Forward

I have the pleasure to furnish you herewith the Proceedings which herein contains a collection of the papers presented at International Technology, Education and Environment Conference (TEEC2013) organized by African Society for Scientific Research and African Association for Teaching and Learning in cooperation with several partners and collaborating journals. The conference was held August 12-15, 2013 at Michael Okpara University of Agriculture, Umudike, Nigeria.

The TEEC series is an academic activity for interested scholars, educators, scientists, technologists, environmentalists, policy makers, corporate bodies and graduate students. The aim of the conference is to diffuse research findings and create a conductive environment for scholars to debate and exchange ideas that lead to development in social, political, technological and economic spheres of the global community.

Following the call for papers by the International Scientific Commission, papers we received more than 80 proposals from 15 different countries from all continents. As a commitment to the vision and mission of academic excellence and integrity, each paper was anonymously reviewed by two members of the editorial sub-committee of the Commission. This book of proceedings contains a selection of the papers presented at the conference.

We wish to express our sincere thanks to the Michael Okpara University of Agriculture, Umudike, Nigeria for providing the venue and facilities for the conference and for being committed to towards ensuring the success of the conference. We thank the management and staff of our institutional partners for their cooperation and support for the project. We express our profound gratitude to all and sundry especially our Special Guests, delegates, reviewers, the media, the Nigerian foreign missions and all the cooperating partners for their contributions in promoting this noble academic event.

Please read on!!!

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TEE C2013

International Scientific Commission

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SECURITY SKILLS DESIRED OF OFFICE MANAGERS BY STAKEHOLDERS:
The Participatory Dimension

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Introduction

Although security has always been man’s anxiety from conception, often times, the idea of it being the responsibility of first parents, next other adults, followed by institutional backgrounds surrounding man and then lately the government, especially in the present democracy. Security is seen by Wikipedia (2011) as the degree of resistance to or protection from harm or hazards of any type. This idea signifies or portends an element of vulnerability on the part of the entity involved such as persons, properties, documents, communities, nations, environment, etc. (en.wikipedia.org/wiki/security). In the air, sea, bush, home, on land, etc; there is need for people to be and feel secured from harm of any type. Security has been typified into; job, global, internet, IT(computer), national, physical, finance and documentation (Information); en.wikipedia.org/wiki/job-security.

While Job security has to do with the type of job that has the probability that someone will keep his job because it guarantees good pay, good healthcare, good care after retirement; IT security has some essentials outlined for guiding the Computer against viruses, spywares and other malicious soft-wares. Courses abound that teaches on the right things to be done to keep organizations secure (www.sans.org/course/security-essentials-bootcamp-style).

In recent times, however, security issues have taken dramatic and huge dimensions. The advanced countries saw it a long time from now and made attempts to curb, in the intent of eradicating the vice. The under-developed and developing countries are only beginning to experience the magnitude because governance has now been left in their hands in addition to tackling the menace of insecurity alongside with other vices.

It was not until the September 11, 2001 bombings saga that the world realized that insecurity could also engulf the strong, hence the rich also cry. When we recall that America was really not at war and is also not Islamic, it was indeed a rude shock to the world, especially those who regarded America as the big brother that will protect them when invaded.
The American case is that of physical with mental and economic undertone. The importance of taking a holistic look at security has now become issues of global importance. Individuals, organizations, information, environment, military and economy have taken the center stage and thus sharpened the emphasis, thus laying benchmark for security issues.

Terrorism (as was tagged the September 11, 2001 saga), arson, kidnapping and abductions, environmental degradation leading to climate change, human and drug trafficking, robbery, corruption, hacking and accidents of various types have all triggered up the need for security skills and consciousness heightened by advances in technology as a result of globalization. It is therefore, obvious that without relative peace and harmonious environment, no sustainable development can be achieved. With the number of natural and man-made disasters happening daily, we cannot ignore the debilitating consequences of hunger, poverty, death, sickness, unemployment, under-development arising there from and demanding intensified security measures. This unusual times demanding unusual solutions to the daunting challenges should make room for waste free skills that can abate, if not eradicate the situation.

**Participatory dimension aimed at social, economic, environmental and global protection**
As a result of this need, change mechanism put in place must reflect the involvement of these multi-facetted entities in order achieve positive results (World Bank, 2004 in Adesola (2012).

The Office Manager, who constitutes one of the people in the organization is seen as the human resource whose actions, reactions and counter-actions reflect the happenings in a work system. Here it must be noted that his activities cannot be divorced from his personal, work and neighborhood environment, hence these environments if not properly considered would improve or hinder his progress. The activities of the Office Manager in the present security challenges are not shielded from harm or contributions for a better society. Unfortunately, the importance of people as vital assets in this dispensation is largely overlooked at this time and period and so this is reflected in the often huge losses recorded.

Documentation has in this present era been regarded as the highest innovation of our time that has engendered series of sporadic technological inventions mostly aimed at protecting nations, peoples, organizations, environments, etc. In spite of technology, the human person (who plans, designs, implements, sustains and makes relevant but correct changes) must be allowed to take an upper hand in developmental strides, especially in securities. Our robots, sophisticated machines and other processes require the intellectual potentials of the human person to meet desired global and local expectations.

Skills are seen as learned or developed abilities/capabilities to carry out pre-determined tasks with a view to achieving results. Survival of the individual or organizations, hinge
therefore, on available skills and competencies. It is obvious in this definition that there must be a willing individual, determined to acquire the necessary abilities through repeated actions/reactions to the extent that practice makes for proficiency (en.wikipedia.org/wiki/skill).

The need for security skills hence is of no less importance in a society massively ridden with disaster tendencies. So many skill acquisition techniques have been initiated recently, especially in connection with our current amnesties. The 2003 skill acquisition model of Dreyfus and Dreyfus supported by Cheetham and Chivers (2005), Dekeyser (2009) among others has identified “novice, competence, proficiency, expertise and mastery” as the stages through which one has to go to achieve good results. In the model, one moves from taking instructions/orders to thinking and organizing laid down principles as gathered during the initial stage; then active decision-making concerning the tasks to developing intuition to guide decisions and finally utilizing tacit knowledge to improve, master, innovate on the tasks. According to Madumere (2012), there is relative low awareness of students and subsequently the Nigerian public to the necessary ingredients of the environment and what constitutes changes to it and the human being around. This has impacted negatively to the demanding security measures needed for sustainable development.

Computer security: This implies information security as applied to the processes and mechanisms of computers and other networks. It has always been broken by hackers, thus the need to protect them. Examples include the 2010 Wikileaks saga as well as the recent (2013) Edward Snowden information leakages on US security strategies.

**RE-ORDERED QUESTIONNAIRE**

**Research Question 1:** Mean responses on the importance of Security skills for protecting oneself as required by Office Managers on the job.

