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**Baraton Interdisciplinary Research Journal (BIRJ)– AuthorAID- International
Network for the Availability of Scientific Publications (INASP)**

**Announcing BIRJ – AuthorAid“SCIENTIFIC WRITING WORKSHOP – KENYA, 10TH – 12TH
JULY 2012”**

**APPROPRIATE FOR RESEARCHERS, AUTHORS, EDITORS, PEER REVIEWERS, AND
MENTORS**

Baraton Interdisciplinary Research Journal (BIRJ) and International Network for the Availability of Scientific Publications (INASP) wish to invite applications for participation in BIRJ – Author AID Scientific Writing Workshop to be held at the University of Eastern Africa, Baraton (UEAB) Research and Community Development Centre on 10th – 12th July, 2012.

Application materials should include a letter of statement of interest, recommendation by employing authority, and an article for improvement and fine-tuning for publication. There will be sponsorship for 20 participants, and room for 5 privately sponsored participants. Sponsorship will cater for public road transport to and from UEAB and full board accommodation at UEAB Research and Community Centre.

Applicants with draft proposal or sample of documents for publication to be used during interactive/group sessions of the workshop will be preferred.

Self-sponsored participants will pay a participation fee of US\$ 200. A joint BIRJ-AuthorAID-INASP certificates will be issued to successful participants at the end of the workshop.

Deadline for submission of application materials extended to Wednesday, 30th May, 2012. Selected participants will be informed by 15th June 2012.

Applications should be sent to BIRJ@ueab.ac.ke

Professor Yoel Margalith - Obituary
(*The Mosquito Biocontrol 'Guru'*)

Arieh Zaritsky and Eitan Ben-Dov
Department of Life Sciences and NIBN
Ben-Gurion University of the Negev,
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Yoel Margalith was born in the Serbian village of Cantavir, Vojvodina on 9 February, 1933, survived the Nazi concentration camps Bergen-Belzen and Terzienstadt, and repatriated with his mother to the newly-established State of Israel in 1948, where he lived through the rest of his life. On Saturday, 2 April, 2011, he lost the final battle at the age of 78 years old. The world thus lost a highly qualified scientist and we lost a good friend who always provided a helping hand.



1948: Among refugees on boat to newly-born Israel

Yoel's education gap that has been opened during WWII was closed in Jerusalem, at an evening secondary school for working youth while supporting himself as a zookeeper, and at the Hebrew University after an obligatory service at the Medical Corps of the Israel Defense Forces (IDF), where he met his wife Miriam who later became a Virology Professor. In the IDF, Yoel encountered mosquitoes as a Preventive Medicine Officer during an eruption of West Nile Virus epidemic. After graduating at the Entomology department, he spent 4 years (1972-1976) in the USA as a post-doctoral fellow and an Associate Professor.



His great serendipitous discovery of the mosquito larvicidal subspecies of *Bacillus thuringiensis* (Bt) was reached while surveying Israel's Negev for natural control agents of mosquitoes as a Scientist at the Israel Institute of Biological Research. This isolate, identified in the Pasteur Institute (Paris) as a new (H-14) serotype and defined as a new subspecies of Bt, was named by Yoel "*israelensis*" (Bti) rather than after his own name.




During the rest of his life since this discovery, Ben-Gurion University of the Negev (BGU) has been privileged to have him as a senior Faculty at the Life Sciences Department of the Natural Sciences Faculty. Yoel's academic life continued as an Emeritus Professor until his last day despite the poor health he suffered.



Fortunately, Bti was quickly accepted as the best biological control agent against mosquitoes and blackflies, vectors of numerous tropical diseases that devastate health and economy of third world countries. Yoel has thus become a world famous ecologist, culminating in being awarded the prestigious Ernst David Bergmann Prize for outstanding biological research (1990) and the Tyler Prize for Environmental Achievement (2003).

During the 35 years since the discovery, Yoel has served as an expert and advisor for biological control of insect vectors of diseases in numerous organizations such as WHO (1978-1988) and KABS (1996), and governments such as the People Republic of China (1986), Honduras (1987/8 and 1994), Turkey




Tyler Prize

2003 LAUREATES

<p>SIR RICHARD DOLL Emeritus Regius Professor of Medicine University of Oxford England</p>	<p>DR. HANS R. HERREN Chief Executive and Director General International Center of Insect Physiology and Ecology Nairobi, Kenya</p>
<p>DR. YOEL MARGALITH Ben-Gurion University of the Negev Israel</p>	

(1998/9), Massachussettes, USA (1990-2), Hungary (1997), Poland (2000) and Israel (1980/1 and 1999).

Yoel received honorary Doctoral degree from the Universidad Autonoma de Nuevo Leon, Monterrey, Mexico (2001), and was elected by the European Union as an active member of the European Academy of Sciences and Arts (2004).



RECTORÍA

R-175/01
February 19, 2001

DR. YOEL MARGALITH
Director, Center for Biological Control
Ben-Gurion University of the Negev
P.O.B. 653 Beer-Sheva, Israel 84105

Dear Dr. Margalith:



The Universidad Autónoma de Nuevo Leon would like to propose an invitation to bestow upon you the degree of *Doctorate Honoris Causa*. We are planning on holding this ceremony on September 19, 2001.

As you know this is the highest and most honorable degree our University bestows upon individuals with such impeccable reputation and model human beings as yourself.

Since this proposal needs to follow the formalities through our University Council, we need for you to formally confirm this invitation.

I thank you beforehand for your kind attention.

Sincerely,

DR. LUIS J. GALAN WONG
President
Universidad Autónoma de Nuevo León

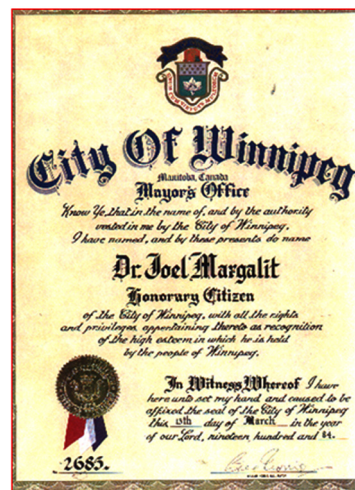
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Yoel has been awarded Honorary Citizenship of the City of Winnipeg, Canada (1984) and the key to the city of Philippsburg, Germany (1985), became the First honorary member of the European (2000) and Hungarian (2001) Mosquito Control Associations, and received (in 2001) Citation Awards by AMCA and the Greek Mosquito Abatement Organization. During these years, he has delivered numerous invited lectures and organized international conferences as well as leading various regional consortia and research projects all around the world. Yoel excelled in grantsmanship: his research, development and

applicative activities at BGU have drawn the equivalent of over 4 million US Dollars during these years.

Yoel's discovery of Bti has had enormous effect on human health and a cleaner environment. His pioneering efforts to implement environmentally sound integrated nuisance and vector control technologies around the world, based on Bti, have had a major impact on the health of millions of people, while at the same time providing very significant benefits to the environment.



In its August 1993 issue, the National Geographic highlighted Yoel's achievements till then by stating that "The discovery marks a humanitarian milestone. The World Health Organization and others spray Bti on vast areas in Africa, Asia and South America to control malaria-bearing

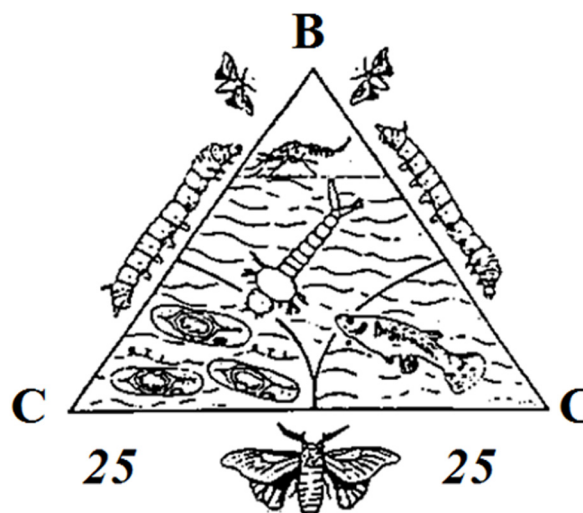
mosquitoes. Bti also kills blackflies, the carriers of River Blindness and spraying campaigns are eradicating the menace in fertile river valleys of West Africa." Indeed, malaria infections from pesticide-resistant mosquitoes have dropped by 90% along the Yangze River, PRC. Bti is widely used in Europe, as recommended and practiced by the European Mosquito Control Association. Specifically, KABS is protecting many millions of people, residents of over a hundred municipalities along 300 km of the Rhine River, and over 6000 km² of inundated flood plains, heavily infested by nuisance and vector-mosquitoes of arboviruses.

Bti, the first subspecies of Bt found to be toxic to dipteran larvae, was discovered by Yoel and his partner Louis Goldberg in 1976. During a survey for mosquito pathogens, they encountered a small pond with a dying dense population of *Culex pipiens* larvae at the dried-out Besor river bed near Kibbutz Ze'elim—about 30 miles away from the main campus of BGU. It was isolated from a floating larval carcass in an epizootic situation, and quickly characterized as a biological agent that is more effective against many species of mosquito and black fly larvae than any previously known bio-control agent. Bti is completely safe to the user and the environment. Due to high specificity, it is non-toxic to non-target organisms

except for a few Chironomid species and only at much higher concentrations than the recommended rates of application. No resistance has been detected to-date toward Bti in field populations of mosquitoes despite 30 years of extensive field usage. Bti has been integrated into vector control programs at the national and international levels.



The larvicidal activity of Bti is localized in a parasporal, proteinaceous crystalline body, synthesized during sporulation, and composed of at least four major polypeptides (δ -endotoxins) with molecular weights of about 27, 72, 128 and 135 kDa, encoded by the following respective genes: *cyt1Aa*, *cry11Aa*, *cry4Ba* and *cry4Aa*. The specific mosquito larvicidal properties are attributed to synergistic interactions between them, but the whole crystal is much more toxic than combinations of the four proteins; several minor polypeptides might contribute to the overall toxicity. Yoel Margalit was a pioneer to introduce concepts of Integrated Biological Control against mosquitoes. He established the Center for Biological Control at BGU and directed it until his death, which is a tremendous blow to his family, friends, colleagues, and the scientific community. We shall cherish his memory for ever and convey his achievements to future generations.





**PEER REVIEWERS FOR BARATON
INTERDISCIPLINARY RESEARCH JOURNAL**

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Message from the Editor-in-Chief

I am grateful to all contributors to the current issue of Baraton Interdisciplinary Research Journal (BIRJ). The journal is growing from strength to strength albeit with some minor challenges. BIRJ is working

with friendly organizations to promote research and availability of research-based publications. Recently BIRJ, through the Editor-in-Chief, received a small grant from AuthorAID (International Network for the Availability of Scientific Publications) to organize a Scientific Writing Workshop for Kenya. Although the workshop will only cater for 20 or so participants, we expect that the beneficiaries will eventually train others in their respective institutions, leading to increased research-based publications. We were encouraged when individual members of BIRJ were actively involved in Bill and Melinda Gates Foundation workshop hosted by the University of Eastern Africa, Baraton, and the reported result was 7 fold increase in grant applications received by the Foundation. Whether or not this translates in to the number of grants received in Kenya is not important. What is important is that researchers are now aware that anybody can write a proposal and win a research grant. All one needs is a clearly articulated viable idea.

There is a great need to improve the research environment in Africa. Statistics shows that the rate of publication and innovation is directly proportional to the research environment in terms of work-load, research budget and availability of resources. This calls for fresh commitments and re-commitment to research funding from institutional strategic planning and budgeting, all the way to national political will and International Corporation. There is need for more collaboration and bench marking. One of the plagues hurting Africa is the

brain-drain syndrome. This problem can be addressed by improving the research environment and by collaboration and sharing of certain resources. This could make it possible for emerging researchers who may not have wan research grants to access all the basic resources they may need to begin their research and development careers.

There are institutions that must be recognized for the good job they are doing to support research and development in Africa. SupportAfrica International has helped to mobilize resources from Europe, and a number of African Universities have benefited. In addition, there are international donor organizations and foundations dedicated to science and technology development, which act individually or collectively to promote science in the developing world. As these organizations do their part to jump-start research activities, the developing nations should not think that they will always be jump-started. They should fix their starters and get ready to move. They should be able to sustain themselves when the good friends withdraw their support. Nations and institution in Africa must graduate from the “colostrum” to ordinary milk and finally to real food, if they have to grow at all. Likewise, we cannot stay in the scientific incubators forever. Every Scientific product needs to graduate from the starter incubator to commercial dissemination.

When it comes to dissemination of information and technology transfer, there will be need of collaboration between IT staff, languages, educators, and the social science interface. The information should be written in plain language, and if possible, in the local language of the community where dissemination is desired. At this point we understand that there is room for everyone in Interdisciplinary Research, and this is the reason BIRJ was born.

Z. Ngalo Otieno-Ayayo, PhD

Editor-in-Chief

Research Articles
Part - A

KNOWLEDGE, ATTITUDES AND PRACTICES OF TRAINED TRADITIONAL BIRTH ATTENDANTS ON HIV/AIDS, KENYA

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Abstract

HIV and AIDS is a global pandemic with cases being reported from virtually every country in the world. There is a growing awareness in many African countries that the Trained Traditional Birth Attendants (TTBAs) have a major role to play in the transmission and prevention of HIV and AIDS. This is because of the bigger proportion of TTBAs attending to mothers at birth compared to trained health workers. The purpose of the study was to determine the knowledge, attitudes and practices of TTBAs on HIV/ AIDS transmission and prevention. A cross sectional survey was conducted. The study population consisted of 64 TTBAs from Kosirai Division, Nandi Central, Kenya. Structured questionnaires were used to collect data on knowledge, attitudes and practices on HIV/AIDS transmission and prevention from August 15 to September 11, 2008. The study revealed that TTBAs had good knowledge, tend to have positive attitudes, and safe practices on HIV/AIDS transmission and prevention. There exist significant relationships between knowledge and practices ($p=.018$), and practices and attitudes ($p=.022$) of TTBAs on HIV/AIDS transmission and prevention, but there is no significant relationship between knowledge and attitudes ($p=.994$) of TTBAs on HIV/AIDS transmission and prevention. Considering the roles of TTBAs in maternal child health as revealed by this study, the study therefore recommends to the government and non-governmental organizations to appreciate the role of the TTBAs in health care delivery system.

Key words: Traditional Birth Attendant, HIV/AIDS, Africa, knowledge, attitudes and practices.

Introduction and Literature Review

HIV infection is a common health problem complicating pregnancy in many countries. The severity of Mother-To-Child Transmission (MTCT) problem in Sub-Saharan Africa is due to high rates of HIV infections in women of reproductive age (UNAIDS, 2010). In 2010 around 390,000 children under 15 years of age became infected with HIV, mainly through Mother-To-Child Transmission globally (WHO, 2011). About 90% of children living with HIV reside in Sub-Saharan Africa. Where in the context of high mortality rates, AIDS account for 8% of all under-five deaths in the region. Around 15-30% of babies born to HIV infected mother will become infected during pregnancy and delivery. A further 5%-20% will become infected during breastfeeding (UNAIDS, 2010).

According to UNAIDS (2010), Kenya's statistics indicated that an estimated 180,000 children were living with HIV in 2009, with approximately 19,000 new child infections in 2010. It is believed that these high rates account for the high infant mortality rates in Kenya.

In many sub-Saharan countries of Africa it has been acknowledged that traditional birth attendants still conduct a high number of deliveries in their communities. This is because of the significant proportion of trained traditional birth attendants (TTBAs) attending to mothers at birth compared to trained health workers (Ministry of Health Kenya, 2001). There is a growing awareness in many African countries that trained traditional birth attendants have a major role to play in the prevention of HIV/AIDS (Silbey et al., 2007), therefore prevention services for pregnant women must continue to grow as HIV transmission from MTCT is still high; an estimated 1 in every 5 babies born to HIV- infected mothers are infected.

The Kenya Integrated Household Budget Survey (KIHBS) as noted in Ministry of Medical Services (2008) reported a survey conducted in 2006 to determine the number of women who delivered in Kenya's health facilities after attending antenatal clinic and those who were delivered by the TBAs. The results revealed that about 54% of births in Kenya occurred at home, 28.5% of pregnant women were assisted during childbirth by nurses or midwives, 10.5% were assisted by doctors, 27.4% were assisted by untrained traditional birth attendants, 11.7% were assisted by trained birth attendants and 7.3% of the

women delivered by themselves at home. Similar findings were obtained by the Kenya Demographic Health Survey (KDHS) conducted in 2003 (Ministry of Health, 2003), which indicated that almost 60% of all births in Kenya occurred at home. Forty two percent (42%) of pregnant women were assisted during childbirth by doctors or midwives, while 28% were assisted by TBAs and 8% delivered by themselves at home.

While a need assessment study of TBAs serving one area of Kenya was conducted for the purpose of designing an appropriate intervention program (Solomon & Rogo, 1989), persistence and challenges of homebirths (Izugbara et al., 2008; Izugbara & Ngilangwa, 2010), no studies have been done to determine the knowledge, attitudes and practices of TTBAs on HIV/AIDS transmission and prevention in Kenya. The purpose of this study was to determine the knowledge, attitudes and practices of trained traditional birth attendants on HIV/AIDS transmission and prevention.

A traditional birth attendant may be defined as a self-developed community practitioner who assists in the management of the mother during pregnancy, labor, delivery, postnatal period and care of the baby (Ministry of Health Kenya, 2001). According to Mathole (2005), TBAs regarded themselves as counselors, community teachers and advisors of women and pregnant women in particular. A trained traditional birth attendant is one who is empowered with necessary knowledge and skills such as early recognition of obstetric complications and referral, prevention of HIV transmission from mother-to-child (Shangase et al., 2006).

According to Sibley and Sipe, (2006) the broad goals of TBAs' training programs are to reduce maternal and child mortality and morbidity and improve the reproductive health of women. The objectives include: enhancing the linkages between the modern health system and community, increasing the number of TTBAs attended births, and improving the skills and stature of TBAs.

The Government of Kenya, through the Ministry of Health, developed the first curriculum for traditional birth attendants (TBAs) in 1981 and revised it in 1991 and 2001. This was done with the aim of adopting a primary health care approach to attain Health for all by the year 2000. The curriculum was also developed because mothers and children were a priority target group and safe delivery was an important objective. Traditional birth attendants were thus an important

resource for the achievement of better health for all (Ministry of Health Kenya, 1991).

According to safe motherhood policy alert No. 4, (2003) and Mulama (2006), it is noted that the ministry of health is working on setting a code of practice for them to ensure that TTBA's operate within the set standards.

Kenya's second National Health Sector Strategic Plan (NHSSP II-2005-2010) defined a new approach to the way the sector will deliver health care services to Kenyans. It is mentioned that the Kenya Essential Package for Health (KEPH) introduced six life - cycles cohort and six service delivery levels. One of the key innovations of KEPH is the recognition and introduction of level 1 service, which are aimed at empowering Kenyan households and communities to take charge of improving their own health. The level 1 care unit was established to serve a local population of 5,000 people constituting a cadre of well trained community-owned resource persons (CORPs), among whom trained traditional birth attendants are included. These CORPs will work under the supervision of the Community Health Extension Workers (Ministry of Health, 2006).

