandwidth for downloading and exchanging documents over the network.

The American technology institute MIT (Massachusetts Institute of Technology) has made available complete BSc. and MSc. level curricula that can be accessed and downloaded through the Internet. Their statement on this is: "…While recognizing that people in the developing world — who may benefit most from the open sharing of knowledge — are hindered by a lack of Internet access and connectivity, we must not let this problem obscure our vision of the future, but rather, take it as a challenge: Can the decision-makers of the world's leading educational institutions use what we are doing on our campuses to improve the lives of people around the world? History has proved that education and discovery are best advanced when knowledge is shared openly. We believe the idea of open courseware is an opportunity that we must seize during the next decade" (MIT 2001).

The Internet can also improve collaboration and interaction with research groups in other institutes, regions or countries contributes to quality of research and education. The Association of African Universities (AAU) shares this vision by stating on their website: *"*African universities and researchers are often working in a silo model, insulated from regional actors and drivers of funding and requirements. Through establishing low cost high quality networks a platform for generative discourse can be created leading to improved policy advice, more effective cross pollination of best practices and lessons …" (2007).

Distance learning is already used at many African universities, and fills a clear need for education of people who work during the day, and live in remote areas. Distance learning can be improved significantly by the use of Internet and electronic learning environments.

All the above mentioned activities require adequate Internet connectivity with sufficient bandwidth. To underline this statement, the following goal was set by the Association of African Universities (AAU), at the Conference on African Research and Education Network Infrastructure, held in Tunis, in November 2005; here professor in Telecom Systems Björn Pehrson, from the IT-University KTH in Sweden, mentioned:
"No later than 2008, universities and research institutions in Southern Africa will have access to broadband services and the global Internet on the same level as peers in the developed parts of the world, with a quality of service in the Gbps rather than kbps[4]", (Association of African Universities 2005).

PROBLEMS IN THE DEPLOYMENT OF INTERNET

In addition to adequate and inexpensive broadband access to global Internet, higher education institutes need proper institutional ICT management. Lack of an ICT strategy and policy often leads to inefficiency in operational and management structures of ICT departments. Sife et al. (2007) describe lack of systematic approach, and lack of awareness and attitude towards ICT at institutional level as one of the challenges for higher learning institutions in developing countries.

Connectivity at African universities is often obtained through expensive VSAT connections, because of lack of a regional optical backbone. The capacity of this VSAT is acceptable, but it is not comparable to an optical connection, and it is unsuitable for broadband document downloading, and data exchange and other bandwidth consuming applications. This capacity is further reduced by inadequate management of campus networks, causing frequent power cuts, service denial, poor security, and virus spread, leading to even lower capacity of Internet to the end-users. This is caused by poor ICT management and insufficient human resource capacity. Other problems in the deployment of Internet are lack of ICT equipment, high licence fees for software, and lack of ICT-skilled teachers, technicians and support staff.

OTHER TERTIARY EDUCATION NETWORKS IN THE WORLD

It is possible to bring the Internet to African society through tertiary education, in the same way that it happened in the rest of the world. The Internet originated in the domain of higher education. Although the technology for interconnection of computer networks was developed for the American military network, important applications such as email and http (i.e. the world wide web), emerged within higher education (Stanton & Stöver 2005; SURFnet 2002). There are successful examples from many countries of how collaborating tertiary institutes have improved the national ICT situation.

In Europe, national research and education networks (NRENs) were established in the 1980s and early 1990s to interconnect universities, mainly for use of email. Networking technologies evolved every year, gradually enabling larger data exchange and more enhanced applications. In 1993 a consortium of European NRENs was formed, called DANTE (Delivery of Advanced Network Technology to Europe) and its first international network of networks was formed, named GÉANT. GÉANT has recently been connected to Asian university networks forming TEIN (Trans-Eurasia Information Network). GÉANT2 and TEIN2, as the second generation networks are named, operate at high data transmission rates, up to 80 Gbps.

In Latin America (LA), a collaboration initiative between several universities led to the formation of a continent wide research and education network in 2005, RedCLARA, through the interlinking of seven existing NRENs (Argentina, Brazil, Chile, Costa Rica, Mexico, Uruguay and Venezuela) and the formation of seven new NREN's (Colombia, Ecuador, Guatemala, Nicaragua, Panama, Peru, El Salvador). RedClara was then connected to GÉANT. The project costs were 12.5 million euros and were financed by the European Commission (80%) and the governments of the participating countries (20%). The backbone is mainly composed of optical cable, and some copper wire (Stanton & Stöver 2005).