<table>
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<th>S/n</th>
<th>Variables</th>
<th>VN</th>
<th>N</th>
<th>UD</th>
<th>U</th>
<th>V</th>
<th>U</th>
<th>Decision Ranking</th>
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<td>14</td>
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<td>00</td>
<td>740 104 6 00 00</td>
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<td>00</td>
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<td>3</td>
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<td>00</td>
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<td>Ability to withhold from being nosy</td>
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<td>10</td>
<td>18</td>
<td>6</td>
<td>00</td>
<td>230 424 54 12 00</td>
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<td>5</td>
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<td>N</td>
<td>U</td>
<td>D</td>
<td>N</td>
<td>V</td>
<td>U</td>
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<tr>
<td>12</td>
<td>64 88 16 8 00 320 352 48 8 00 736</td>
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<td>A</td>
<td>10th</td>
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**Research Question 2:** Mean responses of Stakeholders on the Security skills for protecting documents in the office

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<th>S/n</th>
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<th>VN</th>
<th>N</th>
<th>U</th>
<th>D</th>
<th>N</th>
<th>V</th>
<th>U</th>
<th>N</th>
<th>weight</th>
<th>f&lt;\bar{x}&gt;</th>
<th>x̄</th>
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<th>Ranking</th>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td>18</td>
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<td>A</td>
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<td></td>
<td></td>
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<td>19</td>
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<td>20</td>
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them in cases of security

<table>
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<th>Variables</th>
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<th>UD</th>
<th>U N</th>
<th>V U N</th>
<th>Weight</th>
<th>f̅x</th>
<th>Dec (ação)</th>
<th>Rank-ing</th>
</tr>
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<tr>
<td>21</td>
<td>Ability to utilize search engines to acquire knowledge</td>
<td>64</td>
<td>16</td>
<td>8</td>
<td>00</td>
<td>320 352 48 16 00</td>
<td>736</td>
<td>4.18</td>
<td>A</td>
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<tr>
<td>22</td>
<td>Ability to use given information</td>
<td>60</td>
<td>4</td>
<td>8</td>
<td>00</td>
<td>300 416 24 8 00</td>
<td>748</td>
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<td>Knowledge management</td>
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Research Question 3: Mean responses on the importance of Security skills required by Office Managers for protecting others on the job.

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<th>UD</th>
<th>U N</th>
<th>V U N</th>
<th>Weight</th>
<th>f̅x</th>
<th>Dec (ação)</th>
<th>Rank-ing</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Ability to recall important phone numbers in case of danger/emergency</td>
<td>11</td>
<td>2</td>
<td>00</td>
<td>00</td>
<td>550 256 56 00 00</td>
<td>812</td>
<td>4.61</td>
<td>Accepted</td>
</tr>
<tr>
<td>25</td>
<td>Ability to refrain from answering questions on others when this is capable of putting them in danger</td>
<td>66</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>330 360 24 20 00</td>
<td>736</td>
<td>4.18</td>
<td>A</td>
</tr>
<tr>
<td>26</td>
<td>Ability to warn others from danger</td>
<td>74</td>
<td>00</td>
<td>2</td>
<td>00</td>
<td>370 400 00 4 00</td>
<td>774</td>
<td>4.40</td>
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</tr>
<tr>
<td>27</td>
<td>Ability to be a good team-player</td>
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<td>4</td>
<td>00</td>
<td>450 312 12 8 00</td>
<td>782</td>
<td>4.44</td>
<td>A</td>
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<tr>
<td>28</td>
<td>Ability to protect the boss/employer/superior from unnecessary pressures or interference</td>
<td>68</td>
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<td>2</td>
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<tr>
<td>29</td>
<td>Ability to work in the interest of the organization and not self</td>
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<td>6</td>
<td>6</td>
<td>00</td>
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<td>30</td>
<td>Ability to ensure improved performance</td>
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<td>00</td>
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<td>608</td>
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<tr>
<td>31</td>
<td>Ability to identify and take away objects that can constitute weapons of destruction</td>
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<td>4</td>
<td>00</td>
<td>420 336 12 8 00</td>
<td>776</td>
<td>4.41</td>
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<tr>
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### Research Question 4: Mean responses on the importance of Security skills for protecting the environments of the Office Manager

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- Deci: A
- Rank: 6th
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**COMPARISMS BETWEEN MALE AND FEMALE RATINGS OF RESPONDENTS ON THE NEED FOR SECURITY**

1. 55(63%) 8(9.1%) 1(1.1%) 0(0%) 0(0%) 19(21.6%) 5(5.7%) 0(0%) 0(0%) 0(0%)
2. 35(39.8%) 27(30.7%) 2(2.3%) 0(0%) 0(0%) 12(13.6%) 11(12.5%) 1(1.1%) 0(0%) 0(0%)
3. 35(39.8%) 28(31.8%) 1(1.1%) 0(0%) 0(0%) 9(10.2%) 15(17.1%) 0(0%) 0(0%) 0(0%)
4. 20(22.7%) 34(38.6%) 7(8%) 3(3.4%) 0(0%) 3(3.4%) 19(21.6%) 2(2.3%) 0(0%) 0(0%)
5. 49(55.7%) 13(14.8%) 2(2.3%) 0(0%) 0(0%) 18(20.5%) 6(6.8%) 0(0%) 0(0%) 0(0%)
6. 37(42.1%) 27(30.7%) 0(0%) 0(0%) 0(0%) 12(13.6%) 12(13.6%) 0(0%) 0(0%) 0(0%)
7. 34(38.6%) 27(30.7%) 3(3.4%) 0(0%) 0(0%) 14(15.9%) 9(10.2%) 1(1.1%) 0(0%) 0(0%)
8. 44(50%) 14(15.9%) 1(1.1%) 5(5.7%) 0(0%) 16(18.2%) 7(8%) 0(0%) 0(0%) 0(0%)
9. 33(37.5%) 28(31.8%) 0(0%) 3(3.4%) 0(0%) 14(15.9%) 8(9.1%) 0(0%) 1(1.1) 1(1.1%)
10 13(14.8%) 32(36.4%) 11(12.5%) 8(9.1%) 0(0%) 4(4.6%) 10(11.4%) 5(5.7%) 4(4.6%) 1(1.1%)
11 29(33%) 28(31.8%) 4(4.6%) 3(3.4%) 0(0%) 10(11.4%) 13(14.8%) 1(1.1%) 0(0%) 0(0%)
12 24(27.3%) 33(37.6%) 6(6.8%) 1(1.1%) 0(0%) 8(9.1%) 11(12.5%) 2(2.3%) 3(3.4%) 0(0%)
13 17(19.3%) 38(43.2%) 9(10.2%) 0(0%) 0(0%) 5(5.7%) 12(13.6%) 5(5.7%) 2(2.3%) 0(0%)
14 25(28.4%) 33(37.5%) 5(5.7%) 1(1.1%) 0(0%) 6(6.8%) 15(18.2%) 2(2.3%) 0(0%) 0(0%)
15 24(27.3%) 36(40.9%) 3(3.4%) 1(1.1%) 0(0%) 4(4.6%) 18(20.5%) 2(2.3%) 0(0%) 0(0%)
16 16(18.2%) 24(27.3%) 13(14.8%) 8(9.1%) 3(3.4%) 7(8%) 10(11.4%) 4(4.6%) 3(3.4%) 0(0%)
17 29(33%) 27(30.7%) 6(6.8%) 2(2.3%) 0(0%) 5(5.7%) 17(19.3%) 2(2.3%) 0(0%) 0(0%)
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A SUB-GROUP DECOMPOSITION ANALYSIS OF LAND INEQUALITY IN THE LIMPOPO RIVER BASIN OF SOUTH AFRICA

Abayomi Samuel Oyekale,
Department of Agricultural Economics and Extension,
North-West University Mafikeng Campus,
Mmabatho 2735 South Africa.