Silbey and Sipe (2004) reported that in the 1990's it became widely accepted that training of traditional birth attendants was likely to cause reduction in maternal mortality, but due to lack of evidence to demonstrate that trained traditional birth attendants can reduce maternal mortality led to controversy over training in relation to safe motherhood and a policy shift to skilled birth attendants (Sibley & Sipe, 2006). Recent reviews suggest that training of TBAs may improve their knowledge, attitudes and behavior, according to Saravana et al., (2011), where the practices of trained traditional birth attendants and untrained were compared. The results indicated positive post training practices.

TBAs in Zimbabwe have been incorporated into the health care system and are trained on imparting biomedical knowledge and skills in maternal health care such as identifying and referring women at risk. The training is expected to strengthen the role of TBA in reducing maternal and infant mortality and morbidity through improved practices. Mathole (2005), however, reported that the TBAs expressed the dilemmas and challenges faced when implementing the skills acquired. For example, referring women categorized as being at risk because of lack of transportation, transport costs and unpleasant encounters with professional providers.

To strengthen the collaboration between traditional birth attendants and the Department of Health, the South African government developed a training curriculum on traditional birth attendants and HIV/AIDS. The training manual was piloted and evaluated in a number of training sessions in the Eastern Cape. The South African manual went on to state that TTBA's have the potential to improve maternal and neonate health at community level. The role of traditional birth attendants in caring for pregnant women and conducting deliveries is acknowledged because home deliveries are still prevalent (40%-50%) in some parts of South Africa. Moreover, home deliveries still contribute to a certain percentage of maternal deaths (Shangase et al., 2006).

The tasks of a TTBA as listed in Kenya (Ministry of Health, 2001; 2003; Mathole, 2005; Silbey et al., 2007) include the following: conducting deliveries in case of emergency, help with initiating breastfeeding, providing information on reproductive health and nutrition, and visiting mothers during and shortly following delivery making and keeping record and reports of number of deliveries, and perinatal deaths, prevention of STI/ HIV and AIDS by promoting awareness to mothers and family on the need to prevent and control STI/ HIV and AIDS.

Interestingly, as noted by Cotter et al., (2006), a minority of women believe that child birth-related complications are caused by witchcraft, and TBAs are perceived as better equipped to intervene in these cases. The health facility is perceived to be a harsh setting for child birth. Whereas the TBA stays with the mother and helps her to deal with the pain, the skilled birth attendants at the health facility leave the mothers alone during their labor pains (Cotter et al., 2006). According to Tami et al. (2011), recent study in Bangladesh indicated that 88% of deliveries occur at home. Renewed interest in community-based approaches and the urgent need to improve birth care has necessitated a re-examination of how provider training should be conducted and evaluated.

Materials and Methods

A quantitative, descriptive survey design was used in this study to collect and analyze data on TTBA's knowledge, attitudes and practices on HIV/AIDS.

The knowledge, attitudes and practices (KAP) surveys were originally developed to assist in the development and implementation of family planning programmes (Katzenellenbogen et al., 2005). The

extensive use of these surveys in the field population led to the concept of the KAP gap. KAP surveys have been applied in a wide range of problems, including tobacco and alcohol consumption, adherence to medications schedules, use of preventive health services, and traffic safety. These kind of surveys re-emerged strongly in the 1980s in response to the need to curb and prevent the spread of HIV infections. The eruption of AIDS pandemic called for the need to get baseline information to measure the outcome of intervention.

The target population comprised of 104 trained traditional birth attendants of Kosirai Division, in Nandi North District, Rift Valley province of Kenya, part of the division is situated along Eldoret- Kisumu road, latitude 0.28 degrees and longitude 35.1 degrees. This district covers an area of approximately 195 square km with a population of 45,765 thousand as per 2008 estimates /census. All the TTBA's who are trained on conducting safe deliveries and on HIV/AIDS prevention and are working under one organization called Academic Model for the Prevention and Treatment of HIV/AIDS (AMPATH) were included, based on the register kept by their coordinator.

Since the population of trained traditional birth attendants is not very large (104), the total population was used as the sample for the study so as to have a full representation and to make more accurate conclusions as suggested by De Vos et al., (2005). Thirty (30) TTBA's participated in the pilot study. From the remaining population of 74 TTBA's, 64 TTBA's consented to participate in the study. It is not easy to tell why the remaining 10 did not participate in the study because the respondents have autonomy to participate, and others did not turn up when the questionnaire was being administered.

The study utilized a structured questionnaire to expose depth of knowledge, attitudes and practices of respondents concerning HIV/AIDS transmission and prevention. The questionnaire was self administered and researcher assisted in cases where TTBA's were unable to interpret the questions because of their level of formal education (Mugenda & Mugenda, 2003), the questionnaire was interpreted with the assistance of the AMPATH training coordinator who spoke the same language with the participants.

The questionnaire contained knowledge questions on modes of transmission of HIV, risk of transmission related to the services they render to the community and whether there is cure to infections

due to HIV/AIDS or not. The attitudes of the TTBA's towards the infected persons and HIV/AIDS preventive practices that they utilize during prenatal, natal and post natal period were addressed.

A pilot study was conducted in June, 2008 utilizing 30% of the TTBA's population from the same study population. The data from the pilot study was used to establish the reliability of the questionnaire using the Cronbach alpha coefficient (Tredoux & Durrheim, 2002). The reliability coefficient of 0.5330, 0.4075 and 0.4813 were obtained for knowledge, attitudes and practice respectively. The scores were probably low because the study sample was homogeneous, that means the TTBA's had the same characteristics that they had been trained on PMTCT of HIV/AIDS. Since the score was low for all the three variables of knowledge, attitudes and practices, some questions in the questionnaire were removed and others were modified to raise reliability to an acceptable level.

To ensure consistency, all respondents received the questionnaires at the same time during their monthly meetings, after the research had been explained and their consent obtained.

Prior to conducting the study, permission was obtained from the Ministry of Education, District Medical officer of Health Nandi North District and District Educational officer, Nandi North District and the office of graduate studies at University of Eastern Africa, Baraton.

Consent was obtained from the TBAs participating in research in order for them to make an informed decision about participating or not. An informed consent contained the purpose to the research study, any foreseen risks if any, a guarantee of anonymity and confidentiality, identification of the researcher, benefits and compensation or lack of them.

Results

Sixty four (64) participated in the study. This was a response rate of 86.4%. All the participants in the study were female.

The minimum age grouping of the trained traditional birth attendants is 21-30 years (3.1%) and the majority of respondents were over 51 years (64.1%). Majority (53.1%) had worked as TTBA's for over twenty one (21) years. Forty one (41) TTBA's, which account for sixty four point one percent (64.1%), attained primary school level of education only while twenty one point nine percent (21.9%) did

not have any formal education.

Thirty four (34) TTBA's (53%) were trained less than 6 months earlier. Sixteen (16) TTBA's (25%) were trained between seven (7) to twelve (12) months earlier. Eleven (11) TTBA's (17.2%) were trained more than nineteen (19) months prior to the study. Ninety point six percent (90.6%) of TTBA's knew their HIV/AIDS status while nine point four (9.4%) did not know.

Figure 1 indicates the number of deliveries conducted by respondents and number of referrals sent to the health facilities per month. From these findings, TTBA's in Kosirai Division conduct between 54-270 deliveries in a month and refer 52-270 women in labor to health facilities every month.

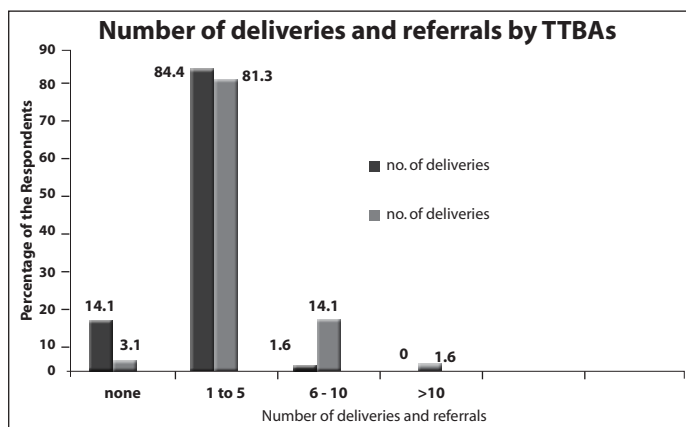


Figure 1

TTBA's number of deliveries and referrals. (N=64)

Knowledge of HIV and AIDS

The average knowledge level of participants was 3.97 (out of 4.0 scale) with a standard deviation of 0.43. Table 1 indicates TTBA's aspects of poorest knowledge. The items on which more than 2% of TTBA's gave an incorrect response are listed. Two of these items dealt with the issue of a cure (4 and 17), three dealt with anti-retroviral therapy (15, 16 and 17), while another three dealt with prevention and transmission (5, 7 and 19). Three of the items dealt directly with pregnancy and childcare (18, 20 and 21).

While more than 80% of TTBA's reflected positive attitudes on 5 and 9 items, a larger group (62.5%) were afraid of contracting HIV from infected mothers (item 2), while at the same time believing they were less likely than other people to contract HIV (39.1% in item 4).

The fear of contracting HIV might also explain

why many of them (31.3% in item 5) would rather work with other diseases. The very punitive attitude about sex in item 3 was held by the majority (51.6%) of the TTBA's.

Table 1

Knowledge of TTBA's on HIV/AIDS in Kosirai division

Item	Statement of knowledge	Yes	No
1	HIV is a virus that lives in the human body cell	100%	
2	HIV is transmitted from one person to another	98.4%	1.6%
3	HIV weakens the immune system, which fights infection in the human body	98.4%	1.6%
4	HIV infection cannot be cured	95.3%	1.6%
5	Sex abstinence the risk of contracting HIV from person to person	95.3%	4.7%
6	Being faithful to one partner reduces the risk of contracting HIV	98.4%	1.6%
7	Using a condom during sex reduces the risk of contracting HIV	95.3%	4.7%
8	Sexually transmitted infections increase the possibility of HIV transmission	100%	
9	The only way to know for sure that someone has HIV is to get a test done	100%	
10	Unsafe or unprotected sexual intercourse is the most common mode of HIV transmission	100%	
11	HIV is transmitted through contaminated blood or blood products	98.4%	1.6%
12	HIV can be transmitted from infected mother to the child through breastfeeding	100%	
13	HIV can be transmitted from infected mother to the child during child birth process	98.4%	1.6%
14	Anti-retroviral therapy lowers the amount of virus in the body	98.4%	1.6%
15	Anti-retroviral therapy increases the number of immune cells to help fight infections	96.9%	3.1%
16	Anti-retroviral therapy must be taken for the rest of the person's life or virus can grow stronger	98.4%	1.6%
17	Anti-retroviral therapy does not cure HIV	93.8%	6.3%
18	Exclusive breast feeding for the first six months, then stopped at once and start the baby on other feeds reduces the risk of contracting HIV/AIDS from mother to child.	90.9%	9.4%
19	A person can be infected with HIV/AIDS but not have symptoms	89.1%	10.9%
20	Offering anti-retroviral therapy in pregnancy to HIV infected mother reduces Mother-To-Child Transmission of HIV	96.9%	3.1%
21	Offering anti-retroviral medication during labor to HIV infected mother reduces Mother-To-Child Transmission of HIV	93.8%	6.3%

Table 2

Attitudes of TTBA's on HIV/AIDS in Kosirai division

	Statement of attitudes	Disagree	Tend to disagree	Tend to agree	Agree
1	I could not conduct a delivery to a known HIV infected mother	82.80%	1.60%	1.60%	14%
2	I am afraid of contracting HIV from infected expectant mother	34.40%	1.60%	1.60%	62.50%
3	People infected with HIV should not have sex	45.30%	3.10%		51.60%
4	I am less likely than most people to get HIV	57.80%	3.10%		39.10%
5	I would rather conduct a delivery of a mother suffering from other diseases than HIV/AIDS	64.10%	3.10%	1.60%	31.30%
6	I have heard enough about HIV/AIDS and I don't want to hear anymore about it	85.90%			14.10%
7	Radio programs on HIV/AIDS should be aired more often	7.80%			92.20%
8	People with HIV/AIDS are already dead and they should not be given ARVs or any treatment	90.60%			9.40%
9	I am comfortable discussing with someone about HIV/AIDS	6.30%			93.80%

From the summary on table 3, it would seem that more than 90% of TTBA's report safe practices with regard to HIV. The one exception is the education of women about safe feeding options (item 8) which is at 82%.

Correlation of TTBA's Knowledge Attitudes and Practices on HIV and AIDS.

The correlation statistics indicated that there was a positive relationship between TTBA's knowledge and their practices (p=.018) on HIV/AIDS transmission and prevention. Additionally, there was a positive relationship between TTBA's practices and their attitudes on HIV/AIDS transmission and prevention (p=.022). The correlation coefficient of 0.284 and 0.286, for knowledge and practices; attitudes and practices respectively suggested a weak relationship. However the relationship was significant. There was no significant relationship between the TTBA's

Table 3

Practices of TTBA's on HIV/AIDS.

	Statement of practice	Never	Rarely	Sometimes	Always
1	I use new blade in conducting each delivery	1.60%	1.60%	4.70%	92.20%
2	I conduct deliveries with gloved hands	1.60%	1.60%	3.10%	93.80%
3	I educate expectant mother at term to carry gloves with them all the time in case of emergency delivery while not at health facility.		3.10%	3.10%	93.80%
4	I educate every pregnant woman to go for HIV/AIDS testing	1.60%		1.60%	96.90%
5	I promote condom use during pregnancy to infected spouses to prevent re-infection with HIV/AIDS	1.60%	4.70%		93.80%
6	I refer primigravidas for antenatal services		3.10%		96.90%
7	I offer information on safer sex practices to prevent HIV/AIDS infection in pregnancy	1.60%	3.10%	1.60%	93.80%
8	I educate infected pregnant mothers on infant feeding options	9.40%	4.70%	3.10%	82.80%
9	To reduce Mother-To-Child Transmission of HIV, I wipe away secretions from the baby's face.	1.60%			98.40%
10	To reduce Mother-To-Child Transmission of HIV, I reduce trauma to the mother during delivery				100%

knowledge and their attitudes on HIV/AIDS transmission and prevention (p=.994). See table 4.

Discussion and Recommendations

Doyle & Ward (2001) observed that individual behavior is driven by a multitude of influencing factors. Immediate influences come from personal knowledge, attitudes and beliefs as well as confidence in one's ability to perform a particular health behavior. Whereas Katzenellenbogen et al., (2005) asserted that there is a weak connection between knowledge, attitudes, beliefs, and behavior, the research findings indicate that there is a weak connection but significant relationship between knowledge and practice, attitudes and practice. In support of these findings, Green and Kreuter (1991) have explained that health knowledge of some kind is necessary before a conscious personal health action can occur. The desired health action will

probably not occur unless a person receives a cue strong enough to trigger the motivation to act on that knowledge.

Table 4

Correlation of KAP OF TTBA's on HIV/AIDS

Correlations					
			Meanknow	Meanprac	Meanatti
Spearman's rho	Meanknow	Correlation Coefficient Sig. (2-tailed) N	1.000 64	0.294* 64	0.001 64
	Meanprac	Correlation Coefficient Sig. (2-tailed) N	0.294* 0.018 64	1.000 64	0.286* 0.022 64
		Correlation Coefficient Sig. (2-tailed) N	0.001 0.994 64	0.286* 0.022 64	1.000 64

*. Correlation is significant at the 0.05 level (2-tailed)

Increased knowledge may not always result immediately in a change of behavior or practice but will eventually lead to a change due to value system of a person.

Downie et al., (1996) defined attitude as a 'learned predisposition' (p. 121) in that it might be changed as a result of consciously acquired knowledge, and understanding. This may not however be the case always since 'attitudes are not necessarily consciously learned predispositions. Rather, they might sometimes be more accurately said to be acquired'. Downie et al., (1996) also stated that the relationship between behavior and constructs such as attitudes, beliefs, and values though not completely understood, give ample evidence of their association.

From these research findings, it is clear that there is no relationship between TTBA's knowledge on HIV/AIDS and their attitudes. For example 98.4% of the respondents agreed that ART lowers the amount of virus in the body of the HIV infected person, but surprisingly a lower percentage of 90.6% indicated that people with HIV/AIDS should be put on ART. A notable 9.4% stated that there is no need for them to be put on ART. It was expected that an equivalent number of the respondents (98.4%) would advocate that the HIV infected persons be put on ART, but not lower given that they are trained on the importance of ART to HIV infected persons.

The majority of the TTBA's are over the age of 51 with more than 21 years of experiences as traditional birth attendants in their communities. With little or no formal education, TTBA's interact with expectant mothers, conduct a significant number of deliveries and refer a substantial number of expectant mothers to hospital facilities for antenatal care and for safe delivery every month. It is noteworthy that the

TTBA's are experienced enough to pre-determine if there could be complications.

The majority of TTBA's have good knowledge of HIV/AIDS in general, the mode of transmission, mother to child transmission, anti retroviral therapy, and preventive measures. Similarly, in a study done in South Africa on TTBA's, Peltzer & Henda (2006) showed that TTBA's have good knowledge about HIV/AIDS. The good knowledge was explained by the training TTBA's had received on HIV/AIDS.

The responses indicate that some TTBA's don't have adequate knowledge on infant feeding options available to a mother infected with HIV/AIDS while the majority have adequate knowledge on the use of ART during pregnancy and labor. Inadequate knowledge on exclusive breastfeeding as an infant feeding option available to a mother who is infected with HIV/AIDS poses a risk to children born from HIV infected mothers because the TTBA's will not be in a position to give them the required education on exclusive breastfeeding. The Ministry of Health (2002) guideline on prevention of MTCT of HIV/AIDS has advocated exclusive breastfeeding of the baby for the first six months of life since mixed feeding increases the risk of breast milk transmission of HIV. It is recommended that there is a need to improve TTBA's knowledge on infant feeding options available to a mother infected with HIV.

TTBA's seem to have been afraid of contracting HIV from positive mothers. This may be a realistic fear if they do not have the equipment to protect themselves adequately. TTBA's need to be provided with the necessary delivery equipment to protect themselves so that they can be less afraid of contracting HIV while conducting deliveries.

Conclusion

According to the findings from this study, trained traditional birth attendants have adequate knowledge, tend to have favorable attitudes and safe practices on HIV/AIDS transmission and prevention. There is a positive relationship between TTBA's knowledge and their practices (p=.018) on HIV/AIDS transmission and prevention. Additionally, there is a positive relationship between TTBA's practices and their attitudes on HIV/AIDS transmission and prevention (p=.022). While some African governments have tried to ban TTBA's from practicing, it is evident that TTBA's are indispensable until the African countries manage the problem of its infrastructure and poverty.

It is noteworthy that there is still stigma and discrimination against the HIV/AIDS infected population. The risk of Mother-To-Child Transmission of HIV/AIDS would be reduced if all the expectant mothers were taught on infant feeding options and antiretroviral therapy prophylaxis to their babies in case the mothers are HIV infected when they deliver at home.