The RedClara network interconnects 600 universities in Latin America and 3,500 universities across Europe. The first scientific collaboration projects between LA and EU which directly benefited form this new network were in the field of grid computing, astrophysics and life sciences.

Six groups from Mediterranean universities have taken the first step towards forming an association of Mediterranean NRENS in 2006; these are Algeria, Egypt, Jordan, Morocco, Palestine and Syria (EUMEDconnect 2007).

The Eassy cabling system, that is currently being developed for the east coast of Africa, was at risk of being a copy of the monopolistic system applied by the SAT-3 cable, instead of an Open Access connectivity model (Zuckermann 2006). With aid of the AAU, a consortium was formed in 2006, called Ubuntunet Alliance, composed of 43 universities in south-eastern Africa, to negotiate with the EASSy operating companies, in order to obtain a considerable bandwidth on this cable, against low price. This initiative is supported by the World Bank, which is willing to contribute financially to the Eassy project, on condition that the Open Access will be applied (Balancing Act 2005).
In West Africa, until present, only a few consortia or NREN initiatives exist between universities, or countries. Yet, awareness is increasing, and this might happen in the very near future. Many countries were encouraged by the Ubuntunet Alliance initiative, and have expressed interest in contributing and subscribing to this consortium (Steiner et al. 2005). These are currently Botswana, Burundi, Cote d'Ivoire, Democratic Republic of Congo, Egypt, Lesotho, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe UbuntuNet 2007).

DISCUSSION

The problems African universities are facing in their deployment of ICT, aggravated by lack of communication and collaboration with peers, may become a vicious circle. The scientific field is a preferential ground to create a collaborative environment, ultimately promoting scientific and technological development.

Internet connectivity and pricing could be considerably improved by the formation of bandwidth consortia, which cooperate and emit tenders, insist on low prices, and encourage competition between Internet providers. Consortia of tertiary education institutes consist of homogeneous user groups that can also lobby at governmental level. The high prices of Internet connectivity in Africa are a direct consequence of a producer dominated market, too few consumer organizations and lack of governmental policies and regulations enforcing competitiveness.

In many countries of the world, tertiary educational institutes have already organized themselves into consortia to obtain and share resources. These National Research and Education Networks consortia, (NRENs), are important organizations that can influence ICT policies on a national scale and benefit their member institutions (Dyer 2005). The member institutes share the same need for good bandwidth and affordable Internet connectivity, forming a strong consumer group.

Taking the example of the SARUA fibre study (Pehrson & Ngwira 2006), similar studies in other parts of Africa should be carried out, in order to map the available optical fibre connections that might be used as regional backbones.

The next step would be gaining access to these private closed infrastructures. This could be developed in public-private projects, where again consortia of tertiary education institutes can act as strong lobby groups to enforce Open Access, thus making these infrastructures also available for society.

At remote sites where no optical backbone is available, consortia can negotiate for lower VSAT prices, through economics of scale. Moreover, tertiary education consortia can negotiate still other issues, such as favourable licence fees for software.

Because infrastructure that connects research and educational institutes with one another constitutes an indisputable public good, donor investments can be applied without disadvantage and false competitiveness to the private companies. The enforcement of Open Access by governmental legislation policies on the communication infrastructure could be obtained by the lobbying consortium as well, using the examples of many countries where this type of legislation has already been adopted.

CONCLUSIONS

African countries need good and inexpensive Internet services, to become “information societies” in their search for more favourable social and economic conditions.

Tertiary education institutions should be aware of their key role, as contributor to Open Connectivity and of their potential influence in market mechanisms. At this level, user awareness is important as well as knowledge of mechanisms that control the telecommunication market. Examples from peer institutions in other countries are very important. Some countries in Africa are already joining forces, but many are still failing to grasp this opportunity! The human resource capacity problem in ICT must be addressed at both management and at technical and operational

levels. Collaboration between institutes should be encouraged on regional and international platforms.