Abstract
Land inequality in South Africa is a problem that is deeply rooted in land use policy of the dethroned apartheid government. Although land reform is advocated as a means for rectifying the havocs of the past and ensuring that economic development process that favours the poorest segments of the population is set in motion, government has faced a lot of difficulties in its implementation. This study therefore analyzed the degree of inequality in the Limpopo River Basin. The data were collected by the International Food Policy Research Institute (IFPRI) and the Centre for Environmental Economics and Policy in Africa (CEPPA) in 2005. Only 794 households completed the questionnaires out the 800 that were initially targeted. Data analysis was implemented with descriptive statistics and Gini sub-group inequality decomposition. Results show that land inequality is high with overall Gini being 0.9212. Also, inequality between the groups accounts for the highest share of total Gini. It was recommended that efforts at ensuring equity in land ownership should be speeded up with due consideration of inequality across the districts.

Keywords: land fertility, land ownership, decomposition, land reform

Introduction
The constitutional mandate for correcting the injustices invoked by the South Africa’s 1913 Land Act by ensuring equitable land distribution had been clearly spelt in the Act No. 108 of 1996. This is well understood by all citizens because issues of land are very sensitive in the socio-economic development and political agendas of South African government. No doubt, agitation of many South Africans during apartheid era were largely bordered on forceful and illegal dispossession of land. It is already indicated in the land reform policy that restitution of illegally possessed land to initial owners and redistribution of land to landless citizens are paramount policy agendas which have been tenaciously pursued by the government. Also, land reform has been seen as a means for having a development process that can favour the poorest segments of the population.

The prospects of economic liberalization among poor South Africans greatly lie in securing adequate access to production resources. This cannot be over-emphasized for Africa as a whole, where 33 of 48 underdeveloped countries are found, making achievement of reducing poverty by half in 2015 a mere dream (Wongibe, 2002). Furthermore, high concentration of poverty in South Africa’s rural areas portends a state of development policy that still engenders unfair treatments and marginalization of the past. If pursued with deserved seriousness, land reform can propel a national democratic
revolution for ensuring that the poorest among the poor benefit substantially from economic development and growth processes (Walker, 2000).

Inequality in access to land is unimaginably high in South Africa. It should be noted that while 86 percent of the country’s agricultural land belongs to some 60,000 commercial farmers, poor smallholders control less than 13 per cent (Wongibe, 2002). Therefore, redistribution of land goes beyond a democratic struggle, it is a resolute fight for the future of millions of unborn black South Africans, and a transformation of the colonial class that has long been rooted in capitalist development and national oppression of the poor (Walker, 2000). Suffice it to emphasize that while inequality in land ownership between white and black races is high, intra-racial inequality can as well be tremendously high. This may result from landlessness of many, while some had acquired large tracts of land by transfer through inheritance. It is therefore worthwhile to have an assessment of the nature of intra-race land ownership inequality, given that conventional wisdom has denoted the enormity of inter-racial land ownership inequality.

There are many socio-economic issues that can engender intra-racial land ownership inequality even after implementing land reforms policies. This is motivated by the fact land is a property for which the owners have some rights to use in a manner that maximizes expected utility. This implies that even if land areas are returned to previous owners, the policy of “willing seller and willing buyer” can further promote inequality. This keenly lies on the nature of economic destitution that may make reclaimed lands to be productively redundant in the hands of new owners. It had also been noted that currently, most of the redistributed farms are financially bankrupt, bedeviled by inadequate infrastructure, among others. In the face of numerous production bottlenecks, reclaimed land may be sold thereby returning the initial status quo, though initially aggrieved party may have been financially settled. In such a case, would government have achieved the objective of land reforms which solely dwells on long-run human capacity development for permanent exit from the web of chronic poverty? We may also ask if new owners will possess the needed competence for using the land for food production in order to averse food crisis and malnutrition? Government and other stakeholders involved have got to tactically address these issues and lots more in their effort towards ensuring land redistribution in South Africa.

In the Limpopo River Basin, access to land defines the types of crop that can be grown and other enterprise combinations. In absence of sufficient land, production decisions are confronted with serious obstacles. This study seeks to provide an assessment of land ownership pattern and its inequality decomposition in the Limpopo River Basin. The remaining parts of the paper are divided into materials and methods, results and discussions and conclusion.

Materials and Methods
Sources of Data and Sampling Methods
The data used in this study were collected by the International Food Policy Research Institute (IFPRI) and the Centre for Environmental Economics and Policy in Africa (CEEPA). Based on some met criteria, permission to download the data was granted by IFPRI. The multi-stage sampling method was used to select 794 households that were interviewed, although the initial target was 800 households. The data were collected from 20 districts in the South Africa’s Limpopo River Basin. The districts were selected to reflect key Water Management Areas (WMAs) and agricultural production
activities. At the first stage, total number of sample districts was identified. At the second
step, 20 districts were selected out of the 5 WMAs. The third step involved determining
the distribution of the 20 districts across the 4 provinces in the basin. The Gauteng (2),
Limpopo (9), Mpumalalanga (6) and North West (3) were selected. The fourth step
involved random sampling of farm households that undertook some farming activities
during the April 2004 to May 2005 farming season. The survey was carried out between
August and November 2005.