In conclusion we can therefore state that TTBA's knowledge on HIV/AIDS did not necessarily change their attitudes towards a person infected with HIV/AIDS, but better knowledge on HIV/AIDS had an influence on their practices on HIV/AIDS transmission and prevention. TTBA's attitudes on HIV/AIDS have a positive relationship on their practices regarding HIV/AIDS transmission and prevention. Considering the roles of TTBA's in maternal child health as revealed by this study and review of other studies, the study therefore recommends to the government and non-governmental organization to appreciate the role of the TTBA's in health care delivery system. Until TTBA's are replaced by skilled birth attendants, they remain the only option to many women of Africa.

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RESPONSE OF THREE MOSQUITO SPECIES TO RECOMBINANT BACTERIAL TOXINS FROM *Bacillus thuringiensis* SUBSP. *israelensis* EXPRESSED IN TWO MODEL SYSTEMS

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Abstract

Toxicity of lyophilized powders prepared prepared 16 combinations of four genes, *cry4Aa*, *cry11Aa*, *cyt1Aa* and *p20* from *Bacillus thuringiensis* subsp. *israelensis* (Bti) expressed in *Escherichia coli* were examined against three mosquito vectors of diseases, *Culex quinquefasciatus* Say, *Anopheles arabiensis* Patton, and *Aedes aegypti* Linnaeus, followed by simulated studies using transgenic *Anabaena* PCC7120 expressing the most toxic combination of genes. The following clones were the most toxic to the three mosquito species: pVE4-ADRC expressing all four genes (LC_{50s} of 0.59, 3.2, and 0.68 µg ml⁻¹); pVE4-ARC expressing *cry4Aa*, *cyt1Aa*, *p20* (LC_{50s} of 0.93, 6.2 and 0.87 µg ml⁻¹), and pVE4-AD expressing *cry4Aa* and *cry11Aa* (LC_{50s} of 1.51, 7.5 and 1.3 µg ml⁻¹). The clone pVE4-ADRC was undoubtedly the most effective. The role of appropriate promoter(s) in enhancing toxicity was demonstrated by comparing expression of the same gene combination under a strong *E. coli* promoter (PA1) either singly, in pVRE4-DRC or two (the second preceding *cyt1Aa* in pVE4-DRC). The latter produced more *Cyt1Aa*, which is less toxic, at the expense of the more toxic *Cry11Aa*, thus reducing toxicity. On the other hand, the combination of toxins under pVRE4-DRC control had an enhanced toxicity. This observation implies that further toxicity fine-tuning could be reached by manipulating promoters to enhance toxicity in recombinant systems. In simulated semi-field experiments, transgenic *Anabaena* PCC 7120 protected the toxins from premature degradation and better delivered the toxins to the larvae compared to commercial Bti preparations.

Key words: recombinant Bti toxins, *A. aegypti*, *An. arabiensis*, *C. quinquefasciatus*, western blot, LC₅₀

Introduction and Literature Review

With the ever-emerging elusive mosquitoes resistant to chemical pesticides (Chandre et al., 1999a; Martinez-Torres et al., 1998) and drug-resistant *Plasmodium* spp. (Björkman & Bhattarai, 2005; Lopes et al., 2002), coupled with emergence of arboviral infections (Gould & Higgs, 2009) and the growing fear of the inter-relation in transmission of various vector-borne diseases, increased efforts in emerging alternative technologies for integration in malaria control are desired.

A powerful environmentally friendly component of this approach is *Bacillus thuringiensis* subsp. *israelensis* (Bti) de Barjac, discovered by Goldberg and Margalit (1977). This soil inhabiting gram-positive bacterium produces a parasporal, proteinaceous crystal (δ -endotoxin) during sporulation. The crystal dissolves upon ingestion by mosquito larvae and its components are cleaved into toxic polypeptides by specific proteases present in the basic larval mid-gut. The active toxins then bind to receptors in the gut epithelium of susceptible species and cause paralysis and death, depending on the concentration used.

Toxin stability and delivery are limiting factors in Bti's efficiency to control mosquitoes in field conditions. It has been demonstrated that the cyanobacterium (blue-green algae) *Anabaena* PCC 7120 expressing the toxin genes is a novel way to simultaneously protect the insecticidal crystal proteins (ICPs) from sunlight inactivation (Manasherob et al., 2002) and from sinking into bottom sediments. *Anabaena* has been used to deliver the toxins to mosquito larvae in simulated semi-field experiments (Manasherob et al., 2003). This system must be field tested for effectiveness in natural mosquito habitats. It is anticipated that this toxin expression and delivery system will contribute to the reduction of mosquito populations and yield a long lasting solution to the prevalence of malaria in the tropics.

Other subspecies of *Bacillus thuringiensis* (Bt) (Bulla et al., 1980), have been characterized by the formation of a parasporal crystal protein (the δ -endotoxin) during sporulation (de Barjac & Sutherland, 1990). Susceptibility is based on the capacity of the target species to dissolve the crystal by specific proteases in the basic larval mid-gut of many species, thus exposing the toxins, which bind to specific receptors on the gut membrane (Yamagiwa et al., 2001; Boonserm et al., 2005, 2006; Fernandez

et al., 2006; Chayaratanasin et al., 2007). Lethality is believed to be due to destruction of the transmembrane potential, with the subsequent osmotic lysis of cells lining the midgut (Knowles & Ellar, 1987).

The toxicity of Bti resides in at least four major ICPs, of 134, 128, 72 and 27 kDa, encoded by the genes *cry4Aa*, *cry4Ba*, *cry11Aa* and *cyt1Aa*, respectively, all mapped on the 128 kb plasmid known as pBtoxis (Ben-Dov et al., 1999; Berry et al., 2002). These ICPs differ in toxicity levels and specificity against different species of mosquitoes (Margalith & Ben-Dov, 2000). Despite the low toxicity of Cyt1Aa against exposed larvae, this protein is highly synergistic with the Cry toxins and their combinations *in vitro* (Crickmore et al., 1995; Wirth et al., 1997; Wirth et al., 2007) due to different modes of action (Butko, 2003). Cyt1 Aa has been found to restore toxicity of *B. sphaericus* against *Culex quinquefasciatus* (Wirth et al., 2000). Cyt1Aa synergizes the Cry toxins when expressed simultaneously in transgenic *E. coli* and *Anabaena* PCC 7120 (Khasdan et al., 2001 and 2003, respectively), and with the heterologous mosquito larvicidal binary toxin of *B. sphaericus* (Wirth et al., 2000a; 2000b; 2005). Various combinations of Bti Cry toxins with Cyt1Aa may be necessary to avoid selection for resistance in the target mosquitoes (Georghiou & Wirth 1997; Wirth et al., 1997; 2007). Bti's limitations can compromise its efficacy in natural environments (Ohana et al., 1987). Expressing cry genes in other model systems may alleviate such limitations by effectively delivering the toxins in optimal combinations to the targets (Margalith & Ben-Dov, 2000).

Advantages and limitations of Bti in biocontrol of mosquitoes

Biological control agents active against mosquito larvae include several species of fish, nematodes, fungi, protozoa, viruses and bacteria (Scholte et al., 2004; Floore, 2006; Lacey, 2007; Futami et al., 2011). Bti was the first subspecies of *Bt* found to be toxic to dipteran larvae, and is much more effective against many species of mosquito and black fly larvae than any previously known bio-control agent. It is highly specific and hence safe to the environment (Murthy, 1997). No resistance has been detected to-date toward *Bti* in field populations of mosquitoes, despite over three decades of extensive field usage (Margalith & Ben-Dov, 2000). It has therefore been integrated into many vector control

programs worldwide.

Application of Bti for mosquito control is limited by short residual activity of current preparations under field conditions. The major reasons are: (a) sinking of the protoxin to the bottom of the water body (Manasherob et al., 2003); (b) adsorption onto silt particles and organic matter (Ohana et al., 1987); (c) consumption by non-target/non-susceptible aquatic organisms; (d) inactivation by sunlight (Hoti & Balaraman, 1993; Liu et al., 1993). Furthermore, the persistence of Bti elements in the environment may have the potential to induce resistance in mosquitoes (Tiquin et al., 2008; Paris et al., 2011). Efforts are being made to improve effectiveness of Bti by prolonging its activity, as well as by targeting delivery of the active ingredient in the larval feeding zone. These improvements are being facilitated by development of new formulations utilizing conventional and advanced tools in molecular biology and genetic engineering. It is also necessary to develop culture conditions for Bti that maintain the integrity of the protoxin when used in the conventional way for mosquito control (Otieno-Ayayo et al., 1993). The strategy of transferring Bti's toxin genes for expression into alternative hosts that are eaten by mosquito larvae is much safer and more economical than chemical insecticides. These alternative hosts may also multiply in their habitats to prolong the effectiveness of the Bti application.

Activity of the Insecticidal Crystal Proteins (ICPs) from Bti

The polypeptides and their genes

The larvicidal activity is produced by several ICPs organized in a parasporal, proteinaceous (δ -endotoxin) synthesized during sporulation (de Barjac & Sutherland, 1990). The specific mosquitocidal properties are attributed to complex, synergistic interactions between three proteins (Poncet et al., 1995), Cry4Aa (125 kDa), Cry4Ba (130kDa) and Cry11Aa (68-72 kDa) (Donovan et al., 1988; Höfte & Whitley, 1989), and the non-specific Cyt1Aa, which is hemolytic and cytotoxic (Höfte & Whiteley, 1989; Tabashnik, 1992; Crickmore et al., 1995; Poncet et al., 1995). At least one accessory protein, P20, involved in δ -endotoxin production (Visick & Whiteley, 1991; Xu et al., 2001; Shao & Yu, 2004), seems to stabilize both Cyt1Aa and Cry11Aa in recombinant *E. coli* and Bt by a post-transcriptional

mechanism, probably protection from proteolysis by interaction with Cyt1Aa while the latter is synthesized (Visick & Whiteley, 1991; Wu & Federici, 1995). In addition, it stimulates production of Cry4Aa in recombinant *E. coli* (Yoshisue et al., 1992). All genes involved with δ -endotoxin production are located on the 128 kb (pBtoxis) plasmid (Ben-Dov et al., 1999; Berry et al., 2002), have been cloned and expressed, their sequences deciphered and toxicities examined (Margalith & Ben-Dov, 2000).

Mode of action of toxins

The toxicity of the ICPs has been demonstrated through applications to the larval mid-gut (Gill et al., 1992; Knowles & Dow, 1993). A two-step model was proposed for the action of Bt processed toxins (Knowles & Ellar, 1987): binding to midgut cell receptors (Van Rie et al., 1990; Yamagiwa et al., 2001; Feldmann et al., 1995) and pore formation disrupting membrane permeability. Consequently, an uncontrolled efflux of ions, which disturbs the osmotic equilibrium, leading to colloid osmotic cytolysis (Knowles & Ellar, 1987).

Synergistic interactions of toxic polypeptides

The ICPs differ qualitatively and quantitatively in their toxicity levels and against different species of mosquitoes (Poncet et al., 1995). The crystal complex is much more toxic than each of the polypeptides alone. Various combinations of toxins are necessary to avoid selection for resistance in the targets (e.g., Wirth et al., 1997), and expression of such in other model systems is necessary to alleviate limitations in delivering the toxins to the targets. Synergism among Bti proteins has been demonstrated and widely studied (Wu and Chang, 1985; Poncet et al., 1994). All combinations of the three Cry proteins against three mosquito species had different synergy factors of between 2.5 - 15 (Crickmore et al., 1995; Poncet et al., 1995). The three Cry toxins were much more toxic than *Cyt1Aa* (Poncet et al., 1995; Delecluse et al., 1991), but Cyt1 Aa was the most synergistic to any of the three Cry proteins and their combinations (Tabashnik, 1992; Canton et al., 2011). The Cyt1Aa concentration-response curve was different from those of the Cry toxins, indicating different mechanisms of action (Crickmore et al., 1995). Synergism has also been demonstrated between Bti's *cyt1Ab* and *B. sphaericus* toxins (Wirth et al., 2001a). This suggests that the host range of a selected model system can be expanded by the interaction of gene combinations

across species.

A number of laboratory studies have shown levels of resistance to specific combinations of genes (Wirth & Georghiou, 1997; Wirth et al., 1997; Wirth et al., 1998). Information of this type is important in determining optimal larvicidal gene combinations for vector management. According to Wirth et al. (2001b), cross-resistance does not exist between cry19 of *B.t.* subspecies *jegathesan* and single or multiple *Bti* toxin genes.

Selecting alternative model systems *Escherichia coli*, a molecular biology tool for recombinant protein production

The Gram negative bacterium, *E. coli*, is one of the most widely used hosts for the production of heterologous proteins (Baneyx, 1999) because its genetics, biochemistry, and metabolic pathways are far better understood than those of any other microorganism (Terpe, 2006). *E. coli* is thus widely used for recombinant protein production for industrial and research applications.

Anabaena PCC 7120

The organisms considered for toxin delivery should multiply in mosquito-breeding habitats, produce the toxic proteins efficiently, protect them from degradation, and efficiently deliver them to the larvae. Photosynthetic cyanobacteria are attractive candidates for this purpose (Boussiba & Zaritsky, 1992; Boussiba et al., 2000). They are ubiquitous, float in the upper water layer and resist adverse conditions (Porter et al., 1993). They are used as natural food sources for mosquito larvae (Merritt et al., 1992; Avissar et al., 1994) and can be genetically manipulated (Shestakov & Khyen, 1970; Wolk et al., 1984). Strain PCC 7120 of *Anabaena* species, the delivery system used in this study, is non-toxic and does not produce toxic blooms (Rouhiainen et al., 1995).

The suitability of *Anabaena* PCC 7120 is due to the following advantages (from Margalith and Ben-Dov, 2000):

- Multicellular organisms such as *Anabaena* more efficiently deliver toxicity than unicellular because larger amounts of toxin are carried in a single aggregate.
- The high copy number of the *Escherichia coli*-*Anabaena* shuttle plasmid raises the number of gene copies per cell. Tandem promoters—the transcription rate, and appropriate Ribosome Binding Site (RBS)—improve translation

efficiency in the transgenic organism.

- Codon usage of *Anabaena* sp. resembles that of *Bti* for the four cry genes.

Materials and Methods

Media

All media used in this study were autoclaved 20 min at 121°C, 1.5 Atm, and filter sterilized. Antibiotics were added after the media cooled to approx. 40°C when required. All liquid media were solidified with 1.5% bacteriological agar when required.

LB Medium

This complex, undefined medium was used for *Bti* and *E. coli* and consisted of 1% Bacto Tryptone, 0.5% Yeast Extract, 1% NaCl.

BG-11 Medium

This defined medium for *Anabaena* PCC 7120 consisted of the following (in mM): 17.65 NaNO₃, 0.18 K₂HPO₄, 0.3 MgSO₄, 0.25 CaCl₂, 0.19 Na₂CO₃, 0.003 Na₂Mg EDTA, 0.029 citric acid, and 0.03 ferric ammonium citrate, pH8, and the following trace minerals (in μM): 46 H₃BO₃, 0.17 Co(NO₃)₂, 0.32 CSO₄, 9.2 MnCl₂, 1.6 Na₂MoO₄, and 0.77 ZnSO₄.

Pharma medium

This is a cottonseed-derived protein nutrient from Southern Cotton Oil Company (POB 80367, Memphis, TN 38108, USA) used for rearing *Ae. aegypti*. Powder was suspended in distilled water at a concentration of 1.5g L⁻¹ and autoclaved.

Microorganisms

Strains of (cyano)bacteria

Plasmids and the cloned *Bti* genes are listed in Table 1.

Bacterial storage conditions

For routine use over short periods, bacteria were inoculated onto fresh LB agar plates, incubated at 37°C overnight and stored at 4°C. The bacteria were sub-cultured into fresh plates every two months. For extended storage, *E. coli* were cultured to mid-log phase in liquid LB medium and then stored in well-mixed aliquots containing 20% glycerol (200 μl into 400 μl freshly concentrated culture) at -86°C.

Table 1

Plasmids used in this study: List of transgenic E. coli clones used in this study. All the clones were transformed to XL-Blue MRF', a commercial clone from clone library.

Plasmid	<i>Bti</i> gene(s) cloned	Source/Reference
pHE4-A	<i>cry4Aa</i>	Ben-Dov et al., 1995
pVE4-AC	<i>cry4Aa, cyt1Aa</i>	Khasdan et al., 2001
pVE4-AD	<i>cry4Aa, cry11Aa</i>	Ben-Dov et al., 1995
pVE4-ADC	<i>cry4Aa, cry11Aa, cyt1Aa</i>	Khasdan et al., 2001
pVE4-ADR	<i>cry4Aa, cry11Aa, p20</i>	Ben-Dov et al., 1995
pVE4-ADRC	<i>cry4Aa, cry11Aa, p20, cyt1Aa</i>	Khasdan et al., 2001
pHE4-AR	<i>cry4Aa, p20</i>	Ben-Dov et al., 1995
pVE4-ARC	<i>cry4Aa, p20, cyt1Aa</i>	Khasdan et al., 2001
pRM4-C	<i>cyt1Aa</i>	Manasherob et al., 2001
pHE4-D	<i>cry11Aa</i>	Ben-Dov et al., 1995
pVE4-DC	<i>cry11Aa, cyt1Aa</i>	Khasdan et al., 2001
pHE4-DR	<i>cry11Aa, p20</i>	Ben-Dov et al., 1995
pVE4-DRC	<i>cry11Aa, p20, cyt1Aa</i>	Khasdan et al., 2001
pVRE4-DRC	<i>cry11Aa, p20, cyt1Aa</i>	Khasdan et al., 2001
pHE4-R	<i>p20</i>	Ben-Dov et al., 1995
pRM4-RC	<i>p20, cyt1Aa</i>	Manasherob et al., 2001
pUHE24	-	Deuschle et al., 1986 (via S.Leu)

Storage as lyophilized powder

Bacteria grown for expression of larvicidal protein toxins were harvested by centrifugation, washed and overnight freeze dried in a LABCONCO 2.5 Plus FreeZone freeze-drier (LABCONCO Corporation, Kansas City, Missouri), operating at maxima of 0.009 Torr, and -85°C (at the lower level).

Storage of competent cells

Competent cells were stored in 0.1 M CaCl₂ buffer at 4°C for less than a month. Usually these cells were used after overnight storage or at least within a week.

Bacterial growth conditions

E. coli plasmid isolation

For plasmid DNA isolation and purification, *E. coli* cells were grown in 5 ml LB medium containing appropriate antibiotics) in test tubes incubated at 37°C with shaking at 200 rpm in a shaker incubator. Bacteria were harvested after overnight culture and used for plasmid isolation.

Competent E. coli cells preparation

Presumed host bacteria were cultured on LB agar (without antibiotics) overnight and a single colony was transferred to a starter tube containing 5

ml LB medium. These tubes were cultured at 37°C, 200 rpm to mid log phase and diluted 1:150 into a flask culture maintained in same conditions up to OD₆₀₀ of 0.2-0.5 nm before harvesting and processing for competence.