Governments should apply their legislative authorities to enforce “low price/ high connectivity” business models and encourage competitiveness, so as to prevent monopolistic telecommunication markets. This is essential both for the connection to the global Internet, and for the formation of a regional communication infrastructure, owned by private or state companies.

Donors should be aware of the importance of ICT and Internet connectivity as a motor for economic and social development, and should focus attention on this in their development programmes.

The private telecommunication sector should be aware of the business opportunities that may emerge when Internet penetration increases by low price/high volume business models for connectivity. Last, but not least, all the above mentioned stakeholders should collaborate and focus on the issue that will bring benefit to all: how to bring Africa online.

Endnotes

[1] An Internet user is defined here as anyone currently in capacity to use the Internet, i.e. having access to an Internet connection point, and with the basic knowledge to use it.

[2] The most recent data available on Internet usage per country are estimates as from 2005, 2006 or 2007. From just a few African countries the most recent data are from 2003 (Internet World Stats 2007).

[3] Bandwidth in kbps (kilobits per second), Mbps, or Gbps is the unity in which the amount of digital data transmission per time interval is expressed.

[4] Professor Pehrson was referring to a difference of a factor > 1000 in data transfer rate between African universities and other universities in the World.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2007, Vol. 3, Issue 3, pp. 132-135

Improving production and accessibility of agricultural information through capacity-building, networking and partnerships in the South Pacific

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Project Title:	Development of Sustainable Agriculture in the Pacific (DSAP) Project
Project Objective:	The overall DSAP project objective is to increase sustainable agricultural production of farm families in the 16 participating countries of the Pacific region. There are three main project components aimed at achieving this objective. The first is to develop appropriate agricultural technologies based on farmer livelihood needs. The second component is to improve access to agricultural information, and its production, by improving country capacity in the area of information and communication technologies (ICT). Thirdly, the project aims to build institutional capacity and partnerships with National Agricultural Research and Extension systems (NARES), NGOs, information providers, and farmer and community groups. in order that technology identification and knowledge dissemination will be sustained beyond the end of the project.
Supporting Agencies:	The Secretariat of the Pacific Community (SPC) and the European Union (EU).
Project Component Director:	Bernadette Masianini, bernadettem@spc.int, Agricultural Information Officer (AIO), is responsible for capacity-building and development of ICT strategies within the DSAP Project

Project Description:

The Pacific is unique compared to other regions of the world. It is defined by large expanses of ocean. Over five times the size of Europe, with scattered and isolated areas of land of varying size, the so called 'tyranny of distance' has presented considerable complexities and challenges for information dissemination. At the same time, sustainable agricultural systems in the Pacific are coming under increasing pressure due to population growth and other factors. In the high volcanic islands farmers are moving away from shifting cultivation, where soil fertility was maintained and erosion controlled, to cropping plots of land more frequently. This increase in the intensity of land use is resulting in deforestation, soil erosion and declining yields. High population growth rates, unfavourable age structures and increasing urbanisation on islands with limited land and water availability are a reality particularly the low-lying atolls. This has serious implications for these fragile island ecosystems. Further, the lack of trained local researchers and extension officers with skills in sustainable farming systems and combined with the poor access to ICTs, and

information in general, has resulted in promotion of inappropriate technology and further degradation of the natural resource base. The lack of involvement of rural communities in the development process compounded by weak NARES and poor linkages between farmers, NARES, NGOs and information providers have all contributed to the problem. Rural communities have been the losers and opportunities to enhance their ability to cope in such vulnerable contexts have been squandered.

At the early consultation and needs assessment stage of the project a broad range of ICT-related constraints were identified in the region and participating countries. Overall there existed weak extension services, NGOs and farmer group's extension activities. This resulted largely from poor institutional and individual capacity in the production and utilisation of information materials resulting in production of inappropriate information and promotional materials, resulting in few, badly designed and produced extension communications materials. Information was not being translated into a format that is understood by local communities. And although much information is freely available, it was largely irrelevant material. Access to necessary ICT equipment and software was poor, as well as the necessary training. There was limited collaboration and networking between NGOs and NARES in the same country despite targeting the same audience. Surprisingly, there was limited collaboration between Information Units and research and extension staff within the same Ministry. Added to this, there was poor collaboration and networking between regional and international information providers operating in this environment. In effect, this meant in most countries there was no network in place to disseminate agriculture information to those who most needed it.