Data Analytical Approach

This paper used the traditional Gini coefficient decomposition proposed by Silber
(1989) and Lambert and Aronson (1993) which had been widely applied in economic
literature. Griffiths (2008) submitted that this decomposition approach is completely
similar to that proposed by Dagum (1997). Suppose there are \( k \) sub-groups that make up
the total population of a district, region or province, a decomposition framework for
determining the contribution of each sub-group to total inequality can be specified. Let
\( \mu_i \) denote the mean land for the \( i \)-th sub-group and \( y_i \) is the population share of the \( i \)-th
sub-group. Then, the mean land for the district is \( \mu = \sum_{i=1}^{k} y_i \mu_i \) and the land share for ith
sub-group can be expressed as \( s_i = y_i \mu_i / \mu \). The decomposition begins by specifying an
expression for Gini coefficient which is:

\[
G = G_w + G_B + G_R
\]

where \( G_w \) is the within-group inequality, \( G_B \) is the between-group inequality and \( G_R \) is a
residual which is positive when some of the subpopulation land distributions overlap. The
contribution of a sub-group to inequality is given by weighted average of the Gini
coefficients for each of the sub-groups, with weights given by the products of the
population and land shares. Therefore,

\[
G_w = \sum_{i=1}^{k} y_i \mu_i G_i
\]

where \( G_i \) is the Gini coefficient of ith sub-group.

Between district inequality \( G_B \) is the Gini coefficient that would be obtained if
everybody in a given sub-group was given the mean land for that group. In order to define
\( G_B \), we need to define \( y_{ih} \) as the land of the \( h \)-th sub-group. Let \( n_i \) be the number land units
in ith sub-group and \( n = \sum_{i=1}^{k} n_i \) is the number of land units in the sub-group. The Gini
for the sub-group is expressed as:

\[
G = \frac{1}{2n^2 \mu} \sum_{i=1}^{k} \sum_{j=1}^{k} \sum_{h=1}^{n_i} \sum_{k=1}^{n_j} |y_{ih} - y_{jk}|
\]

if \( y_{ih} \) and \( y_{jk} \) is replaced with their sub-group means \( n_i \) and \( n_j \) respectively, then

\[
G = \frac{1}{2n^2 \mu} \sum_{i=1}^{k} \sum_{j=1}^{k} \sum_{h=1}^{n_i} \sum_{k=1}^{n_j} |\mu_i - \mu_j|
\]

Results and discussions

Description of land ownership

Table 1 shows the pattern of land ownership. It shows that the lowest proportion (2.39 percent)
of the respondents borrowed the land they were using, while the
highest proportion (37.41 percent) was on communal land. This finding shows that majority of the farmers were having the livestock or their farms on communal lands. Also, 24.69 percent of the respondents indicated to own their lands, but 8.44 percent rented the land. Also, 2.39 percent were on sharecropping. These findings are clearly pointing towards the fact that majority of the farmers were not personally owning land. In addition, average total land owned is 106.45 hectares with standard deviation of 524.68. Communal land has a mean of 101.66 with standard deviation of 576.31. Land areas that were personally owned by the farmers have mean of 190.90 with standard deviation of 710.67. The high standard deviation in all the land ownership groups suggests very high variability. Average total land owned is 106.45 with standard deviation of 524.69. This clearly shows very high dispersion in the distribution.

Table 1: Land ownership patterns in the Limpopo River Basin of South Africa

<table>
<thead>
<tr>
<th>Land Group</th>
<th>Freq</th>
<th>% total</th>
<th>Mean</th>
<th>Standard dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowed</td>
<td>19</td>
<td>2.39</td>
<td>164.18</td>
<td>391.41</td>
</tr>
<tr>
<td>Communal</td>
<td>297</td>
<td>37.41</td>
<td>101.66</td>
<td>576.31</td>
</tr>
<tr>
<td>Others</td>
<td>196</td>
<td>24.69</td>
<td>32.44</td>
<td>239.64</td>
</tr>
<tr>
<td>Owned the land</td>
<td>196</td>
<td>24.69</td>
<td>190.90</td>
<td>710.68</td>
</tr>
<tr>
<td>Rent</td>
<td>67</td>
<td>8.44</td>
<td>68.80</td>
<td>158.09</td>
</tr>
<tr>
<td>Sharecrop</td>
<td>19</td>
<td>2.39</td>
<td>148.63</td>
<td>423.76</td>
</tr>
<tr>
<td>Total</td>
<td>794</td>
<td>100.00</td>
<td>106.45</td>
<td>524.69</td>
</tr>
</tbody>
</table>

Table 2 shows the distribution of across the districts. It shows that average land owned by farmers from Warmbad is highest with a mean of 329.34 hectares and standard deviation of 1226.10. This is followed by farmers from Nebo with average land ownership of 250.70 hectares and standard deviation of 406.89. Other districts with high average land ownership are Middleburg (237.28 hectares), Witrivier (188.68 hectares) and Thohoyandou (155.88 hectare). The table also reveals that districts with lowest average land areas are Brits (6.08 hectares), Cullinan (11.40 hectares), Tzaneen (12.47 hectares), Messina (25.47 hectares), Krugersdorp (25.50 hectares) and Thabazimbi (27.04 hectares). The table further shows the land share of each of the districts. It reveals that Middleburg has the highest share of the total land areas with 14.32 percent. This is closely followed by Warmbard, Nebo and Witrivier with 12.47 percent, 11.86 percent and 11.61 percent. Districts with lowest land share are Brits, Krugersdorp and Tzaneen with 0.91 percent, 0.42 percent and 0.66 percent, respectively.

Table 2: Land ownership across the selected districts of the Limpopo River Basin of South Africa

<table>
<thead>
<tr>
<th>District</th>
<th>Frequency</th>
<th>Average (ha)</th>
<th>Standard deviation</th>
<th>Share of total land area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brakhortspruit</td>
<td>30</td>
<td>89.70</td>
<td>172.36</td>
<td>3.18</td>
</tr>
<tr>
<td>Brits</td>
<td>26</td>
<td>6.08</td>
<td>13.43</td>
<td>0.19</td>
</tr>
<tr>
<td>Carolina</td>
<td>34</td>
<td>44.50</td>
<td>153.73</td>
<td>1.79</td>
</tr>
<tr>
<td>Cullinan</td>
<td>5</td>
<td>11.40</td>
<td>8.20</td>
<td>0.07</td>
</tr>
<tr>
<td>Krugersdorp</td>
<td>14</td>
<td>25.50</td>
<td>21.81</td>
<td>0.42</td>
</tr>
<tr>
<td>Lephalele</td>
<td>63</td>
<td>16.79</td>
<td>63.77</td>
<td>1.25</td>
</tr>
<tr>
<td>Lydenburg</td>
<td>36</td>
<td>109.28</td>
<td>338.55</td>
<td>4.65</td>
</tr>
</tbody>
</table>
Table 3 shows the computed Gini-coefficients of the land areas across the different districts. It shows that inequality in land ownership is highest in Makpopane and Thohoyandou with Gini indices of 0.9470 and 0.9444 respectively. Other districts with very high land inequality are Middelburg, Nkomazi and Lydenberg with Gini coefficients of 0.9377, 0.9338 and 0.8459, respectively. The Gini coefficients are also represented in figure 1 which arranges them in decreasing order. The districts with lowest land inequality Ginis are Cullinan, Krugersdorp and Tzaneen with Gini indices of 0.3298, 0.4596 and 0.6155, respectively. The table also shows that the between-group inequality accounted for 47.69 percent of the total land inequality, while overlap of the between- and within-group inequality accounts for 46.84 percent. Within group inequality accounts for just 5.46 percent of the total inequality. In actual fact, the result shows that inequality between the groups is the main underlying factors for the observed land inequality. This is very critical because it portrays the wide land inequality between the groups. The results further show that if inequality within the groups are totally addressed, overall land inequality would be very low. The impact of inequality overlap reveals substantial amount and shows that sub-population land distribution overlapped in many districts.