Expression of Bti toxin genes in transgenic E. coli

Media for recombinant *E. coli* strains were supplemented with 100 µg ml⁻¹ Ampicillin (Amp), 10 µg ml⁻¹ Tetracyclin (Tet), 10 µg ml⁻¹ Chloramphenicol (Cm) (when required). A colony was inoculated into a test tube containing 5 ml LB and incubated overnight in a shaker (250 rpm) at 37°C. The cultures were diluted (1:150) into 250 ml flasks containing 30 ml medium, brought to exponential growth phase after about 2h (determined by spectro-photometry), and diluted (1:150) into 2 liter flasks containing 600 ml medium. Induction with IsoPropyl-β-ThioGalactoside (IPTG) to a final concentration of 0.1 mM was done at the exponential stage. The bacteria were harvested by centrifugation after 12 hr and washed twice with double distilled water. The resultant paste was freeze-dried overnight and ground into fine powder for bioassay.

Anabaena PCC 7120 and the recombinant strain

Anabaena PCC 7120 and its recombinant

clone (pSBJ2 # 11; containing toxicity of 6 AA ITU mg⁻¹) expressing *cry4Aa*, *cry11Aa* and *p20* from *Bti*, were cultured as described by Khasdan et al., (2003) and Manasherob et al., (2003). For bioassays, 2.5 L glass columns were used (30°C) under continuous illumination (85 μmol photon m⁻² sec⁻¹) and furnished with air containing 1.5% CO₂.

Microbial growth measurements

Bacteria

Growth of *E. coli* and *Bti* was measured by introducing 1 ml of culture into a disposable micro-cuvette and measuring optical density using UVIKON 860, Software Version 8611 (from Kontron Instruments, supplied by Lumitron Electronic Instruments Ltd, Israel) at OD₆₀₀ nm. Alternatively, a Klett-Summerson colorimeter was used to determine cell density in Klett Units.

Cyanobacteria

Cyanobacterial growth was determined by estimating chlorophyll-a (Mackinney, 1941). A blank reading was set with distilled water. 200 μl of sample was added to 800 μl methanol and mixed by hand before incubation at 70°C for 2 min. The mixture was then centrifuged at 13,000 rpm for 1 min. The optical density of the supernatant was determined at 665 nm for chlorophyll-a. The chlorophyll-a content was calculated using the equation: C (μg ml⁻¹) = OD₆₆₅ * Dilution factor * 13.9.

Recombinant DNA methods

Standard molecular techniques (Sambrook et al., 1989) were applied in most procedures.

Preparation of competent cells

Cells harvested from above mentioned culture conditions were cooled in ice for 10 minutes. They were then harvested by centrifugation at 350 rpm for 5 minutes at 4°C, and washed twice in ice-cold 0.1 M CaCl₂ before concentrating 50-100 times in the same solution. For increased competence, the cells were stored overnight at 4°C before use.

E. coli plasmid DNA isolation and purification

E. coli plasmid DNA was isolated and purified from 5 ml of culture using QIAprep®Spin Mini prep kit (from QIAGEN, supplied by Westburg (Israel) Ltd) following the instructions from the supplier. Plasmid DNA concentration and purity was determined by capillary method using GeneQuant

spectrophotometer from Amersham Biosciences. Procedures were according to the user manual.

Transformation of *E. coli* cells by heat-shock method

In a sterile Eppendorf tube, 1 μl of plasmid vector DNA was mixed with 50-100 μl of overnight competent cells and incubated on ice for 2 min. The cells were then heat shocked by transferring the tube to a 42°C heat system for 2 min followed by incubation on ice for 2 min. To the heat-shocked cells was added 1 ml of LB medium without antibiotic and the tube incubated for 1 hr at 37°C. 100 μl of the cells were plated on LB agar plates containing appropriate antibiotics and incubated at 37°C overnight.

Protein and biochemical methods

Purification of Bti Crystals

Bti crystals were separated from spores and purified by the method of Otieno-Ayayo et al., (1993), modified from Pendleton and Morrison (1966). When large quantities were purified, the spore/crystal complex was processed in a blender rather than by vortexing.

Processing of recombinant *E. coli* strains for protein analysis

Culture and sonication of cells

E. coli strains were cultured and induced as described earlier, harvested and washed. The biomass was concentrated 25-fold and disrupted by sonication (SONICS vibra cell™ from SONICS and Materials Inc.) at 100% energy pulsing the cells for 2 min 30 sec (with regimes of 5 pulses of 30 seconds each, alternating with 30 sec breaks between pulses).

Estimation of total protein and sample preparation

Total protein was estimated from the lysates at OD₅₉₅ using Bradford's method (Bradford, 1976). Calculated quantities of protein from the lysates were denatured in sample buffer (40% glycerol, 4% mercaptoethanol, 0.1% bromophenol blue and 8% SDS) by boiling for 5 minutes prior to loading onto the gel for electrophoresis using Laemmli's method (Laemmli, 1970).

Sources of insects for bioassays

Source and rearing of Ae. aegypti larvae

Dry strips of paper bearing eggs of *Ae. aegypti*, received from the Centre for Biological Control of BGU (courtesy of the late Prof. Yoel Margalith), were submerged in 1 l sterile tap water supplemented with 1.5 g of Pharmamedia and incubated at $28 \pm 0.5^\circ\text{C}$ for hatching and larval growth (Khawaled et al., 1988) until the 3rd instar stage.

Source and rearing of *An. arabiensis* and *C. quinquefasciatus* larvae

Anopheles arabiensis and *Culex quinquefasciatus* eggs were obtained from a laboratory colonies, courtesy of the National Institute of Health Sciences, Harare-Zimbabwe and University of Nairobi in Nairobi-Kenya. The eggs were hatched at 28°C and maintained on Tetramin Baby Fish Food, Tetra GmbH D-49304 Melle, Germany and supplied by Martons, P.O. Box 12711 Jacobs, 4026, Kwa Zulu Natal, South Africa, until the larvae were in the third instar.

Laboratory bioassays

Bio-assays were performed in 125 ml disposable cups, each containing 100 ml of sterile distilled water. The test organism were suspended in sterile distilled water and serially diluted in the disposable cups. Twenty early third instar larvae of each mosquito species (*Ae. aegypti* and *An. arabiensis*) were introduced into each cup. Each test replicated at least thrice, on different days. Bioassays with *C. quinquefasciatus* were performed with the powders only. The test mosquitoes were deprived of any other food except *Anabaena* PCC 7120, either the transgenic (for test) or wild type (for control) and the respective *Bti* formulations as a known active control. The cups were incubated at 28°C for 24h and survival/mortality recorded before killing in hot water and discarding using environmentally sanitary procedures. Probit analysis was used to determine the concentration response.

Results

All 16 possible combinations with *cry4Aa*, *cry11Aa*, *cyt1Aa* and *p20* have been prepared in *E. coli* (Ben-Dov et al., 1995; Manasherob et al., 2003; Khasdan et al., 2001), and the most toxic clones were transformed into *Anabaena* PCC 7120 (Wu et al., 1997; Khasdan et al., 2003). A battery of chaperonins accompanied production of the recombinant toxins by *E. coli*, albeit to a lesser extent than in protease deficient *E. coli* strains.

Expression of Bti toxin genes in *E. coli*

Production of the polypeptides varied from one combination to another (Khasdan et al., 2001) and depended on the promoter(s) used. For instance, great variation (and different patterns of cross-reacting polypeptides) in the turnover of Cry11Aa was observed in clones with different gene combinations (Figure 1). The same gene combinations but with different promoter systems yielded different proportions of the Cry11Aa and Cyt1Aa proteins (Figure 2). It was evident that the integrity of the proteins produced by the recombinant *E. coli*, especially of Cry11Aa, i.e. in pVRE4-DRC and pVE4-DRC, varied greatly depending on whether the genes were regulated by a single strong *E. coli* promoter in the former or when *cyt1Aa* had in addition a second promoter in the latter.

Mosquito larvicidity of clones expressing all combinations of four genes

Larvae of three different mosquito species, namely *C. quinquefasciatus*, *Ae. aegypti* and *An. arabiensis*, exhibited varying levels of susceptibility to *E. coli* expressing genes and combination of genes from Bti. The responses of *C. quinquefasciatus* and *Ae. aegypti* were however very close, and more pronounced than of *An. arabiensis* (Figure 3).

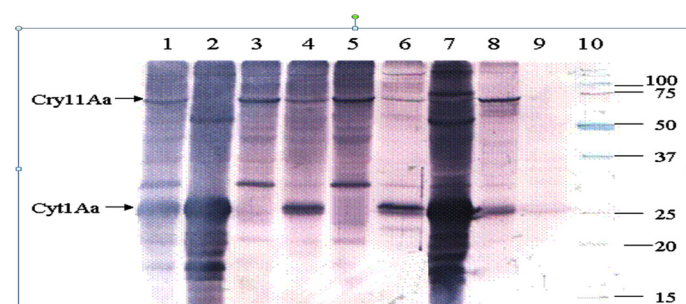
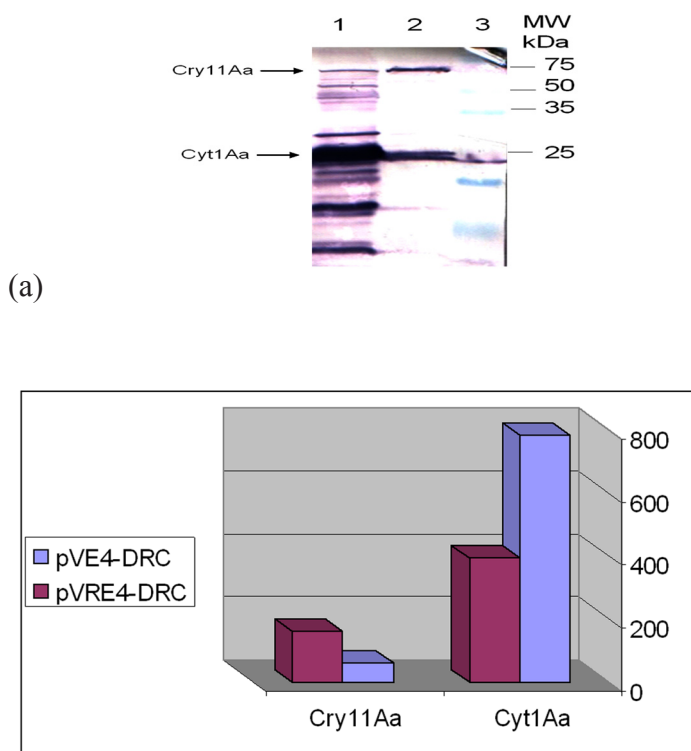


Figure 1

Western blot analysis for the expression of Bti toxic proteins genes by *E. coli*. The protein bands reacted to antibodies developed against whole crystal, with primary detection using anti-rabbit anti-IGg: Lane 1, pVE4-ADRC; L2, pVE4-ARC; L3, pVE4-AD; L4, pVE4-AC; L5, pUHE4-ADR; L6, pVE4-ADC; L7, pVE4-DRC; L8, pVRE4-DRC; L9, pUHE24; L10, MW markers.

Toxicities of this series of 16 clones were reported previously, in wet form against *Ae. aegypti* (Khasdan et al., 2001) and as dry powder against

C. quinquefasciatus (Wirth et al., 2007). The same set of powders was used here to evaluate relative toxicities of the whole series against *Ae. aegypti* and *An. arabiensis* as well. Recombinants pHE4-R, pRM4-C and pRM4-RC expressing *p20*, *cyt1Aa* and both, respectively, consistently failed to display any toxicity (even at 200 µg dry weight ml⁻¹) towards susceptible larvae of all three mosquito species.



(a) Immunoblot analysis of *E. coli* clones pVE4-DRC and pVRE4-DRC expressing *cry11Aa*, *cyt1Aa* and *p20* from *Bti*. Lane 1, pVE4-DRC; L2: pVRE-DRC, L3: MW markers; (b) Histogram of EZQuant-gel quantification of Cry11Aa and Cyt1Aa of blot (a).

The clones expressing *cry11Aa* alone or in combination with *p20* or with *cyt1Aa* (pHE4-D, pHE4-DR and pVE4-DC, respectively) displayed similar, moderate toxicities (LC₅₀ of about 6.5 µg ml⁻¹) against *C. quinquefasciatus* but not against *An. arabiensis* and *Ae. aegypti*. Disparity in toxicities was observed in two clones in which all three genes were combined, depending on the way of their construction: when *cyt1Aa* was added to pHE4-DR as the third gene without an additional promoter to form a single operon, the resultant clone pVRE4-DRC displayed similar toxicity against *C. quinquefasciatus* but much higher against *Ae. aegypti*. On the other hand, when *p20* and

cyt1Aa were added with a second, identical promoter PA1 to clone pHE4-D, the resultant pVE4-DRC was less toxic to both and not at all to *An. arabiensis*, as was pVRE4-DRC. Consistently, clone pVRE4-DRC produces lower levels of Cyt1Aa and higher levels of Cry11Aa than pVE4-DRC (compare lanes 2 and 1 respectively, in Figure 2). This differential expression of these proteins demonstrated that higher expression of *Cry11Aa* and less of *Cyt1Aa* produced higher toxicity than vice versa.

Toxicity of recombinant clones pHE4-A (and pHE4-AR) expressing *cry4Aa* (and *p20*) against all three susceptible mosquito larvae was low. Toxicity rose significantly upon addition of *cyt1Aa* (in pVE4-AC) and even more so when *p20* was included in pVE4-ARC.

Recombinant clones, pHE4-ADR and pHE4-AD expressing *cry4Aa* and *cry11Aa* with and without *p20* respectively were moderately toxic against all three mosquito species. They had comparable toxicities against *Ae. aegypti*, but pHE4-AD was 1.5 and 2.1 times more toxic against *An. arabiensis* and *C. quinquefasciatus*, respectively.

Highest toxicity levels were achieved in pVE4-ADRC and pVE4-ARC producing Cry4Aa, Cyt1Aa and P20, with and without Cry11Aa, respectively. LC₅₀ values of both clones against *C. quinquefasciatus* and *Ae. aegypti* were between 0.6 – 0.9 µg ml⁻¹, and between 3.2 – 6.2 µg ml⁻¹ against *An. arabiensis*. The same constructs lacking *p20* (pVE4-ADC and pVE4-AC) were less toxic, most likely because cells expressing *cyt1Aa* lose viability (Douek et al., 1992) unless co-expressed with *p20* (Manasherob et al., 2001). The presence of the regulatory protein P20 is also important in increasing the production of Cry4Aa (Yoshisue et al., 1992) and of Cyt1Aa (Manasherob et al., 2001; Wu & Federici, 1993). The significance of the Cyt1Aa contribution to toxicity of Cry4Aa and Cry11Aa against all three mosquito species was demonstrated by this series of bioassays: pVE4-ADRC was 1.9 - 2.5 more toxic than pVE4-AD and 2.7 - 5.3 more toxic than pVE4-ADR.

The results demonstrate that mosquito larvicidal activity of the δ-endotoxin gene products of *Bti* in transgenic *E. coli* depends not only on the number of genes but also on the expression patterns and varies with target mosquito species larvae (Figure 3). An analysis of variance to test the comparison of the contributions of combinations, concentrations and the interactions between them was highly, highly significant at $\alpha = 0.05$

Hierarchy of toxicities against several mosquito species

In general, higher toxicities of the six most toxic clones were achieved against *Ae. aegypti* and *C. quinquefasciatus*. These clones were less toxic but in the same hierarchy against *An. arabiensis*. A comparison of the responses of the three mosquito species showed a lower performance against *A. arabiensis* (Figure 3).

The results thus show that the concentration-mortality curve patterns in all the three species were similar (Figure 3, a-c) irrespective of the individual LC₅₀ values. In general, *An. arabiensis* was the least susceptible, while in general there were no differences in response of *Aedes* and *Culex*. Comparing the first four clones in order of hierarchy and response by different mosquito species under concentrations of toxic proteins ranging between 0.5 and 15µg ml⁻¹, (Figure 3), pVE4-ADRC was the most toxic in all the three species, followed by pVE4-ARC and pHE4-AD in descending order. Clone pHE4-AC was third in *An. arabiensis* and in *C. quinquefasciatus*, in both cases followed by pHE4-ADR, while pHE4-ADR was fourth in *An. arabiensis*.

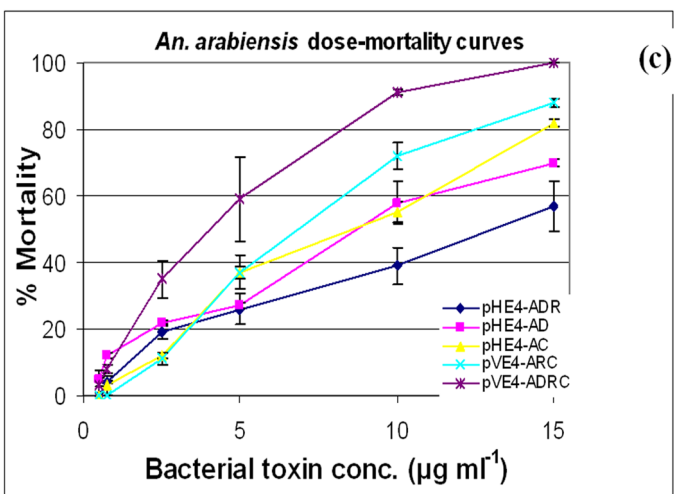
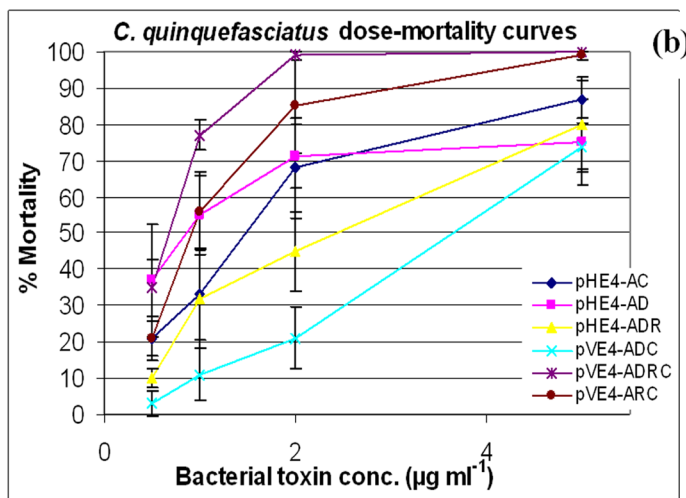
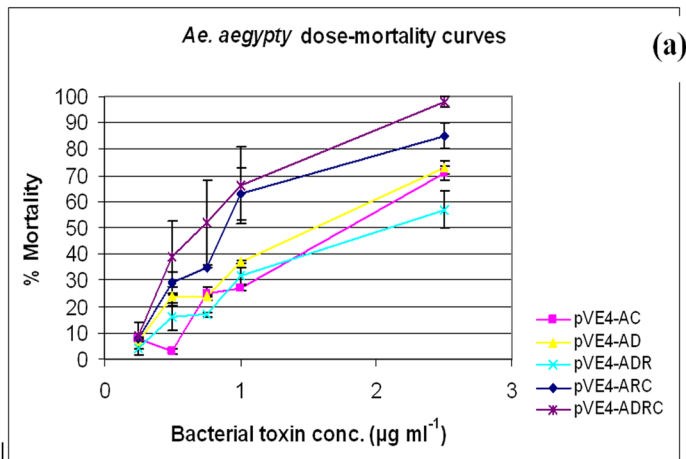


Figure 3 Concentration-mortality toxicity curves against larvae of (a) *Ae. aegypti*; (b) *C. quinquefasciatus*; (c) *An. arabiensis*.