Recognising these shortcomings, the Secretariat of the Pacific Community (SPC) together with NARES, NGOs and other regional stakeholders from 16 countries collaborated in the development of an initiative to address many of the issues constraining sustainable agriculture and rural livelihoods in the region. The outcome of these consultations was the Development of Sustainable Agriculture in the Pacific (DSAP) project, funded by the European Union. DSAP aims to increase sustainable agricultural production of farm families in countries covering Melanesia, Polynesia and Micronesia. Importantly, DSAP is as much about process as product, and employs participatory approaches with farmers and rural communities to identify and validate appropriate technologies to solve agricultural problems.

As part of this strategy, and in order to scale-up and disseminate these technologies, DSAP aims to strengthen national capabilities in the production and use of a variety of extension-related ICTs including traditional media such as television, radio, posters, handbooks, pamphlets and video. To support these activities DSAP focuses on intensive training and capacity enhancement and encourages linking countries with relevant information providers at a national, regional and international level. Some indicative project activities to help achieve this include:

- Recruiting Graduate Research & Extension Assistants (GREAs) and Extension Communications Assistants (ECA) in participating countries and providing them with the necessary training and skills to achieve the above aims;
- Conducting training courses and workshops for national partner staff in effective communications, desktop publishing, radio and video production and editing and other relevant ICTs;
- Establishing and upgrading agricultural libraries in participating countries and improving linkages to information sources regionally and internationally;
- Establishing Information Resource Centres in rural areas to improve access to information by farmer and community groups;

- Preparing information on appropriate agricultural technologies in a form suitable for extension workers, farmers, and NGOs and ensuring materials are tested with representative target groups; and
- Drawing together all relevant DSAP ICT experiences, including lessons learned and good practices, in the format of a DSAP Training Manual that can be used for training and awareness purposes after the end of the project.

Some DSAP achievements to date include:

- The DSAP project has compiled and documented surveys of ICT needs assessment for the Pacific region, which provide an in-depth understanding of the target audience;
- All participating countries have received computers, software and other relevant equipment necessary for the production of effective extension materials;
- DSAP project staff and relevant staff from NARES and NGO Information Units in all 16 participating countries have been trained in desktop publishing and imaging training;
- The project has supported SPC Agriculture Library staff to travel to participating countries to train library staff and assist in the set-up and cataloguing of libraries within Ministries of Agriculture;
- Rural Information Resource Centres have been opened in Papua New Guinea, Samoa, Fiji, Tonga and Kiribati with more planned. This includes purchase of computers and, if appropriate, email and internet services. The project has also supported the SPC Agriculture Librarian to assist with the setting up of these centres and their linkages to relevant information provided by SPC;
- Ongoing evaluations of services provided by Resource Centres have been carried out and information gaps have been addressed;
- Intensive one-to-one video production and editing training has been provided to participating countries as well as video equipment;
- The project has produced 4 generic promotional DVDs covering sustainable agricultural technologies tested and verified by the project. The technologies include simple, low-cost irrigation systems, composting and using neem and derris as organic pesticides;
- DSAP Tonga hired a film crew from the Tonga Broadcasting Commission to produce a television programme on the benefits of velvet bean and simple irrigation systems. This was the project's first-ever television programme, broadcast twice on national television. Subsequent television programmes on market gardening have been broadcast in Wallis and Futuna; and
- Other countries are producing weekly radio programmes that promote and disseminate information and news about agricultural technologies developed by DSAP.

The above activities and outcomes do not say much about networking and partnerships, many of which have arisen as a result of better linkages and collaboration between NARES and NGOs. This has strengthened their links and networks to community groups, farmer groups, womens groups and youth groups. Improved linkages now exist between diverse information providers including local agricultural offices, health offices, schools and NGOs. The project has also helped bring about an improved level of collaboration between regional and international information providers including the University of the South Pacific, FAO, SPC and CTA. One such initiative, involving CTA and DSAP, has been the First Voice International Multimedia Service (FVI-MMS), which enables agricultural workers in the Pacific to access important information on agriculture,

and related topics, by simply connecting a PC or laptop to a satellite receiver. Further measures are underway to strengthen and broaden such collaborations further. This will be important in supporting and sustaining the ICT capacity-building outcomes that DSAP has achieved to date.