Table 3: Source Gini and Between/Within Inequality in the Districts in Limpopo River Basin

<table>
<thead>
<tr>
<th>Group #</th>
<th>Estimated S-Gini</th>
<th>Population</th>
<th>Land Share</th>
<th>Absolute</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brankhortspruit</td>
<td>0.7243</td>
<td>0.0378</td>
<td>0.0318</td>
<td>0.0008</td>
<td>0.0009</td>
</tr>
<tr>
<td>Brits</td>
<td>0.7575</td>
<td>0.0327</td>
<td>0.0019</td>
<td>4.637E-05</td>
<td>5.018E-05</td>
</tr>
<tr>
<td>Carolina</td>
<td>0.8349</td>
<td>0.0428</td>
<td>0.0179</td>
<td>0.0006</td>
<td>0.0007</td>
</tr>
<tr>
<td>Cullinan</td>
<td>0.3298</td>
<td>0.0663</td>
<td>0.0007</td>
<td>0.0000014</td>
<td>1.52E-06</td>
</tr>
<tr>
<td>Krugersdorp</td>
<td>0.4596</td>
<td>0.0176</td>
<td>0.0042</td>
<td>3.423E-05</td>
<td>3.704E-05</td>
</tr>
<tr>
<td>Lephalele</td>
<td>0.8286</td>
<td>0.0793</td>
<td>0.0125</td>
<td>0.0008</td>
<td>0.0009</td>
</tr>
<tr>
<td>Lydenburg</td>
<td>0.8459</td>
<td>0.0453</td>
<td>0.0465</td>
<td>0.0018</td>
<td>0.0019</td>
</tr>
<tr>
<td>Makpopane</td>
<td>0.9470</td>
<td>0.0693</td>
<td>0.0382</td>
<td>0.0025</td>
<td>0.0027</td>
</tr>
<tr>
<td>Marico</td>
<td>0.9055</td>
<td>0.0642</td>
<td>0.0549</td>
<td>0.0031</td>
<td>0.0035</td>
</tr>
<tr>
<td>Messina</td>
<td>0.7905</td>
<td>0.0617</td>
<td>0.0147</td>
<td>0.0007</td>
<td>0.0008</td>
</tr>
<tr>
<td>Middelburg</td>
<td>0.9377</td>
<td>0.0642</td>
<td>0.1432</td>
<td>0.0086</td>
<td>0.0093</td>
</tr>
<tr>
<td>Nebo</td>
<td>0.7420</td>
<td>0.0504</td>
<td>0.1186</td>
<td>0.0044</td>
<td>0.0048</td>
</tr>
<tr>
<td>Nkomazi</td>
<td>0.9338</td>
<td>0.0378</td>
<td>0.0342</td>
<td>0.0012</td>
<td>0.0013</td>
</tr>
</tbody>
</table>
Rustenburg 0.9200 0.0416 0.0439 0.0017 0.0018
Soutpansberg 0.8701 0.0831 0.0837 0.0061 0.0065
Thabazimbi 0.8761 0.0378 0.0096 0.0003 0.0003
Thohoyandou 0.9444 0.0655 0.0959 0.0059 0.0064
Tzaneen 0.6155 0.0567 0.0066 0.0002 0.0003
Warmbad 0.9235 0.0403 0.1247 0.0046 0.0050
Witrivier 0.8869 0.0655 0.1161 0.0067 0.0073
Within-Group - - - 0.0505 0.0546
Between-Group - - - 0.4408 0.4769
Overlap - - - 0.4329 0.4684

Figure 1: Distribution of land inequality Gini coefficients in Limpopo River Basin of South Africa

Conclusions
The results have shown the extent of land inequality in the Limpopo River Basin. There are empirical facts to support the much debated problem of skewed land distribution in South Africa as a whole. This paper has distinctively shown that the Gini coefficients of land ownership are very high, with the between group inequality accounting for the highest contribution to inequality. There is therefore the need for rapid implementation of the land reform in order to address the much debated problem of land inequality. This is fundamental for giving hope to the black race that had suffered from serious deprivation and marginalization in their own fathers’ lands.
References


A SYSTEMC CACHE SIMULATOR FOR A MULTIPROCESSOR SHARED MEMORY SYSTEM

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Abstract
In this research we built a SystemC Level-1 data cache system in a distributed shared memory architectural environment, with each processor having its own local cache. Using a set of Fast-Fourier Transform and Random trace files we evaluated the cache performance, based on the number of cache hits/misses, of the caches using snooping and directory-based cache coherence protocols. A series of experiments were carried out, with the results of the experiments showing that the directory-based MOESI cache coherency protocol has a performance edge over the snooping Valid-Invalid cache coherence protocol.

Keywords: Cache Coherency, Cache Simulator, Multiprocessor Architectures.

INTRODUCTION
Architecturally, computing systems have their memory organized hierarchically and this memory nomenclature is scientifically termed the memory hierarchy (Hennessey and Patterson, 2007; Stalling, 2012). The nearer the memory module is to the processor, the smaller and faster are the components resulting in an inverse relationship between the size and speed of the memory module. However, according to Hennessey and Patterson (2007) fast memory comes with cost implications as these modules are relatively expensive per byte. Altogether the memory modules in a computer system collectively allow the data and instructions to flow through the system. The central processing’s unit registers are the most vital as these store the operands and results of all computations capitalizing on the principle of locality (Hennessey and Patterson, 2007).

The computer program and data are typically stored on non-volatile storage such as disk drives and tapes before execution but these are first loaded into main memory, which is much faster, but still significantly slower than the registers (Hennessey and Patterson, 2007, p288 –299). As an intermediate step in the memory hierarchy, caches were invented to avoid the penalties of memory access by keeping the most recently used data and delivery is much faster to the processor. Cache memories are therefore the conceptual foundation for this research.

PROBLEM STATEMENT
As has been observed through various computer architecture research the problems facing the multicore processor systems at large are that, processor speeds are “rising dramatically at approximately 75% per year”, according to McKee (2004). The memory clock speeds at the same time are increasing steadily at a paltry 7% per annum (Hennessey and Patterson, 2007). The research by NASA and scientists at the University of Virginia confirm this dilemma, that, there is a divergence in the operating speeds of memory architectures and processor systems, referred to as the Memory Wall (McKee, 2004). The challenge facing computer scientists and engineers today is therefore to design a memory architecture that operates at
the same clock speeds as the processor architecture.