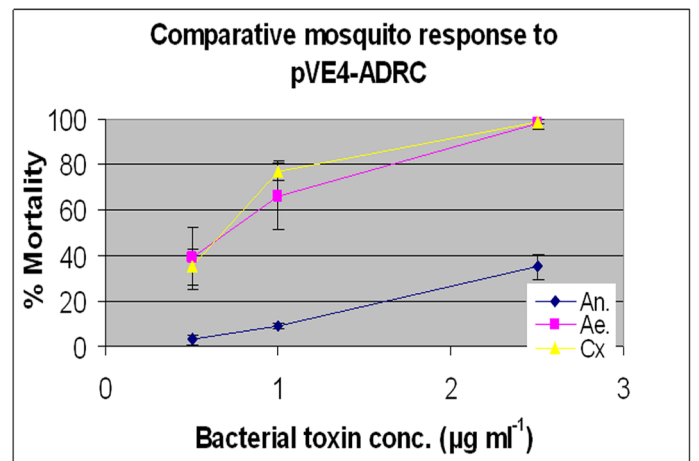


Figure 4. Comparative mosquito response to (pVE4-ADRC) the most toxic combination of toxins.

It was evident that as important as cry4Aa may be, it did not show significant toxicity to *An. arabiensis* on its own (LC₅₀ 23 µg ml⁻¹ on average). It was even less toxic to *Ae. aegypti* and *C. quinquefasciatus*. The toxicity of Cyt1Aa with and without p20 (pRM4-RC and pRM4C, respectively) was not significant in all the three species (data not presented here)

Toxicity of transgenic *Anabaena* PCC7120 to *Ae. aegypti*

Initial studies were done using various batches of *Anabaena*, harvested at varying growth stages. This produced test materials with considerably varying toxicity. There was a sharp drop of toxicity at the end of the lag phase, after which toxicity (inverse of LC₅₀) rose with culture age, together with protein and chlorophyll synthesis (Figure 5). There was significant increase in toxicity from the stationary phase to the harvest time (at ca. 13 days).

Comparative bioassays in controlled (outdoor) light conditions

The recombinant *Anabaena* PCC 7120 expressing *cry4Aa*, *cry11Aa* and *p20* has shown high potency in the laboratory and relatively higher persistence in semi-field trials when compared to commercial Bti. The toxicity of the transgenic *Anabaena*'s persisted for 8 days, but considering the lower initial concentration of chlorophyll, it lasted for at least 12 days (Fig. 5).

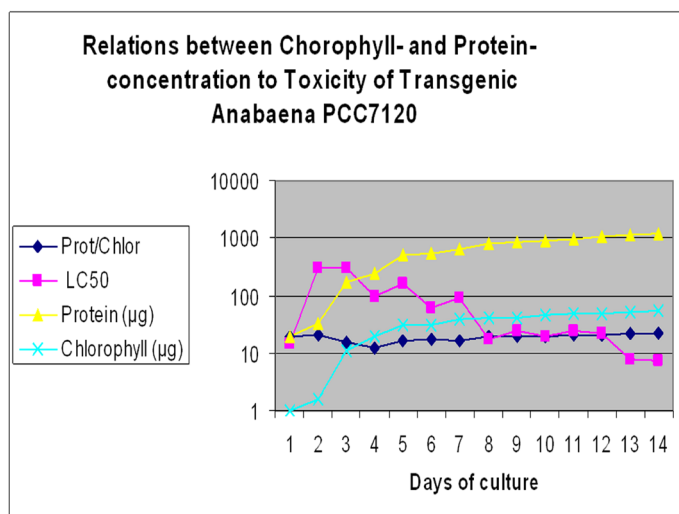


Figure 5

Relationships between chlorophyll and protein concentrations with toxicity of *Anabaena* PCC 7120 at different (column) culture stages.

Discussion

Lyophilized powders of recombinant *E. coli* strains expressing *cry4Aa*, *cry11Aa*, *cyt1Aa* and *p20* individually showed varying toxicity levels (moderate, low or none) against larvae of *C. quinquefasciatus*, *Ae. aegypti* and *An. arabiensis* (Figures 3 a-c). *Cyt1Aa* was the least toxic of the four ICPs of Bti, but was the most active synergist in combination with any

of the other three and with their combinations (not *p20*) (Tabashnik, 1992; Wu et al., 1994; Crickmore et al., 1995; Wirth et al., 1997, 2007; Otieno-Ayayo et al., 2008), most likely due to different mechanisms of action (Butko, 2003). Furthermore, *Cyt1Aa* binds differently when used alone as in combination with the *Cry*'s: it is dispersed when applied separately, whereas together, it preferentially associates with the other toxins, which might explain the synergy between them. Binding of *Cry11Aa* to the membrane of midgut epithelial cells is enhanced by membrane-embedded *Cyt1Aa*, just as it interacts with its natural receptor (Pérez et al., 2005). *Cyt1Aa* thus enhances *Cry11Aa* toxicity and suppresses resistance of the target organisms with mutations in the *Cry11Aa* receptor (Pérez et al., 2005). Enhancement of *Cry11Aa* toxicity by *Cyt1Aa*, e.g., moderate synergy against *Ae. aegypti* (Crickmore et al., 1995), was also found in this study. This synergism was demonstrated with pVRE4-DRC against *C. quinquefasciatus* and *Ae. aegypti* but not against *An. arabiensis* (Figures 3 a-c). Consistently, toxicity of pure *Cry11Aa* has been similar against *Ae. aegypti* and *C. pipiens* and lower against *An. stephensi* (Poncet et al., 1995). Toxicity of *Cry11Aa*-free inclusions was similar to that of the wild-type crystals against *An. stephensi* but half as high as against *C. pipiens* and *Ae. aegypti* (Poncet et al., 1993). On the other hand, our clone pVE4-ARC expressing *Cry4Aa*, *Cyt1Aa* and *P20* had higher and similar toxicities against *C. quinquefasciatus* and *Ae. aegypti* but only about half the toxicity against *An. arabiensis* than pVE4-ADRC expressing *Cry11Aa* in addition to the other three proteins.

The next challenge will be to design a releasable transgenic organism, which will satisfy the minimum toxicity demands in addition to demonstrating a mechanism for minimising the possibilities of resistance and horizontal gene transfer.

Role of promoter system on gene expression and subsequent toxicity

It was interesting to note that two clones with the same gene combination had very different levels of toxicity. These clones, pVRE4-DRC and pVE4-DRC expressed the same three genes (*cry11Aa*, *p20*, and *cyt1Aa*) but were derived differently. In pVRE4-DRC, *cyt1Aa* was added as the third gene without an additional promoter to form a single operon, whereas in pVE4-DRC, *p20* and *cyt1Aa* were added with the promoter PA1 to the original clone pHE4-D (Ben-Dov et al., 1995) expressing *Cry11Aa* from another PA1 promoter (Khasdan et al., 2001). The clone

pVRE4-DRC produces a lower level of Cyt1Aa but a higher level of Cry11Aa in comparison to pVE4-DRC (compare lanes 2 and 1 in Figure 2). In western blot patterns quantified by *EZQuant-Gel 2.11* (Figure 2 b), the density ratio of Cry11Aa in pVE4-DRC compared to pVRE4-DRC was 1:2 (with total value of 1:3). The Cyt1Aa ratio of pVE4-DRC to pVRE4-DRC was 1:3 (with total value of 1:4). This analysis only provided qualitative comparisons and may not be considered valid quantification of absolute densities because of exposure saturation in several lanes. Clone pVRE4-DRC was much more toxic with an LC_{50} of about $4.7 \mu\text{g ml}^{-1}$ and $4.2 \mu\text{g ml}^{-1}$, whereas pVE4-DRC had LC_{50} s of $> 200 \mu\text{g ml}^{-1}$ and $15.5 \mu\text{g ml}^{-1}$ against *C. quinquefasciatus* and *Ae. aegypti* respectively. Both clones were not toxic against *An. arabiensis*. The different expression pattern had implications on toxicity, in that enhanced production of Cry11Aa and less Cyt1Aa resulted in higher toxicity than *vice versa*.

This study concludes that: (a) The type, strength and tandem number of promoter used for gene expression was important for polypeptide pattern, intensity and subsequent toxicity of the desired products; (b) Of the 16 possible combinations, the 6 most toxic clones displayed a consistent hierarchy in all the three mosquito spp. tested; (c) The combination clone with all four genes was consistently the most toxic; (d) *Anabaena* PCC 7120 is quite promising as a candidate for field release; and (e) Recombinant *Anabaena* performed better in simulated semi-field conditions than *Bti*.

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Research Articles

Part - B

A LEADERSHIP DEVELOPMENT MODEL FOR FEMALE PASTORS

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Abstract

Recent scholarship on leadership advocates for generation of new impulses in leadership development. A more comprehensive level of integration in the development of theory and research has been projected for perpetual progress in the evolution of leadership as a science and practice. The guiding idea for integration centers upon a leader-follower relationship that must be contextually emphasized in the leadership process (Avolio, 2007). This article presents a descriptive model for effective leadership development of female pastors in religious organizations. Emphasis is placed on the leader-follower dyad; the criticality of context; and the need to comprehensively integrate those two elements in theory and practice of the leadership. The model is characterized by its cognitive, functional, authentic, and contextual nature as well as by the corresponding constructs: (1). Leader-follower self-awareness; (2). Functional Competence; (3). Authenticity; and (4). Context.

Key Words: Leadership Development Model, Female Pastors, Leadership in Religious Organizations

Introduction

Recent scholarship on leadership advocates for generation of new impulses in leadership development. A more comprehensive level of integration in the development of theory and research has been projected for perpetual progress in the evolution of leadership as a science and practice. The guiding idea for integration centers upon a leader-follower relationship that must be contextually emphasized in the leadership process (Avolio, 2007). This article examines the lived experience of leadership for female pastors in religious organizations to determine the capability of the idea to actualize an integrative model for leadership development of these pastors. The author relies on qualitative data from her recent dissertation (Truman, 2010) to present a descriptive model that is especially useful for the controversial environment in which the leadership must occur. Through the lens of authentic leadership perspectives (Avolio, 2007; Gardner, Avolio, Luthans, et al., 2005), and the connectionist perspective (Lord, Brown, Harvey, et al., 2001), the leadership is examined at an integrative level that emphasizes the leader-follower dyad as well as the criticality of context.

Interactive consideration bears on leader-follower self-awareness, leader-follower perception, and the preceding and prevailing contexts in which the leadership development must occur.

Leadership Development and the Next Level of Integration

Critics of the leadership literature argue for a model that exemplifies a more integrative role of the follower as well as the context in which leadership occurs (Avolio, 2007; Lord et al., 2001; Rost, 1991; Zaccaro & Klimoski, 2001). Avolio argues against the narrow address of the phenomenon as the leader becomes the primary focus to the detriment of the follower and other equally relevant contextual elements such as time, place, culture, and the manner in which they interact. Rost finds the literature lacking in its address on the equally defining elements as the leader alone is exemplified. Lord et al. (2001) substantiate the merits of that discussion in their argument for a next level of integrative theory and research. Their model emphasizes an interconnection of perception and context. Leadership processes respond to the varying perceptions of subordinates,

required performances, context, or organizational or group developmental stages. The interactiveness of the leader-follower dyad together with the tasks and culture create perceptions which are also influenced by an extended culture in a wider social and interpersonal setting that also has tasks.

Furthermore, the psychological literature on organizational leadership fails to greatly emphasize context. The structural contingencies that account for the how and the why of its conduct are scarcely addressed. It is believed that in the absence of structural contingencies, an effective model of organizational leadership cannot be presented (Zaccaro & Klimoski, 2001). In addressing the projection of an elevated or next level of integrative theory and research, the leadership experience of female pastors in religious organizations has been utilized in creating a leadership development model. The author has taken an integrative and interdisciplinary posture relative to a synthesis of the authentic and connectionist leadership models of Gardner et al. (2005) and Lord et al. (2001). This integrative and descriptive model is scaffold on cognitive elements, psychophysical behavior, and contextual influences that involve historical, proximal and distal aspects.

A Descriptive Leadership Development Model

Central to the model for effective leadership development of the female pastorate are the areas of integration and the corresponding constructs that fit together for a more comprehensive level of integrated leadership as depicted in figures 1 and 2 below:

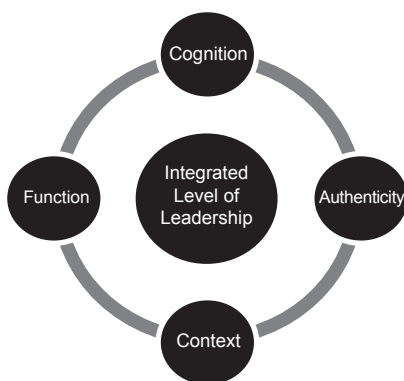


Figure 1
A Descriptive Leadership Development Model. Figure depicts the central idea and the areas of integration for the leadership development: Center – Integrated Level of Leadership; Top – Cognition; Left – Function; Right – Authenticity; Bottom – Context

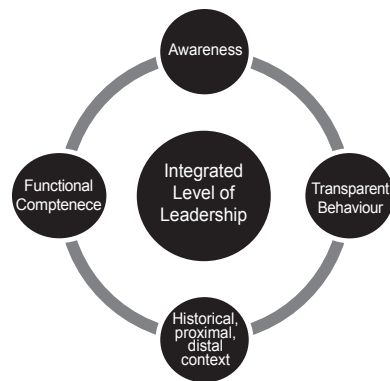


Figure 2
A Descriptive Leadership Development Model. Figure depicts the corresponding constructs to the areas of integration: Center – Integrated level of Leadership; Top – Self-awareness; Left–Functional Competence. Right – Transparent Behaviors; Bottom – Historical, Proximal, and Distal Context.

Interrelatedness and Connectedness of the Model

The areas of the model speak to its qualitative nature and the comprehensiveness of integration for leadership development. The integrated level of leadership is extended to include leader-follower psychophysiological processes as well as the contextual processes and their impact on the leadership. The constructs deeply interrelate with the central idea and greatly connect with one another. The interrelatedness, as well as the connectedness, is useful for enhancing the strength of the model. Each construct points to a specific area of usefulness and can be efficiently adopted for effective development of female pastoral leadership. The first construct, self-awareness, bears on the cognitive nature of the model as it brings the self of the leader and the self of the followers into immediate focus. The second construct, functional competence, also bears on the cognitive nature and separately on function. It is the perception of competence coupled with the actual competence that precipitates allocation and dictates the degree of leadership influence. The third construct, transparent behavior, bears on the element of authenticity. It emphasizes transparency of the leader and the leadership as well as its effects on influence allocation. Leader-self-awareness is demanded for a focus on the authentic behaviors as one necessitates the other. The fourth construct, context, bears on the complexities of context in the affiliated organizations. It demonstrates the criticality of it all, and emphasizes the need for contextual leader-awareness. The female pastoral leadership that is scaffold by those four constructs is likely to emerge

and be effectively developed in both small and large congregations even when those congregations are highly conservative and traditional.

Leader-follower Self-awareness

The female pastor who is fully aware of the inner-self and seeks to transform that self into the fully developed potential self is on the way to developing a leadership that is expected to bring about transformation of minds and propel a pendulum swing of time and change. The cognitive construct of the model, therefore, refers to self-awareness in the leader-follower dyad relative to perceptions of the actual self and a translation of that perception into the potential self. It also includes objective self-assessment as well as assessment of decision-making for both the present and predicted future context. The female pastor must then return to that deep inner sensing that is described as "The Divine Calling." She must remain in full consciousness of her "Call to Leadership" so that she must stand unwavering and remain in a state of perpetual response to that Calling for that is the foundation of her leadership and the true purpose of its development. It is incumbent upon her to make vivid the Divine Calling so that the followership become aware of the self that may be uninformed, doubtful, questioning, or opposing and translate that perception into the self that can or must become informed, supporting, affirming, or accepting.

In the face of gendered issues and challenges that precipitate examination of self-concept and decision making for both leader and follower, the female pastor must be fully conscious of the scriptural confirmation and divine validation on her Call to Leadership. In times when controversial interpretation and application of Scriptures precipitate gendered rejection, and failure to recognize the ecclesiastical authority of the leadership dictate deep soul searching and broad self-examination, the pastor must return to the initial perception of the Call as deeply direct and personal. She must come to a state of eidetic seeing in which she vividly recognizes her Call to Leadership as a "Call to Obedience." She must become so eidetically engaged that the vividness of that extraordinary image of the Calling would be permanently visualized in her mind's eye. In the phenomenological world, an eidetic engagement refers to a vivid mental grasp or recall of an extraordinary form or evident. (Husserl, 1977; Moustakas, 1994). As such, the pastor's vivid reflection

of that phenomenon should permit identification of its presence as it were in life experiences, even from childhood. Although that identification may compel deeper soul-searching and identity-questioning that may even result in self-struggle and self-doubt, the pastoral leader must remain in deep self-awareness until that Call is fully conceived and conceived as divine and divinely irrevocable. It is the irrevocability of the Call that is the pillar of the leadership. It is that pillar that must also be conceived by the followership. It should be perceived with that certain kind of self-conceived strength that comes in the face of adversary and so impel a leadership that is even unorthodox in its development.

Functional Competence

It is important for the female pastor to acknowledge that perceptions of potential and incumbent followers are particularly critical. Leadership development becomes defined by the perceptions of those persons as individuals and as groups of individuals although those persons are typically limited in their information regarding leader and leadership-characteristics. Hence, leader and follower self-concepts relative to leadership in religious organizations, particularly in congregations, may greatly differ. Arguably, the female pastoral leader must showcase her attributes for the benefit of her leadership development. It is not until some individuals or groups have received a revelation of leader-attributes and leadership characteristics that perceptions become positively changed. The self of the follower and his or her decision-making are both examined and are brought into conformity with the leadership. Because leadership emergence and effectiveness of the female pastorate have been influenced by follower-perception of leader-competence, both spiritual and physical categories of competence must be demonstrated. They are both necessary, but one without the other is not sufficient for the allocation of influence that is demanded in the congregations for the necessary support and affirmation of the leadership.

Follower-perception of the required spirituality must be confirmed by demonstration of functional competence. Functional competence is multifaceted in the context of spirituality, roles, and performances. The people must perceive a high level of spirituality accompanied by role and performance efficiency. For instance, in the pastoral role of mediating conflicts relative to gender and leadership, the female pastor

must engage in the appropriate intrapersonal and interpersonal skills that lead to impressionable resolution. Intrapersonal behavior must embrace spiritual intelligence which includes spiritual discernment as in perceiving thought processes, sensing the underlying issues, developing the broad schema, and unequivocally addressing the whole matter from a convicting biblical perspective. The word convicting is used because the word convincing would suggest human ability, but the change must be perceived as a divine movement.