The computing industry facing the dilemma of the memory wall resolved that to increase performance on computing systems should be as a result of building latency-tolerance prefetching non-blocking cache memory systems (McKee, 2004). This resulted in the computing industry building processor architectures consisting of larger cache memory systems and more latency tolerance on chip. Memory architectures are organized hierarchically, with the memory components nearer to the processor being smaller and faster (Hennessey and Patterson, 2007). Cache memory systems are there to prevent the penalties of memory access by keeping the most recently or frequently used data and deliver it as fast as possible to the processor. The memory wall results in memory being considered as the bottleneck for processor performance, and modern computer architectural designs feature different cache memory levels (Hennessey and Patterson, 2007).

Caches exploit the benefits of temporal and spatial locality of the data in the computer's main memory by having regular access patterns. Typically each memory request goes through the cache memory and subsequently channelled to the main or a higher level cache memory if the requested data or instruction is not found in that cache. Complications arise when multiple processors with each having a local cache have a shared main memory system. If the various caches keep private copies of shared data while being unaware of what is the state of these copies in the other caches, undefined cache performance behaviour may arise.

Cache coherency protocols are required to maintain the cache consistency of all the data stored in the different local caches (Leiserson and Mirmam, 2008). The cache coherency protocols consist of cache line state transitions that can be captured by cache simulators. However it is not easy to get the actual behaviour of these caches and also to prove the correctness of such cache behaviour. Despite their benefits, multiprocessors can only scale so far and bottlenecks can occur when several CPUs on a board share a single memory system and a bus (Hennessey and Patterson, 2007).

In this research we evaluated the performance of Level 1 data cache memory systems in a multiprocessor environment by looking at the influence of the bus traffic, and cache coherency protocols, number of processors and cache associativity. We addressed the following research questions:

1. To what extent do the number of processors in multiprocessor architectures affect the performance of Level 1 (L1) data cache memory systems?
2. How do cache coherency protocols influence the Level1 data cache memory performances of multiprocessor architectures?

THEORETICAL FRAMEWORK

The problems that have been identified for uniprocessors have been addressed by the development of multi-core architectures. The real world is parallel, and the reason why single processors have faced problems is that they have been executing instructions sequentially in short bursts of time. The real explanation why chip companies shift to multi-cores is prosaic in the sense that it includes several reasons that are not within the context of this research. There is an inherent concept that multi-cores increase the speeds of execution of multiple tasks, but achieving parallelism is not a trivial task (Nussbaum and Smith, 2002). What are the challenges or problems which multi-core designers face? Let us look into these problems briefly.
**Programmability**

Historically parallel processing computer architectures and multi-cores have presented computer architecture designers and system software developers programming challenges. The programming challenges include intellectual programming skills needed to develop programs for such systems, and the need for specialised software tools to program them. The daunting task for programmers is on the “parallelisation of sequential programs” (Szydlowski, 2005). The multi-core programming model should be based on standard programming tools and programming languages. There are no real standards in the programming landscape of multi-cores (Duller and Towne, 2003; Towne et al., 2004; Jourbet, 2008). Echoing the same sentiments about programming multi-cores (Leiserson and Mirmam, 2008) wrote that “multi-core processors are parallel computers and parallel computers are notoriously difficult to program”. Chris Jesshope identified 3 different models of machine/programming models which are sequential; ad-hoc parallel and fully parallel models (Jesshope, 2008). Even though these programming models exist there is need to address the issue of standards and automation of multi-core programming tasks (Blyler, 2009).

**Scalability**

Multi-cores reduce system latency but one of the challenges that multi-core systems developers face is developing systems that are scalable. Multi-cores produce tangible benefits but making the processes parallel brings with it programming challenges as mentioned before. Increasing more processor cores on chip might entail that the whole system has to be rewritten (Blyler, 2009; picoChip, 2007). Rewriting code for more cores has a direct implication on production cost, longer marketing times and consumers end up paying for these shortfalls. In the event of increasing more processor cores the programmer has to rethink about the routines to use and repartitioning the processing operations between the individual processors added.

**Communications**

Multi-cores present problems in the communication channels used by the processing elements to communicate between or to each other. PicoChip identified the “saturation of the communications links between processing elements” (Panesar et al., 2005, 2006; picoChip, 2007) as a major drawback especially to multi-cores with more than 10 processors. Race conditions are also “pernicious bugs” (Leiserson and Mirmam, 2008) that are difficult to detect. There is always need to have a reliable and efficient way to eliminate race conditions. Designing the interconnection channels between the various processing elements is crucial in order to achieve higher performance gains. The data or instructional dependencies may cause some of the processors to be idle hence loosing performance gains. The width of the communication channel is an important factor to consider. There is a concern that power dissipation can increase with multiple processing elements operating concurrently.

**Managing a heterogeneous architecture**

Multi-core systems are in most cases constituted by different types of processors and technically the architecture is referred to as a heterogeneous architectures. The heterogeneous architecture is not as easy to program as the homogeneous architecture that consist of similar processing elements. Homogenous architectures are easy to implement on silicon (picoChip, 2007, Hobson et al., 2006). Heterogeneous architectures provide greater yields in execution speeds because they include dedicated processing elements for specific application tasks, some elements are designed to speed up code.


**Cache Memory Systems**

As mentioned earlier, processor speeds have been scaling up faster than memory speeds resulting in the memory wall. Computer engineers have seen that both processor and memory clock cycles have been decreasing over time (processor by about 60% per year, Moore’s Law and the memory by about 7% per year, Less’ law) (Jesshope 2008; Hobson et al., 2006). There have been of course attempts to increase memory bandwidth by introducing concurrency in memory accesses through pipelining (Jesshope 2008; Hobson et al. 2006), but, this requires regular memory access patterns and random access to the main memory bringing with it degradation in memory performance (Chevance, 2006; Jesshope 2008). The memory hierarchy brings conflicting requirements in the memory systems as computing systems require a large and fast memory to scale up performances.

A memory hierarchy attempts to make a large slow memory appear fast by buffering data in smaller faster memories close to the processor (Hennessey and Patterson, 2007). Electronic systems slow down as they increase in size, for example the speed of light is approximately 1ns for 30cms and 1ns is 3 clock cycles in a state of the art processor (Jesshope, 2008). Memory performance is therefore a compromise between power and performance, as is the processor performance today (Chevance, 2006; Hennessey and Patterson, 2007). The key indicators of memory performance are the memory bandwidth and latency (Hennessey and Patterson, 2007). Memory latency is the delay required to obtain a specific item of data (measured in seconds), and, this is larger in dynamic random access memory (DRAM) than in static random access memory (SRAM) (Hennessey and Patterson, 2007). SRAM can access any bit each cycle while DRAM is restricted to bits in the same row, cell address space (CAS) cycles. Memory Bandwidth is the rate at which data can be accessed (e.g. bits per second), Bandwidth is normally 1/cycle time, and this rate can be improved by concurrent access (Hennessey and Patterson, 2007).

The most common solution to the memory wall is to cache data and caching requires locality of access or memory reuse, which may be achieved by compiler optimisations that can help to localise data (Jesshope, 2008). Computing scientists also designed banked memory systems to provide high bandwidth to random memory locations (Hennessey and Patterson, 2007; Jesshope, 2008), but, some access patterns still break the memory (Jesshope, 2008). Processors that tolerate high-latency memory accesses have been designed but this requires concurrency in instruction execution (Hennessey and Patterson, 2007; Jesshope, 2008). Caches are largely transparent to the programmer, but, programmers must be aware of the cache while designing code to ensure regular access patterns (Hennessey and Patterson, 2007; Jesshope, 2008, 2009, 2011). Caching the right data is the most critical aspect of caching to improve maximum system performances. More cache misses end up reducing performance instead of improving and this might end up consuming more memory and at the same time suffering from more cache misses lead to system deadlocks, where the data is not actually getting served from cache but is re-fetched from the original source. The development of a cache simulator requires a deeper understanding of how the memory hierarchy operates (Schintke, Simon, and Reinfield, 2012).

**DESIGN AND IMPLEMENTATION**

This research study is based on simulating a 32KB 8-way set-associative Level1 Data Cache. In this research study we have concentrated on the Shared Memory Architecture. The reason for choosing shared memory architecture is that we wanted to scale up the cache simulator, from having one processor to a maximum of eight processors using different trace files. We have to modify the architecture to make sure that each processor node has
access to a local cache (reads and writes). The architectural implementation for this research implies that each processor node can write to a memory location, and its local cache stores the memory contents locally, consequently a read of the same memory location on another processor node can be of a different value from its cache. The modified shared memory architecture used in this research is not unique as Jesshope (2011), suggested such memory architecture for scaling up processor frequencies. Associativity of caches (Hill and Smith, 1991) is an important metric that determine cache performance.

The implementation environment based on SystemC (Black and Donovan, 2004; OSCI, 2005; Bhasker, 2009; Ma, 2011) resulted in us simulating a 32KB Level 1 data cache within the Arch Linux environment. We developed SystemC/C++ code for the implementation of the CPU, Memory, Cache, Bus and used Jesshope’s (2011) Trace Files used to drive the simulator. For our simulation we used the UNIX platform, Arch Linux 3.8 (http://www.archlinux.org) with GNU C++ compiler versions gcc-4.8. It is one of the lightweight GNU/Linux based operating system. The installation of Arch Linux takes place as if you will be building your own operating system, as it is heavily command driven. The three main issues that one should take care of when installing Arch Linux is the graphics, network especially wireless networks and UEFI. We chose to install the KDE desktop environment for our Arch Linux environment because of having used it in another Linux ambience which is the Linux Mint environment. We followed the instructions in the INSTALL document that comes with the SystemC-2.2.0 package to compile it in Arch Linux. The SystemC installation is a nasty experience and it took us some days to compile it and run in Arch Linux. Jesshope (2011) provided the theoretical and programming foundations of the trace files used for this research, and we use his trace files version 3, and his philosophy behind these trace files to drive our simulator.

The approach to implement the SystemC Level 1 Data-cache simulator followed the conventional programming norms of increasing the programming complexity as the demands of the system increases. We started by implementing a bus snooping cache coherence protocol, the Valid-Invalid protocol. The term ‘snooping’ allows for each cache node in the system to monitor the activities on the bus to which each of the cache nodes can write exclusively. In the event of a write enquiry if a cache node realizes that another processor belonging to another cache node has written to an address which it has a copy, the cache line containing a stale copy of the associated memory segment is immediately invalidated. The programming logic behind this protocol is that it does not allow for two cache lines to be valid in different cache nodes, in the event that they are mapped into the same set and even share the same address tag. The implementation of this protocol served as the basis for diagnosing anticipated programming problems and we used the debugging traces to eliminate errors until we were satisfied with the program executions.

We then implemented the MOESI Cache coherence protocol which is theoretically and programmatically built as an extension to the MESI protocol. The MESI protocol is the most common cache protocol that supports the write-back replacement strategy. The acronym MESI indicates that the protocol supports four cache line state transitions and these are Modified, Exclusive, Shared and Invalid, which logically implies that it implements the same cache line invalidation scheme as the valid-invalid cache coherency protocol. The difference to the valid-invalid cache coherency protocol is that it monitors whether the cache line is shared or not. The caches are allowed to make the cache line dirty if the cache line is in a modified or exclusive state. The MOESI cache coherence protocol introduces a fifth cache line transition state ‘owned’ which means it has characteristics of exclusive modified and shared cache line state transitions. We have to point out that this cache coherency
protocol allows for cache lines to be shared, and is not supposedly written back to memory before the sharing.

As a starting point we build a single 32KB 8-way set associative cache with 32 Byte line size. We also built a CPU module connected to the cache that was asking for reading or writing some data from or to memory through the cache. In addition we made a memory module to help in checking the correctness of the data. The connection between the memory and the cache has been made from an 8-bit wire, therefore to fill the 32 Byte cache line, the cache has to read the memory 32 times. This was also useful to simulate the memory latency. We only used the random trace file for one processor to test the correctness of our simulator. The result of the simulation can be seen in the Table 1.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Execution Time</td>
<td>55329 ns</td>
</tr>
<tr>
<td>CPU Read</td>
<td>6140 times</td>
</tr>
<tr>
<td>CPU Write</td>
<td>6081 times</td>
</tr>
<tr>
<td>Read Hit</td>
<td>5113 (83.3%)</td>
</tr>
<tr>
<td>Read Miss</td>
<td>1027 (16.7%)</td>
</tr>
<tr>
<td>Write Hit</td>
<td>5017 (82.5%)</td>
</tr>
<tr>
<td>Write Miss</td>
<td>1064 (17.5%)</td>
</tr>
</tbody>
</table>

Table 1: Results of simulating with a Uniprocessor

The results in the show that the CPU made 12221 requests composed as 6140 read requests and 6081 write requests. The results further show that more than 80% of the requests hit the cache, with an execution time of 55329 ns.