The female pastor must demonstrate interpersonal skills that must embrace emotional intelligence which permits awareness of personal emotions, as well as that of others. The leader must focus on controlling those emotions to the required outcomes through holistic approaches and effective communication. The outcome should be marked by transformation of follower-behavior that is often characterized by question, rejection, and poor or no allocation of influence. Jin, Seo, & Shapiro (2008) suggest that emotionally intelligent leaders are likely to be transformational leaders. However, some leaders may exhibit more strength in both domains more than others. Truman (2010) found that in spite of such social skills demonstration, full transformation of follower-attitude and behavior does not occur when full functional competence is not perceived. Leadership influence is not fully allocated unless there is solid demonstration of business acumen and efficiency in physical performances. Competence consideration is the key factor in group-allocation of influence. Moreover, functional competence is superior to social competence for the required allocation, and especially in the face of social roles expectation.

In religious organizations, spirituality is added to the equation. It is the crowning jewel of the leadership development. Convicting spirituality must also be perceived in the physical arena. For example, in the performances of the ordinances of communion, baptism, and marriage, the leader must perceivably evoke the Holy Spirit in a manner that would present a profound aura of reverence, and the glory of God must be sensed perceivably as in the day of the prophet Isaiah when the glory of the Lord filled the temple and the seraphim purged his lips with coals from the eternal flame (Holy Bible, n.d.). Each ceremony must be performed without blunder. Members of congregations perceivably behave as in the day of the sanctuary sacrifices when the object of the sacrifice must be checked for

blemish which rendered the sacrifice unacceptable. In their perceivably self-righteous indignation, the congregations must experience a convicting spiritual presence while witnessing efficient performance which must be perceived as the manifestation of the Holy Spirit, especially because of the social role expectation. Because the woman is not expected to perform efficiently in the man's role, the perceived divine intervention becomes absolutely necessary. Performance capability makes for the defining difference between effectiveness and ineffectiveness as "low task ability disqualifies an individual almost immediately from leadership status" (Van Vugt, 2006, p.362). Social skills do not overshadow functional abilities and neither of the two, or even a combination of those two capabilities, does not lessen the compelling demand for demonstration of the 'High Calling' which is the manifestation of divine power. The female pastor must conscientiously ensure that she is confidently demonstrating the required competence if her leadership must become developed.

Transparent Behaviors

This individual leader-follower behavioral construct especially emphasizes authenticity in leadership behavior. This consideration is also associated with the manner in which the leader-follower dyad controls the conversion of their new awareness into transparent behaviors. Gardner et al. (2005) suggest that leaders as well as followers are expected to regulate authentic relationship-building behaviors as well as behaviors for principled decision-making. The female pastor must then engage in behaviors that do not only demonstrate authenticity but reciprocates authenticity in follower-behaviors. This authenticity must be aligned with the spiritual gifts and psychological talents bestowed upon her. Each leader must discern and demonstrate the purpose of God for her life and must know, augment, and take control of the use of spiritual gifts and psychological faculties in a manner that permits transparency of self as well as self in relationships and in decision making processes in the organization. Transparency must be regulated in a manner that unequivocally presents leadership capabilities which in turn is strongly likely to stimulate members to become transparent and allocate the influence that is necessitated for effective leadership development in the affiliated organizations.

Consistent with the discussion under the cognitive and competence constructs, it is the

transparency of the spiritual gifts within the cognitive as well as physical, professional and social task performances that would foster awareness of the required leadership capabilities. The awareness is likely to compel conversion of the questioning minds and change the concomitant rejecting behaviors into open, supporting and affirming behaviors. Member-awareness of the spiritual gifts, psychological acumen, and functional competence is expected to alter the non-acknowledgement, rudeness, and disrespect for the ecclesiastical authority, as well as facilitate behaviors of due deference to the legitimate authority of the leadership. For example, members of congregations, who became experiential beneficiaries of the tripartite nature of the competence consideration, have been known to openly confess of their misguided beliefs and the concomitant behaviors. They have been known to demonstrate a willingness to affirm the leadership by moral and religious support which included open and active participation. They acknowledged the women as pastors and allowed them to lead the congregations. They sought pastoral guidance and counsel from them and showed their appreciation for the transforming leadership effectiveness (Truman, 2010).

Additionally, the leader-follower conversion of new awareness into transparent behaviors is likely to be evidenced in pastoral leadership that is holistically aligned. That means that the female pastoral leader ought to demonstrate, without any ambiguity, authentic concern and care for the welfare and well-being of followers. Hence, the concern must be spiritually, psychologically, and socio-economically aligned. The pastor must therefore engage in individualized consideration that includes spiritual level, religious and social-economic background, current problems and issues, and the underlying or hidden meanings of demonstrated cognitive and physical behaviors of members of her organization. The leadership must be aligned with active listening and other follower-centered practices that permit the meeting of needs. And even more pronounced is the alignment that would facilitate the meeting of followers at their needs. There is that perceived distinction which suggests that meeting of needs speaks to general needs of a congregation. However, when followers are met at their needs, there is an indication of deep personal relationships. It is suggestive of seeking out as well as reaching out and touching individuals in a manner that is indelible. It suggests going beyond expectations and experientially meeting a particular individual at his or her levels of need. And that kind

of individualized consideration is greatly likely to unambiguously speak to the required reciprocal authenticity in the leader-follower behavioral dyad. The saying that nobody knows how much you know until you show how much you care may become true in this context.

Furthermore, women have been known to be relational, and that relational attribute has also been known to be incorporated into their professional lives. Such knowledge has been historically and empirically supported (Ealy, Johannesen-Schmidt, & van Engen, 2003; Legako & Sorenson, 2000; Truman, 2010). Because women display a natural tendency to be relational, it is greatly likely for them to strongly incorporate psychology into their theology. Because integration is included in their natural approach to personal life, the professional life would be no different. The female pastor who understands the authentic workings of her authentic God-given nature-nurture attributes can become a great source of benefit to her own development. Hence, the leadership ought to be clearly aligned with authentic relational characteristics such as nurture, praise, spiritual inspiration, intellectual stimulation, encouraged collaboration, and motivated participation which have an expectation to bear fruits of spiritual and psychological empowerments. Those two empowerments have great potential for reciprocating the required idealized influence and strong affirmation for both the leader and the leadership. These authentic behaviors are likely to become a repertoire for leader-follower self-development, leader-follower relationship, and inarguably, effective leadership development.

Context Comprehension

The context construct of the model emphasizes the historicity, proximal and distal nature of context coupled with its significance in the development of female pastoral leadership. The criticality of context in leadership cannot go unnoticed by the female pastor. To begin with, the organizational context in which this leadership must develop is too much of a formidable force to be ignored. The female pastor must recognize the potency with which it impacts her leadership development. She cannot underestimate the force with which it can hold still or sway the pendulum of leadership advancement. She must therefore grasp a true and comprehensive understanding of the internal as well as the external contingencies which underlie the complexity of it

all. Historically, established conservative religious organizations have been known to openly reject the leadership (Barnes, 2006; Yadgar, 2006), and so the female pastor must be in sync with the organization's contextual establishment as well as its lineage and culture.

Follower-awareness, follower-perception and contextual complexities are strongly interwoven, and so it is incumbent upon the leader to be aware of the context in which she must lead. Leader-awareness of context is therefore a pivotal factor. In the absence of that awareness, effective leadership development can be jeopardized. Such awareness should result in an intentional force of leadership action that would propel the pendulum swing from the past to the present; from a traditional conservative stance to a due deference posture; from lack of knowledge and rejection to awareness and acceptance; and from withholding sanctioned authority to granting legitimate authority.

Female pastoral leadership has been viewed from varying scriptural-cultural lens, and hence, it endures varying degrees of rejection. From a scriptural-cultural perspective, the rejection may stem from attitudes, policies, and practices that may lack scriptural contextual consideration and may only be considered relative to cultural influence. This perspective is consistent with the cross cultural approach suggesting that a precise leadership behavior may not be perceived in the exact manner but through varying lens from different people in the same culture or between different people in different cultural frameworks (Lord & Brown, 2004). For example, in the Southeastern region which is considered the "Bible-Belt" in the United States of America (US), highly conservative congregations may not fully be receptive to women in the pastorate or to bestowing ordination status on the leadership. In those denominations that are divided on the issue of ordination, clergy women who are ordained pastors are likely to be found in the liberal structures of those organizations (Cody, 2006).

The female pastoral leader must be prepared to meet the challenges erected by value systems which embrace conservative socio-political principles that are ingrained in religious doctrines. She must identify and understand the workings of societal influences and devise strategies for leadership survival. For example, regional culture and national and international responses to the development of female religious leadership can greatly impact religious practices. The value system that is influenced by conservatism may

be built on socio-religious scaffolds, and whereas personal interests compete with social, political, and religious ideologies, collective communal interests rest upon integration of interests and ideologies which become a formidable force against such leadership development. Social perspectives (van Knippenberg, van Knippenberg, de Cremer, et al., (2004) suggest that the cognitive and corresponding physical behaviors of followers reflect collective norms in the presence of leader-arousal of follower-self-construal regarding collective behavior.

In the psychology of leadership, strategy and intention are emphasized. Strategies are bedrocks for intentionality. An intentional leader is not dormant and is usually seeking change for current situations. That leader is often uncomfortable with present conditions and tasks performances and so becomes engaged in absorptive and adaptive behaviors that are shielded and inundated with wisdom. He or she would envision the future, and in so doing, the point of emphasis would be the long-term future of the organization and the envisioning of the larger organizational goal. However, the organizational contextual setting would not be ignored, but it will be simultaneously comprehended. Moreover, the long-range visions and conceptualizations would be incorporated into day-to-day functions and roles so that the vision ought to establish individual as well as cooperate transformation (Davies & Davies, 2004). If the leadership must be developed and developed effectively with great longevity, a strategic orientation should be in place to bring about the religious organizational reform and make stronger a societal restructure that become necessitated for a forceful pendulum swing.

Female pastoral leadership should therefore be intentionally aligned. Intentionality suggests strategic focus. The pastoral leader is encouraged to devise strategies that would permit the leadership to propel at opportune times and during opportune circumstances. Like a reflective practitioner, she ought to be curious, open to experience, flexible, and always on the look-out for that new circumstance or that challenge that would propel and strategically bring about sustained change. That is, the leadership should be so contextually aligned that the circumstance or challenge would not be an unexpected obstacle but a simple opportunity for development. Her leadership should then be aligned with a vision and a thirst for sustainable change on the individual, group, and organizational levels. The vision must therefore hold

true to transformation in both the organizational culture and climate so that transformation must be intentional. This kind of envisioning leadership dictates a comprehensive understanding of extant realities in the affiliating organization. It also speaks to the establishment of a clearly defined and directional path. In the absence of such a vision, the leadership may surely perish.

Furthermore, organizational learning should become a leadership-alignment because learning has the power to change cultures and climates. Congregations that become sustained learning organizations can make a grave difference in the leadership environment. The strategic pastoral leader would then identify the jewels of truth that are hidden among fears that are not biblically inclined nor supported or buried under cognitive dissonance that refers to individualized perceptions and self-opinionated behaviors. These truths would be taught to the individuals and groups with whom relationships have been built. This means that the female pastor ought not to be satisfied with the egalitarian status or opposing factions of the congregation relative to her leadership. She should not be comfortable in hostile or semi-hostile environments and should effectively use her relational attributes to build strong relationships. Greatly beneficial to the leadership development is relationship building. The strength of relationships usually opens the doors of utterance for the leader to walk through and teach with holy boldness. It is the strength of those relationships that would propel the followership into affording the legitimate authority that is necessary the development of the leadership.

Conclusion, Recommendations and Implications

The model for the development of female pastoral leadership has positively responded to recommendations for more comprehensive attention in building models that would contribute to the advancement of the science and practice of leadership. Although the model emphasizes comprehensive integration, it is not a mere integrative focus of leadership development. It also facilitates multilevel and multi-component analysis that underscores the leader-follower dyad and the context complexities. And it does so in an interdisciplinary manner. Furthermore, it does not only emphasize leader-follower connectedness, but it also underlines the connectedness of social networks and leadership and connects leadership development to social role and psychological perspectives. The model also suggests

that development of female pastoral leadership demands attention to four main areas of integration together with four main corresponding constructs as depicted in figures 1 and 2 above.

As demonstrated by the model, the leadership demands an endowment of:

1. Leader-follower self-awareness. Self-awareness in the leader-follower dyad relates to perceptions of the actual self and a translation of that perception into the potential self. It also includes objective self-assessment as well as assessment of decision-making for both the present and predicted future context. The leader must be in touch with her self-identity and must fully conceive of and illuminate the Divine Calling so that the followership would truly conceive and respond to that sensing.
2. Functional competence. It is incumbent upon the leader to demonstrate her ability to effectively lead the organization. Effective leadership demands competence in tasks and performances which must also be illuminated by spiritual, psychological, and organizational acumens. Both perceived and actual functional competence must be place and must be inundated with deep spirituality that experientially informs the followership. In the absence of the perceivably inextricably interwoven competencies, the leadership would fail to effectively develop as those competencies make a difference in organizational behavior and set the standard for leadership effectiveness and ineffectiveness.
3. Transparent leader-behavior. Transparent behaviors that involve individualized consideration, intellectual stimulation, and inspirational motivation must be insulated by wisdom and make vivid the sincerity, caring, and nurturing nature of the leader and the authentic alignment of the leadership. Openness stimulates psychological processes in the leadership such as follower-perceptiveness of effectiveness and authenticity. Authenticity translates into allocation of influence because sincerity and transparency reciprocate perceptual leader-effectiveness. It can therefore lend, not only to leadership advancement, but also to a leadership that transforms.
4. Leader-knowledge and understanding of the complexities and criticality of context. Leader awareness of the workings and power of organizational context is pivotal. Follower-awareness, follower-perception, and other contextual complexities are strongly interwoven,

and so it is incumbent upon the leader to be aware of the context in which she must lead. The leader must have an intentional focus on the lineage and establishment, as well as on the culture and climate, of the affiliated denomination and organization. Strong intentionality should be a bed-rock in the leadership if it must be developed to a level that would establish sustained change, transformation or organizational reform. Leadership should therefore be aligned with strategic forces that would readily combat adversarial forms that present from time to time, and in so doing, turn challenges into opportunities.

Recommendations resulting from this article bear heavily on models from theory and practice that are specific to the leadership advancement of the female cleric. A continued focus on a more comprehensive and integrated level of leadership is especially noted. As leader-follower behavior and contextual factors continue to greatly influence the leadership-development, future organizational behavior and hierarchical posture should become contingent on comprehensive research and learning that would bring about comprehensive organizational knowledge and education, particularly relative to scriptural interpretation and its contextual application to religious doctrines and societal norms. It cannot be overstated that much emphasis is required on the organizational context in its historical, proximal and distal forms because of the power of the socio-cultural-politicking factors that become engrained in the policies and practices of religious organizations. These factors become incorporated into religious policies and practices and are disguised as scriptural benchmarks which become salient in leadership development.

Furthermore, there is grave implication for organizational posture based on pseudo-scriptural benchmarks. These benchmarks have great potential in molding and sustaining conservative traditional behavior, and in so doing, they establish an overall organizational culture and climate that prevail against the development of female pastoral leadership. The organizational context becomes heavily guided by the behavior of hierarchical bodies, and organizational behavior that displays ambivalence in posture does not lend to effective development because it neither utterly supports nor condemns the leadership. The ambivalence may be sensed or seen in inconsistencies of policies and practices within and among varying

organizational structures. Unfortunately, it leaves open the door for cognitive dissonance as members may disregard policies and practices and determine the legitimate authority of the leadership through subjective influences. Whereas some members or even non-members may interpret the ambivalence as a placement of poor value on gender egalitarianism and poor regard for gendered social justice, others may interpret it as conformity to religious doctrines. Such conflicting interpretations would not lend to value congruency, neither would they lend to organizational loyalty. Even worse, they may threaten overall organizational strength that derives from sustainable unity.

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THE IMPORTANCE OF FEEDBACK AND REINFORCEMENT IN COMPUTER-ASSISTED LANGUAGE LEARNING (CALL)

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Abstract

A major focus of research in Intelligent Tutoring Systems (ITS) has been the identification and implementation of Feedback Strategies that facilitate student learning. Much of this research has been carried out on procedural skills teaching systems in areas such as algebra, physics or computer programming. Nonetheless, very little emphasis has been placed on studies and research on these types of strategies for language learning (Intelligent Tutoring Systems for Foreign Language). This article is an attempt to clearly establish the importance and necessity of feedback and reinforcement in Computer Assisted Language Learning (CALL). A brief description will be given about CALL, and its significance for second and foreign language learning. The terms 'feedback' and 'reinforcement' will be explained, with a view to establishing their inevitability in language learning. Subsequently, a discussion of these very terms will be discussed in the light of CALL, touching on some experiments done in this regard and stressing their centrality in determining the effective use of the computer to promote language learning. The suitability of Artificial Intelligence in language processing and second and foreign language error correction will be established.

Key words: computer, feedback, reinforcement, second language acquisition, intelligent tutoring system, language teaching and learning, artificial intelligence.

Introduction

When the computer comes up for discussion among foreign language faculty members, there tends to be little disagreement about its value in word processing and in scholarly research that requires complex text manipulation. There is a great deal of disagreement, however, about its value in language teaching. Some foreign language teachers are enthusiastic, but many are skeptical or hostile. At the very least, this disagreement provides unarguable evidence that language-teaching software, in contrast to word-processing software, is not yet sufficiently developed to persuade us immediately of its worth. Nonetheless, it is no more reasonable to dismiss the entire enterprise of computer-assisted language education because current software is inadequate than it would be to dismiss the efficacy of textbooks because some are bad.

This kind of debate about the appropriate role of the computer in the classroom is fundamentally

misconceived, because, it is based on, and serves to perpetuate, a problematic split that affects all foreign language education, a conceptual split between knowledge of language, some understanding of its linguistic rules, and the ability to put that knowledge to use. We operate today on the assumption that knowledge of language can be "taught," while the ability to use that knowledge is a set of complex skills—skills such as comprehending spoken discourse, speaking, reading, and writing—that students must acquire. We know that "teaching" a complex skill is not the same as teaching a body of knowledge; in fact, a complex skill cannot be taught but can only be practiced until it has been learned. All the teacher can do to assist in the learning of skills is to structure the class environment to encourage practice, continually adjusting the demands of the environment to allow learning to proceed at an optimal pace. The problem is that in today's ideology this conceptual split automatically devalues knowledge in relation

to the ability to use it, and the entire field of foreign language education is bedeviled by doubts about how (or even whether) knowledge actually contributes to that ability.

The computer can play two roles in research projects investigating the nature of language learning. First, since it can track many details at once and analyze the relations among them, it can deal with far larger and more complex amounts of data than can human researchers, and this ability is crucial to the investigation of anything as complex as the underlying reasons for language learners' errors. Experienced teachers have well-founded hunches about why students have certain problems, but even a very good teacher with a very small class cannot constantly keep track of the details of each student's every language production under minutely specified linguistic and communicative conditions, all of which are needed to diagnose why individual problems occur. The computer can keep track of everything it can be programmed to recognize, so if the researcher can specify the conditions under which a certain error is caused by one misunderstanding and can specify other conditions under which "the same error" has different causes, the computer's tabulation of these conditions can be read with considerable certainty as an analysis of an individual learner's underlying processing problems.

In other words, Artificial Intelligence (AI) can deal with new problems, once the general principles and techniques for working with computer applications for language learning have been learnt. For example, to recognise the erroneous sentence of a student, a computer programme should have the same correct and incorrect forms. In this way, and so that the computer application can provide the student with feedback about why the sentence has errors, the system should also include a record of wrong rules. For an identical syntax error but with a different vocabulary, this application again should have the exact expression pre-stored in its memory. However, an intelligent program would only have to have a rule that the student uses for such an erroneous production. The programme theoretically could recognise the same type of error in any context and any vocabulary. Thus, given the power of AI techniques to correct the user at the same time that he is committing the error, such applications are considered as the best ally of the teacher in correcting L2 errors.

By taking into account the above, this paper aims to highlight the importance of feedback and

reinforcement - through the use of the computer and other technological applications and programmes - to improve linguistic and communicative competence, as it relates to Second Language Acquisition (SLA). This article also outlines the main criteria to consider when introducing computer applications to aid in language teaching and learning. To this end, this paper highlights three empirical studies done with a view to establishing the need for feedback and reinforcement in language learning.

CALL

Computer Assisted Language Learning (CALL) is a type of educational technology designed to serve as a learning tool. In simple terms, it refers to the use of computer applications in teaching and learning languages.

The use of computational tools has become a new medium which shapes the processes and products of communication. Because multimedia technology has opened new opportunities for communication between teachers and learners, and among those who speak a second language, many language teachers have realised the enormous potential for teaching computer-mediated learning (Levy, 1998; Warschauer & Healy, 1998; Warschauer & Kern, 2000).

CALL in the past decade stopped being a mere phenomenon in life and transformed itself into an indispensable tool for teaching modern languages. Along with other technological advances, such as video, the number of students who participate in the experience of CALL continues to increase speedily. Computer Mediated Communication (CMC), which has existed primitively since the 60 (Warschauer, 2000), spread only twenty years ago and today is probably one of the computer applications with a profound impact on the teaching- learning of languages. For the first time, students of modern languages can communicate directly and conveniently with other learners or speakers of the target language all day, from their school, work or home.

In other words, CALL suggests and affirms that the computer has a variety of uses for language teaching: it can be a tutor, offering practical skills; it can be a stimulus or catalyst for discussion and interaction, or as a tool for writing and research. Garrett (1987, p. 70) highlights the fact that "the use of computers is not a method but is an environment in which we can implement a variety of methods, approaches and educational philosophies". In other words, the effectiveness of CALL is not in the medium itself, but

how it is used in the process of language teaching and learning. This assertion by Garrett has much validity since the most important potential of the computer lies in its ability to provide an environment for language learning in which students are supported individually to develop, expand and refine their own language and communication skills in a new language. Computer Assisted Language Learning must be the focus of our efforts and without doubt, the development of their potential will significantly affect the way in which languages are taught and learnt in this century.

Feedback and Reinforcement

In recent decades, many studies have emphasized the significance of interaction in second language acquisition. Several studies have investigated cognitive variables such as working memory, attention, inhibition and noticing (Gass, 1997; Mackey, Adams, Stafford & Winke, 2010), many others pointed to a refurbishment towards capturing the social aspect of learning (Lave & Wenger, 1990; Firth & Wagner, 1997) and situating it in a social context. After all, learning does not take place where learners are clean sheets and teachers are the painters. On the contrary, learning takes place with the co-participation of all agents involved. In a recent study, Ellis, Loewen and Erlam (2006) invited scholars to do more research on socio-psychological factors that may influence learners' receptivity to corrective feedback. Motivation, in our point of view, is a good candidate to predict learners' receptivity to teachers' correction and can direct their attentional resources.

Teachers generally situate corrective feedback episodes in a meaningful context, which is generally effective for the purposes of communicative and meaningful teaching, but also generally conflicts with grammar teaching purposes. These types of interactions are laid out in "initiation, response, follow-up" sequences (IRF). Teachers provide the correction at the follow up section where learners are naturally expecting a comment on the content of their response. In the follow up line, students are not expecting to see a comment on their form. This constitutes the first problem. The second problem is that teachers might give an overwhelming amount of correction that would ideally set a good model sentence to have the students notice the gap between their original utterance and the standard target language, but learners' working memory might be capable of processing such condense information at

once.

The term *feedback* in this context for example, has been viewed differently in various sources. James (1998) restricts the scope of the term 'feedback' to a type of specific response to errors, i.e. the type of intervention that informs the student of the fact that there is an error, but gives no description or specific diagnosis. In contrast, other theoretical investigations of Second Language Acquisition (SLA) (Spada & Lightbown, 1993; Ellis, 1997, Doughty, 2001, Gregg, 2001) like the most of the CALL specialists (Heift & Schulze, 2003; Cowan, Choi & Kim., 2003; Maingard, 1999; Kreindler, 1998, Warschauer, 2000, Pennington, 1989), appear to extend the meaning of the term to include any type of information returned to the learner after perform a comprehension or production task.

In SLA, feedback is seen as a feature of classroom discourse (Van Lier, 1996). As such, it is in favour of a non-interventional descriptive approach (McDonough & McDonough, 1997) to SLA research, in which discourse analysis plays a major methodological role. Thus, feedback is the evaluation of the paradigm Initiation-Response-Feedback (IRF) (Van Lier, 1996), within which both initiation and feedback are performed by the teacher, sometimes with a stifling effect on the controller on the student's production. Sometimes, the student has difficulty producing meaningful, complete, and true statements, and may be apprehensive of public assessment given in the form of feedback.

Intelligent tutoring systems for foreign languages have incorporated techniques of Natural Language Processing (NLP), for example, for the analysis of natural language input from students or to model the competency of a foreign language. All this is to provide students with more flexible feedback strategies and help guides in the process of foreign language learning. These systems use specific techniques of parsers (parsing) to analyse the response of students and identify errors that occur in these sentences. These capabilities of natural language processing have allowed systems to handle more sophisticated feedback strategies as metalinguistic keys and "bug reports" based on an analysis of the error introduced by the student's response (Levin & Evans, 1995; Nagata, 1997; Sams, 1995).

Feedback and Reinforcement in CALL

In CALL, the emphasis may have originally been on the behavioural sense of the term 'feedback'.

As Kreindler (1998) correctly notes, the simple 'correct/incorrect' feedback has been the kind of response that CALL programs most frequently offered and the students learned what to expect from such programmes. This is the legacy of CALL based learning, which put learning again on the agenda by entering the information into small steps (easily digestible) and provided the reinforcement of good habits through feedback at all times. Just like James (1998), Tschichold (2003) believes that such feedback is useful only to a limited degree.

On the contrary, Kreindler (1998), whose approach indicates the fair closeness to cognition, argues for the flexibility of feedback forms, to give clues to correct answers without trying to 'bribe' the student with inflated praise (Schulze, 2003) and, if necessary, draw students to a variety of online resources powered by hypertext and network-based multimedia. These resources may well be dictionaries, glossaries, encyclopedias, concordances or the Internet (Kreindler, 1998). The criteria to provide good feedback in CALL are, according to Kreindler (1998), the following: (1) focus on the content and meaning, (2) support learning instead of testing, (3) be communicative and moderate (4) get personal involvement, (5) promote cognitive skills (eg. inference), (6) provide cultural enrichment, (7) differentiate among students, (8) be simple, clear and economical. Thus, it is obvious that for Kreindler (1998) feedback is a constituent part of the teaching and learning in a predominantly cognitive way.

All this, however, reflects and encourages student participation in receptive language skills rather than productive. On the contrary, Tschichold (2003), who also resents the kind of 'correct/incorrect' feedback, is interested in promoting a genuine second language (SL) input, which does not seem to be supported by Kreindler's approach (1998). While Kreindler (1998) is silent with respect to feedback in the form of the SL output, the point of view of Kuettner (1998) on feedback is more accurate. In his opinion, (Kuettner, 1998), the objective of learning the software is to transport, repeat, reinforce and analyse information. While the former appears to be suspiciously behavioural, the latter seems closer to a cognitive approach and would give way to feedback on form. The analysis of Kuettner (1998) to write support software reveals that teachers tend to believe that one of the virtues of good software packages is to have students analyse to understand, especially when it deals with more creative language learning

for students who know how to use the computer. This is according to Chapelle (1997), who is against the mere click as an output activity that is often and unfortunately the case in some CALL programmes.

Therefore, feedback in CALL, and in its feeder disciplines, has come to signify the information returned to the learner about the outcome of some action taken which may take a number of ways. The term 'reinforcement' also seems to be used in a rather loose way. Kuettner (1998), for example, uses it in distribution with 'information', even though originally it was associated with behaviour or cognition. Maingard (1999), on the other hand, introduces the term 'reinforcement' in CALL within the framework of evolutionary epistemology: this approach, derived by Donald T. Campbell and Gary Cziko on the basis of the epistemology of Popper science, sees knowledge first as a product of variation and selection processes that characterize the evolution (Heylighen, 1995).

Maingard (1999) agrees in particular with the hierarchical organization of knowledge as presented by evolutionary epistemology and the fact that without the lower level, which is the foundation for all subsequent learning, no progress can occur. She sees the lack of a solid foundation in SL learning, especially in the lower levels of competency and is enraged by the call of those followers of social interaction in the area of CALL for more communication and 'creativity'. Her argument is that without the key elements of language, creativity has nothing with which to work. She, therefore, makes a request for the restoration of the lowest level of learning, in which automaticity occurs through practice and reinforcement.

Maingard (1999) is accompanied in her request by DeKeyser (2001) who also believes in progressive automaticity and automation of certain linguistic and communicative tasks. He supports the idea of a three-dimensional SL curriculum that would move along the central diagonal of the low complexity of form, low complexity of meaning and low social pressure, to a higher complexity of form and meaning and increased pressure of linguistic functioning in socially demanding communicative situations. He believes that the automatic progression at each level, which he sees in a continuum, rather in a number of distinctive points like what evolutionary epistemology does, can be achieved by error feedback. Therefore, error feedback here assumes a similar meaning to the interpretation of reinforcement by Maingard (1999), an action that allows the learner to eliminate misperceptions and thereby achieve automaticity of knowledge.

To this end, Ferreira (2006) conducted an

empirical study based on effective feedback strategies for the teaching of languages in e-learning contexts. Much of this research had been directed to dealing with procedural skills' teaching systems in areas such as algebra, physics or computer programming, etc. However, there has been little emphasis on studies and research on such strategies in language teaching (ITS for foreign languages). This paper reported on the design of effective strategies for corrective feedback ITS in foreign languages.

Empirical evidence was explored concerning the effectiveness of feedback strategies in a study based on the experimental design - pre-test/post-test and control group - in which students interact with an e-learning application. The objective was to provide effective guidelines for researchers who develop feedback strategies for ITS for foreign language learning. Two groups of corrective feedback strategies were investigated: Group 1, which included the repetition of error and explicit correction, and Group 2 considered metalinguistic keys and elicitations from the response of the student (without giving the response) (Ferreira, 2006).

Ferreira (2006) reveals that, in general, the results showed that the strategies of Group 2 (metalinguistic clues and elicitations) supported the teaching-learning process of the subjunctive in Spanish more effectively than the strategies of Group 1 (repetition and explicit error correction). After three weeks of the treatment process, the strategies, attempting to look for, extract or elicit responses about the sequence of tenses and subjunctive clauses, were statistically more effective in producing the correct forms in contexts that required the use of the subjunctive mood. Ferreira (2006:123) states, "Now, as the treatment period was relatively short (3 weeks) and also small number of subjects (24 subjects), we will have to conduct further studies to confirm the trends have been observed in this work".

However, despite these limitations, the study suggests that students of intermediate and advanced levels were supported in their learning more significantly by Group 2 strategies. It is proposed therefore that ITS for a foreign language should implement corrective feedback strategies that encourage students to correct themselves and their mistakes.

L'Haire and Faltin (2003, p. 481) make the following observation about contemporary CALL and its potential to deal with errors: Computer Assisted Language Learning (CALL)

is a field in high demand for automatic language processing tools. The voice recognition software and speech synthesizers are certainly the most prominent sellable types of current commercial CALL software. However, the need in CALL for error diagnosis and intelligent and authentic feedback is great. Reliable error diagnosis systems allow users to overcome the limitations of multiple choice type questions and filling in the gap exercises, and to present communicative tasks to learners.

Although these are not explicitly stated in the text, the operating assumptions here seem to be those of Piaget's constructivism (Levy, 1998). The student is seen as an individual working alone with the computer as tutor, and not as a mere instrument. "The success, therefore, of the computer in the role of tutor, depends on how reliable the programme to monitor student learning and how timely, accurate and appropriate is the feedback" (Levy, 1998: 90). It would also appear that the type of feedback mentioned above would not be nearly as threatening as the teacher's publicly given feedback within the "Initiation-Response-Follow-up" framework, although on the surface, the purpose and structure may appear to be the same.

In another research done, Morales & Ferreira (2008) conducted an empirical study based on BLENDED LEARNING (face to face and e-learning classes) in which they provided effective guidelines for researchers who develop computer platforms for foreign language learning. The main objective was to visualize how the methodological principles from the language teaching approaches - Task-Based Language Teaching (TBLT) and Cooperative Language Learning (CLL) - could be applied effectively in the design of activities to develop language skills in e-learning and blended environments.

To this end, empirical evidence was explored about the effectiveness of learning English as a foreign language, in the face to face vs. blended modalities, in a study based on an experimental design - pre-test and post-test with control group. The results showed that the increase in learning English as L2 was higher in the experimental group that used a blended format than the control group who worked with the face to face modality. We propose, then, that models of blended learning methodology be included and implemented in the design of platforms for language teaching.

The use of feedback included in the platform

JClic for focus on form exercises strengthened the statement about the importance of using different strategies defined in CALL and ICALL applications investigated in studies which suggest that its use increases second language acquisition (Ferreira, 2006 & 2007). By incorporating these strategies in this model, the student was able to reflect and analyze in depth the linguistic elements of the target language. In this case, the feedback was an aid for learning, by using the application in the non face to face moments (e-learning) periods. Also, as JClic platform provides different resources for presenting materials, students benefited from a richer input in relation to the grammatical form than what generally would be provided in traditional instruction.

Ferreira & Kotz (2010), in another study about the importance of feedback in CALL, designed and implemented a computational parser for the processing of grammatical errors in Spanish as a Foreign Language. The particularity of this input parser is that it must process erroneous entries and for this to happen, it is necessary to predict the mistakes that the user might make at a particular time of learning and specific grammar topic. The particular objective is to contrast the taxonomy from a theoretical basis on specialized literature with empirical samples resulting from an observational study in traditional classes in order to obtain more detailed information about the mistakes that ELE students could potentially make, especially for those whose native language is English.

This research focus has been enriched by research from different disciplines, including second language acquisition, intelligent tutoring systems in procedural contexts, and intelligent tutoring systems for foreign languages. Thus, this research not only favours a specific area of study but it also nurtures both the face-to-face, non face-to-face and semi face-to-face modalities for language teaching.

According to the above, it should be noted that modern computer technology allows students to practise and get feedback on both their written and spoken output (Krashen, 1987). The spoken output requires the kind of evaluative technology that might not be necessary for the assessment of written output; often, it includes the analytical elements that characterize some of the computer support applications for writing. Therefore, the analysis begins with identifying the main trends that lead to errors and processing errors written in the framework of CALL.

The design of Intelligent CALL (ICALL) systems is founded on two fundamental assumptions about learning. First, individualized instruction by a competent tutor is far superior to the classroom style because both the content and the style of the instruction can be continuously adapted to best meet the needs of the situation. Secondly, students learn better in situations which more closely approximate the situations in which they will use their knowledge, i.e. they learn by doing, by making mistakes, and by constructing knowledge in a very individualized way. Initially, the feedback produced by Computer-Assisted Language Learning (CALL) systems was limited to simple error messages, using a "wrong-try-again" approach to interaction that offered little information about the nature of the learner's errors.

According to Garret (1995), four types of feedback are proposed for error treatment:

- (1) Feedback that presents only the correct answer;
- (2) Feedback that pinpoints the location of errors on the basis of the computer's letter-by-letter comparison of the student's input with the machine's stored correct version (pattern markup);
- (3) Feedback based on analysis of the anticipated wrong answers. Error messages associated with possible errors are stored in the computer and are presented if the student's response matches these possible errors (error-anticipation technique);
- (4) Feedback based on an NLP approach, such as the "parsing" technique, in which the computer does linguistic analysis of the student's response comparing it to an analysis derived from the relevant grammar rules and lexicon of the target language, and identifies problematic or missing items of the student's response.

In order for these feedback strategies to be effective, as part of an ITS for a foreign language, other key issues to be addressed have to do with the tutor model and the student model. Treatment of this type of corrective feedback strategies of the system requires engaging with issues such as:

- (1) The incorporation of feedback strategies in a natural and authentic way within a teaching approach;
- (2) The definition of the degree of explicitness of feedback strategies. It is necessary to choose between feedback strategies that draw student attention to the error discreetly and those who direct the student's attention to the problem area more explicitly;
- (3) Taking into account the degree of effectiveness of feedback strategies in accordance with the types of error, learning level and type of strategy.

Conclusion

It is sufficiently clear that multimedia technology offers, no doubt, many advantages. It encourages the process of foreign language learning, which always requires a long and continuing effort by the student, in the sense that it provides many opportunities and facilities to get a better performance in this effort, while adapting to the individual learning pace of each student. It helps to develop, especially, oral and written comprehension, vocabulary acquisition and retention, and it also helps to improve pronunciation.

A good deal of ambiguity commonly attends discussions of foreign language research in connection with the computer. Among the literature faculty in the foreign language departments of research-oriented institutions, the use of the computer is usually linked to scholarly textual research, in which the computer performs text manipulations such as collocations. In foreign language education, research projects are usually methodological, and research on the computer is often assumed to focus on the computer's efficacy in delivering foreign language instruction. In addition, the computer can collect the same kind of student language output as do paper-and-pencil exercises; it can be programmed to recognize correct and incorrect language and to supply scores on which to base conclusions about various methodological treatments.

The development of software is not recognized as research by most major research universities, any more than is the writing of textbooks. Furthermore, the computer-equipped "language lab" is almost universally thought of as a service unit, a place for the most mechanical, most tedious aspects of language instruction, not as the locus for substantive promotable research. For both these reasons, junior faculty members who are interested in the use of the computer are often warned that such activities will not count toward tenure. This is a serious problem, resulting in the waste of significant opportunities for the advancement not only of these faculty members but also of the field of foreign language education itself.

The solution depends on certain complementary changes. On the one hand, foreign language faculty members and administrators above the department level must understand what distinguishes this kind of research from "pedagogical" studies and what its value is. On the other hand, setting up a computer site to accommodate language-acquisition research

by faculty members as well as language-learning activities by students is not a matter of extra hardware or even of much extra expense. The real essential is the staffing. To have validity as a research facility, the centre must be an academic unit directed by someone with research credentials in the field.

To accomplish that change in perception we need also to enhance the visible status of the research, and one factor in that status is the attitude toward the research locus itself. As long as the "language lab" is thought of as nothing more than a roomful of machinery where students slog through dreary impersonal drills, faculty efforts in that arena will have no prestige.

The most important potential of the computer lies in its ability to provide a richly supportive language-learning environment in which students are helped individually to develop, expand, and refine their own expressive and communicative abilities in a new language as well as to understand what language and language learning are all about—surely important parts of a liberal education. Computer-assisted learning must be the focus of our efforts, but our development of its potential will significantly affect our teaching and our research as well.

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TAILORING HIGHER EDUCATION IN KENYA TO THE DEMANDS OF THE POSTINDUSTRIAL WORK PLACE.

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Abstract

The unemployment rate and the disappearance of certain jobs in the Kenyan work place is a major concern that needs urgent attention. This paper does not necessarily focus on labor market analysis or how to improve graduate employability, but rather attempts to present an anthropological description of the contemporary work place, a reality that most educators may not be familiar with. It reveals the new patterns in organizational structures with a focus on customization and globalization; and stress on the demand for design rather than mass production that characterized the traditional work place. Implications for individual workers and challenges to higher education in terms of academic screening, the curriculum specificity, the basis of education and schooling are discussed. The paper stresses the importance of understanding the changing requirements for today's laborers as this has important implications on higher education in terms of skills, training and capacity. Specifically, educators are asked to respond to the question "What does it feel like to produce graduates whose employment is not guaranteed? This question is foundational and intentionally asked in this paper to awaken the responsibility and imagination of educators, for without a sense of responsibility and imagination the gross problem of unemployment of the Kenyan graduates will not be solved.

Key Words: Higher Education, Post-Industrial Work place, Unemployment, Liberal Education.

Introduction

This paper is premised in the thought that the fundamental responsibility of any institution of higher learning is to identify and provide solutions to societal problems. Unemployment being one of the greatest ills of society today, deserves the attention of university scholars in Kenya and else where. This paper attempts to articulate the state of unemployment of graduates in Kenya. It reveals the new patterns in organizational structures with a focus on customization and globalization; and stress on the demand for design rather than mass production that characterized the traditional work place. The paper addresses implications for individual workers in terms of the types of jobs available and the generic skills required, and challenges to higher education in terms of academic screening, curriculum specificity, and the basis of education. Emphasis is made on the importance of understanding the changing requirements for today's work place and implications on higher education in terms of skills, training and capacity. The paper recommends a liberal arts education.

The State of Unemployment of Kenyan Graduates

What does it mean for our universities to produce graduates whose employment is not guaranteed? According to the report, ILO Global Employment Trends for Youth 2010, out of the world's 620 million economically active youth, aged between 15 and 24, about 81 million were unemployed at the end of 2009. This is the highest number recorded in history. The report estimates that the youth unemployment rate had increased from 11.9 percent in 2007 before the global financial crisis and was now more than 13 percent at the end of 2009.

Records in the Ministry of Youth and Sports show that there are only 125,000 young people (18-35years) registered with formal employment nationwide, among Kenya's population of nearly 40 million: and the majority are graduates. Muthee (as cited by McEnrue, 2011) puts the unemployment rate for youth 15-35 years old at 65%. According to chief economist and director of research and education at the Central Organization of Trade Unions—Kenya, COTU-K new graduates struggle to find jobs because they still

lack the necessary skills to compete in some markets. Therefore, unemployment is not only resulting from lack of jobs but inadequacy of the educational infrastructure (Nesoba, 2010; Mwirigi, 2011). This trend has been picking up from the early 1970s, especially among the arts graduates when the word 'tarmacking' (job hunting) was coined to describe the situation that has now escalated (Bogonko, 1992). To put the problem of unemployment into perspective, let us look at new patterns of organizational structures of the work place, the available jobs and the generic skills required in contrast to what higher education in Kenya offers today.

New Patterns of Organizational Structures of the Work Place

The changes in the 21st century work place are best revealed in the new patterns of the organizational structures common to most companies today. As Cheng (2007) points out, unlike the traditional large industrial enterprises, the modern companies vary from small to medium in size with a minimal number of employees. This is not only the case of countries like Hong Kong with typically smaller service economy, but also the United States with a much larger economy (U.S Census Bureau 2007, as cited by Cheng, 2007) ; and the trend is spreading globally to countries like Kenya. The change in the average company size correlates with the general shift from the large production to increasingly customized products and services. Customization here means that products and services are tailored to the unique needs of customers. Cheng suggests that with customization the diversity of products increases while the demand for each product decreases. When services are customized the transactions are more direct and there is no need for the traditional large organizations, hence the shrinking of some jobs and emergence of others.

A typical example in Kenya is the banking system which used to have many cashiers to take care of deposits and withdrawals. Over the years these banks have created and developed customized services through receptionists, individualized tables and ATM machines relegating the cashier counters to the back office or replacing them all together. There is also a multiplicity of umbrella organizations with branches within and across the Kenyan border controlled by the same parent group. For instance, the Nakumatt supermarket and Bata (shoe industry) are spread in every town in Kenya and across into

neighboring countries like Uganda; and every branch is equipped with some very unique products and services. These patterns reflect a theme common to the changes in traditional productions and goods. Indeed, this new pattern of organizations carries with it aspects of globalization and the "vision 2030" (National Economic and Social Council of Kenya, 2007).

There are major shifts in the global market place, especially with the use of computers. Rule based jobs that require deductive thinking and easily recognizable patterns are easily taken up by computers, or outsourced to workers in another country, or both (Levy & Murnane, 2007). However, Levy and Murnane reject the fact that computers will finally replace human labor; they spot such unique human skills, intellectual and emotional capabilities in the category of expert thinking and complex communication that can never be supplanted by computational technologies. Unfortunately, today's pedagogical practices at our universities are short of these much needed skills. They rather focus on what Einsner (1979) termed as associative reasoning, a serious handicap to skill development. This is the kind of reasoning that is resonated and, therefore, lacks originality and creativity.

No wonder, a significant number of graduates can not easily find jobs, and are often forced to compete for lower skilled jobs. This especially applies to jobs with an international focus. Manda and Sena (2004) used both industry-level and firm-level data to examine some of these effects on employment and earnings in the Kenyan manufacturing sector, and found that the overall effects of international trade on manufacturing employment was negative in the 1990s (a trend that spills over into the millennium). Their firm-level analysis indicated that less skilled workers experienced losses in earnings, and that the inequality in earnings between skilled and unskilled workers had increased. This finding has serious implication on the preparation of graduates for the job market.

Globalization has also created a new situation in which the mode of production is in knowledge generation, information processing, and symbol communications as opposed to the industrial mode that was based on production of energy. In fact, Lash (2007) posits that the logic of manufacturing is getting displaced by the logic of information (as cited by Roth & Gur-Ze'ev, 2007), and the central position of information will now dictate the competencies required of the labor force. There is

also a shift from top-down to lateral management. Instead of distributing work to a mass of laborers coordinated through middle management and separate departments, organizations are operating around smaller working groups- typically the task forces, production teams and project groups.

Procedures, rules and regulations are replaced by exercise of autonomy and self governance (abilities in acting ethical and principled). Workers do not, strictly, specialize, but contribute through integration of different talents, expertise and experiences. This collaborative team effort places a new premium on communication, a skill that should be emphasized in higher education curriculum (Cheng, 2007). In the post industrial work place there is, notably, much more need for design as opposed to production, resulting in increased demand for designers. Subsequently, decrease in the demand for front-line laborers (blue-collar jobs). As mentioned earlier, service industries have become customized and direct; meaning that the front –line worker now bears the responsibility of design, problem solving and decision making; qualities that are lacking in our Kenyan graduates (Mwigiri, 2011).

Available Jobs and Skills Required in Preparation for the Work Place

With all these major shifts at the work place, it is important to study the job market to find out the kind of jobs that will be available for our graduates in the post industrial era. From the World Bank report, Kenya's gross domestic product by sector is agriculture (22%), services (62%) and industry (16%). This suggests that most jobs are available in the service sector (World Bank, 2010). Levy and Murnane (2007) observed a similar trend in the United States of America, though their study also cited growth in sales, professional, managerial and technical occupations. Their argument is that service occupation can not be taken up by computers because it requires optical recognition and many physical movements that can only be done sufficiently by human beings.

The sales market also requires complex exchanges of information that can only be carried out by human beings. In addition, professional, managerial and technical occupations involve higher human cognitive skills such as formulating and solving new problems, exercising good judgment and creating new products and services. This explains the current shrinking of jobs for unskilled workers, and limitless

space in freelancing and entrepreneurship (McEnrue, 2011). These changes, clearly, show that human interaction is a central element of contemporary workplace dynamics. As such, there is need to develop generic skills such as competencies that entails to presentations, negotiation, brainstorming, persuasion, debates and arbitration, capacities for decision making, problem solving, critical thinking, team work and integration, flexibility in dealing with personal differences and conflicts, ethical and emotional stability, socializing and networking, confidence and self- reflection (Cheng, 2007). The 21st century worker is required to work smarter, not harder! Thus, the prospective graduates need more than training in their specializations in order to fit in the job market (Humphrey & Stokes, 2000).

Challenges and Implications for Higher Education in Kenya

Looking at the jobs available and the generic skills required upon graduation, are our universities preparing students for a successful integration into the job market? To larger extent no! The Kenyan higher education system still nurses “platonic” views, inherited from the British colonial masters, as seen in higher cut marks that give only a few students a chance to get a university education, hence a good job. The Kenyan curriculum is structured in a way that classifies and ranks students rigidly to fit in the old patterns of the colonial psychology. Its very sequence of 8-4-4 (meaning eight years of primary education, four years of secondary education and four years of university education) subjects one to be in school much longer and pay much more, especially at tertiary level. This pattern is copied from North American education. D'Souza (1987) compares the four years spent by the American graduates with British three years of tertiary education and still finds the later more affordable and superior in standards.

During the first eight years which culminate into a national exam Kenya Certificate of Education (KCPE) emphasis is on the basic skills of Writing, Reading, Arithmetic and Social Education. The secondary school curriculum, though aimed at improving the above named basic skills, is more subject centered than skill oriented as evidenced in its pedagogy and the three volumes of the syllabus as follows- volume one; English, Kiswahili, Arabic, French, German and Physical Education; volume two has Mathematics, Physics, Chemistry, Biology, Agriculture, and Home Science; and volume three

contains History and government, Geography, Business Studies, Christian Religious Education and Hindu Religious Education. Students take a minimum of seven subjects in which they are examined at the end of the four years in the Kenya Certificate of Secondary Education (KCSE) (Ministry of Education Secondary School Syllabus, 2010).

The exam which mainly tests cognitive skills only permits a few students to join university as there is scarcity of space. At the university students specialize in different disciplines in the categories of humanities, Sciences, Education, Medicine, Nursing, Engineering, Business Education, Architecture and Law- to mention a few. University education being the panacea for a good job is recently rising in demand leading to mushrooming of university extensions in most of the Kenyan towns. This scenario of higher education expansion has compromised quality of graduates, and is a serious concern to employers.

The process of job-predestination is supported by outdated assumptions that there are smart and dumb kids (not everybody can learn), knowledge is the standard measure for intelligence, qualification pyramid in education matches the man power pyramid in society (at all times), people should have occupational identity, knowledge is divided into disciplines and specialization is an indicator of a person's intellectual level (Bogonko, 1992; Cheng, 2007). These assumptions are discredited by the current theories that dictate operations at work places. For example the assumption that knowledge is a standard measure for intelligence is challenged by Gardener's (1983) theory of multiple intelligences.

According to this theory human beings have eight intelligences; linguistic, logical mathematical, spatial, bodily- kinesthetic, musical, interpersonal, intrapersonal and naturalistic. An individual can be stronger in more than one area, thus preparing them for strict occupational identity or dismissing others for academic failure is wrong. Meaning, university education should go beyond the current mosaic structure and focus on broader themes that embrace multiple intelligences in each of the learners. In the words of Mansila and Gardner (2007), the post industrial education systems call for a distribution of areas and levels of expertise in which trained teacher-brokers are used.

This whole process demands for the development of more generic capacity, and as Moisis and Suoranta's (2007) stress all "people must be provided with opportunities to develop skills in

multiple literacies" in order to maintain hope in their lives (p. 237). The duo pursue the concept of hope in pedagogical freedom by asserting that students and educators should be given the autonomy to cooperate in multidisciplinary approaches that open up "thinking spaces" so that they can develop critical understanding. They argue that:

The way to do this is to give students more possibilities to participate in the planning processes... spaces other than the lecture halls and classrooms to practice. This informal learning includes news papers, radio stations, and various forms of independent media, as well as possibilities for voluntary work... a chance to 'go public' to grow up as public and transformative intellectuals with critical and hopeful minds (p. 243).

White (1952) believed that every human being "is endowed with a power akin to that of the creator-individuality, a power to think and do. It is the work of true education to develop this power, to train the youth to be thinkers, and not mere reflectors of other men's thought" p.17. She stresses that the youth should be taken beyond that which men have said or written; be directed to the sources of truth, to the vast fields of research so that they contemplate the great facts of duty and destiny. Dialogue and collaborative learning through research must be the key factors in preparing creative, innovative graduates; with complex communication and social skills needed for today's work place.

From this perspective lies the crucial need for the university education to embrace some informal structures that characterize the African civilization. Our strict adherence to the formal education as it was given by the colonial government, will not allow us to practically deal with the "Kenyan problems", and create "the Kenya we want". Efforts towards emancipation and reformation- as visualized in the vision 2030 and the Millennium Goals, can only be achieved in the Kenyan context, particularly in our universities, where we have top academicians and researchers- who must begin to look at the curriculum content of their subject areas within the context of the most critical problems of the Kenyan society- ignorance, poverty and disease (Bogonko, 1992; Mwigiri, 2011). The professors must consider how to bring about a just, cohesive and a people oriented democracy. For now the Vision 2030 is just but a mirage, for we still glorify in the colonial cognitive formality- focusing on knowledge transmission rather than configuration (creation) and dissemination.

Lumumba (2011) calls for cross-pollination and fertilization of ideas so that we are able to subdue the earth before it subdues us.

On a sad note, this is not happening; Mwigiri (2011) observes that "students who are products of Kenya's formal education are not able to develop and use original, inventive, innovative and entrepreneurial competencies"-that in cooperate cross-pollination and fertilization of ideas. In fact research shows that entrepreneurship is not robust in the Kenya higher education curriculum. As McEnrue (2011) cautions, serious ethnic attitudes must be addressed before entrepreneurship can be accepted as an alternative source of education and employment in Kenya. Nafukho and Muyia (2009), some of Kenyan top professors, believe that if entrepreneurship picks up it can be a strategic approach in addressing the unemployment problem among university graduates in Kenya and Africa in general.

In line with the service and technological needs of the post industrial work place, Kenyan universities need to create a balance between service and technological oriented disciplines (such as Business Education, Education, Information Technology, Family and Consumer Sciences, Psychology, Health Sciences and other related courses) and traditional disciplines such as History, Physics, Geography and Theology. It is in this balance that a properly designed liberal arts education cohabits with technological skills and practical services to produce employable graduates. After all, the chief purpose of education is to prepare the student for service for the joy of service in this world and the world to come (White, 1952). Universities that have realized this purpose are already redesigning their courses to capture this blend.

Liberal Arts, Service Education and Technology: *The Way to Go*

Okeda (2011) in a TV interview on "Managing Generation Y at the Work Place", advised on the need for partnership and mentoring collaborations between mother universities and the work places; to nurture potential employees and the newly employed graduates. Such programs should stress tacit knowledge, civic education, moral education, emotional intelligence and soft skills, internship programs, authentic assessments, learning communities, and problem- based learning. The dynamic nature of the work place requires such life long education, especially in management of

information (Moisio & Suoranta, 2007). All these point to the need for broad based human development (capacity building). This was, and still is, the original purpose of education. In fact, true education is "the harmonious development of the physical, the mental and the spiritual powers" (White, 1952, p. 13). Dewey long ago, pointed out to this, when he said that "a democratic criterion requires us to develop capacity to the point of competency to choose and make ... own career" (Dewey, 1916, p. 119 cited in Eisner, 1979).

Unfortunately, some fourth year students in our universities are still incapable of making sensible vocational choice. Some graduate and keep changing jobs. To solve this problem, universities need to establish career centers where students can learn about their aptitudes and interests, course offerings and make comparisons with market demands. Such programs should also help students on job related experiences- job search, writing vitas, and preparing for interviews. Holmes (1997) recommends liberal arts education, for it has this kind of setting. He argues that liberal education has the advantage of a broad- based curriculum that offers more transferable skills, richer personal qualities and long lasting values that are important for career preparation and general service. He further observes that "the same understanding, skills, and values that constitute career preparation make good life preparation as well" p. 41. Therefore, if our universities will adopt some elements of the liberal arts education, the society will benefit analogously in terms of relevant man power and good citizenship.

However, critics of liberal education are of the opinion that it can contribute little to the development and transformation of society if there is over-attention to the subject matter. The advice is for higher education providers to strike a middle ground curriculum, in which the students' respond authentically, and find their own voices in practical aspects of the society- through research, service education, community outreach, and collaborative projects. In fact Kent State university, in US, has designed a degree specialty that is not so studio intensive but serve students who want to work in the design industry, thus catering for the market demand (D'Ambrosio & Ehrenberg, 2007) . After all higher education is versatile, a social institution and industry. In this sense practical service and technological skills are blended in liberal arts education, in a way referred to as "the conversation of mankind". This

conversation that started in the primeval forests and extended, should not just be a simple narration as presented in liberal arts, but be made more articulate in higher education through acts of logical, critical and reflective conversations (Roth & Gur-Ze'ev, 2007). Initiation into this kind of conversation symbolizes the liberating act of education which should help the universities in bringing socio-cultural transformation to the society in away that meets the exigencies of the market.

Conclusion

In view of the changes in the post industrial work place educators should “practilize” their curriculum in order to produce graduates who will fit in the world of work. Successful reform calls for partnership with external stakeholders including government and the private sector. Institutions of higher education can establish partnerships with business and industrial sectors of the economy. Students can benefit from training programs like internships, workplace seminars, and symposia gaining workplace insights and mindset, which will be beneficial in their prospective careers. The preparation and training of graduates should not only be restricted to making them suited to the postindustrial workplace as employees with employable skills, but in engendering in them entrepreneurial and business acumen as (self)-employers, who would be the engine of growth of the Kenyan economy. The courses must have both technical and practical relevance, that arouse in learners cognitive, affective and physical abilities that permit them to be expert thinkers, designers, and principled individuals. University education should, in deed, provide opportunity for student’s personal development in terms of; a passion for nature, a commitment to society, perseverance, familiarity with other cultures, a sense of justice, belief in equal rights and tolerance of diversity at work place as they compete globally. Remember, the process of learning at our universities should empower students to work smarter not harder!

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