Comparative Results Using Graphs

We plotted graphs to make a fair comparison of the trace files used and also the snooping and directory based cache coherency protocols. We made a comparative analysis of the protocols considering that there is no bus snooping, no barrier synchronization and with barrier synchronisation for each protocol. We started by comparing the Average Cache hit Rate and the two graphs represented by Figure 1 and Figure 2 indicate that there is no major significant difference between the Valid-Invalid and MOESI cache coherence protocols in terms of the cache hit rates, when random trace files are used. The different configurations made to the simulator did not show distinguishable cache performance indicators between the two sets of traces. The MOESI protocol theoretically outperforms the Valid-Invalid protocol.
The other result that was very important to the SystemC cache Simulator experiment was to investigate the contention of the bus interconnection network. This was achieved by taking a count of the time stamps (delta cycles) in which the bus had more than one request to handle. This was handled by a member function in the Bus module which was designed to indicate the number of requests in the queue. The bus contention when using the two sets of traces is shown by Figure 3 and Figure 4.
The synchronised cache simulator runs show a reduction in the bus contention. The synchronisation event relieves the interconnection network as it oblige the processor nodes to wait until the barrier threshold instead of putting them in a race condition towards the end of each trace. The MOESI cache coherence protocol exhibit a smaller footprint on the interconnection network (bus), due to the deferred writes, but consequently uses more memory resources.

CONCLUSION

The SystemC cache simulator we have developed initially showed some feeble plugs, maybe because, of the fact that the trace files we have used in the simulation were designed to pick up read and write addresses for (hits/misses), instead of showing how the data is moved around in the system. In that way we would actually have testified that the processors constituted in the system have actually performed the reads and writes of the data they were supposed to. We also noticed that even if the trace files provided for checking whether the processors read/write the data they are supposed to, there is no assurance that the cache simulator is correct. We introduced a component of non-determinism in the event that the different cache nodes attempted simultaneously to access the bus.

The introduction of a memory latency of a century of cycles did not generally assume that a read issued just a few cycles after a write onto the same memory address, would harvest the correct data response. If the memory was responding to a read request within the memory cycle latency limit, a write request issued to the same memory address was not permissible, and the stale data value was not send back to the bus. The cache coherency protocols resolved such a situation by implementing two further cache coherency organizations, and these are the write-invalidate or the write-update.

As Jesshope (2011) argued that write-invalidate need the management of dynamic requests and the logic to rearrange requests if needed. The write-update requires an extra hardware in the form of a buffer that will contain the addresses of the requests, and the associated data...
elements, forcing the main memory to behave the same as the cache. We implemented the write-invalidate scheme as it is conservative and compatible with our chosen cache coherency protocols. It further pruned away the existence of duplicate read requests by allowing for a small degree of performance optimizations. We studied the graphs and come to the conclusion that cache coherency protocols are comparable, even when we use different traces and different number of processors. We therefore use the experimental data and graphs to answer our research questions.

**Answering the Research Questions**

The first research question refers to an investigation of the performance of the cache when we increase the number of processors. Based on this postulate we then give our response to the following first research question entitled:

*To what extend do the number of processors in multiprocessor architectures affect the performance of Level-1 (L1) data cache memory systems?*

We have noted that the runs of all the cache simulator experiments we have made did not end up in an inconsistent state. The execution time (simulation time) of the cache simulator increases as we have more processor cores. The average hit rate did not increase significantly with the increase of the processor cores. We have also noted that other factors such as snooping have a direct effect on the performance of the cache. From the results of the simulations we could see that increasing the number of cores does not imply an increase in cache performance as there are coherency issues to be taken care of. The deactivation of the snooping on the interconnection network subsequently increased the average hit rate even when using different trace files.

Without snooping on the bus, there is now invalidation in case of probe write hits, meaning that the cache writes to a shared cache line and the status of the cache line remains the same. In such an instance the cache gets a higher hit rate. As performance is determined by the hit rate we would argue that the cache performs much better without snooping. However when we deactivated bus snooping we could not guarantee and assure the integrity of the cache line when we repeatedly run the cache simulator. The other factor that comes into play when we increased the processor nodes is synchronisation of the caches and taking care of the cache misses. One way of taking care of this aspect is to optimize the compiler, by code rearrangement including data rearrangement. Loop interchange and cache blocking could also optimize the cache by improving temporal locality. We can conclude that increasing the number of processors on the multiprocessor architecture implies more cache programming complexity and cache coherency is a major concern in the performance of the caches of a multiprocessor system.

Rightfully we can say that given optimizations in the compiler and having synchronised multibanked caches in the multiprocessor system, we can increase the cache performance. As mentioned earlier increasing processor nodes with their local caches mean that there is a lot of programming issues to consider. In our case we pipelined the cache access so that we would increase the cache bandwidth. We have mentioned earlier that cache coherency is an important aspect to consider in a multiprocessor environment. We therefore investigated how our chosen cache coherency protocols affected the performance of our cache simulator. The research question to answer is the following:

*How do cache coherency protocols influence the Level-1 (L1) data cache memory performances of multiprocessor architectures?*
We have used trace caches to reduce the hit time in our system henceforth improve the cache hit rate. Each implementation of our SystemC cache simulator had to run a set of Random and Fast-Fourier Transform trace files in 1, 2, 4, and 8 processor environments. The comparison graphs showed that the directory-based cache coherence protocol (MOESI) has a slight performance edge over the snooping cache coherence protocol (Valid-Invalid). Though the difference can be regarded as statistically insignificant, MOESI protocol outperforms Valid-Invalid protocol because it can transfer data from one cache to another cache. In such cases the cache miss doesn’t always mean the cache has to read/write from/to memory. Lesser memory access reads leads to faster execution time because the need to wait for memory access latency can be reduced.

The hit ratio of the MOESI protocol is better than the hit ratio in Valid-Invalid protocol meaning that consecutive writes will always contribute to a cache miss. In the MOESI protocol if a write miss occurs, the cache line will be updated (read) and the consecutive write will be marked as write hit. Another contributing factor to the better performance of the MOESI protocol is that it has a lower contention rate of the bus usage. One of the reasons for this could be that, the memory access rate in Valid-Invalid protocol is more than in the MOESI protocol. Since the bus will be used when the cache modules want to have memory access, higher memory access will imply a higher request to use the bus. Following the memory hierarchy principles, accessing the bulk shared memory will take more time compared to accessing another cache. The Valid-Invalid have to wait longer to access the memory than in MOESI protocol.

Unexpectedly in some instances the MOESI cache coherence protocol used more memory writes which might be as a result of a bug in our SystemC cache Simulator. We have actually managed to preserve the coherency of the caches in all our experiments and all simulations. We still need to conduct a proof of the program correctness of our simulator using acceptable, scientific, standard proof-of-program correctness methodologies. All the simulations never ended up in an inconsistent state, which is a significant leap towards the optimization of the cache simulator. We therefore have the following recommendations for the improvements of the cache simulator.

**RECOMMENDATIONS**

The performance graphs showed that there is no significant performance difference between the snooping protocol and the directory-based protocols we have chosen. Theoretically this is wrong and one of the reasons is that there might be a programming error (a bug) in the bookkeeping of the memory writes through the traces used or in the cache simulator itself. We therefore recommend a program proof-of-correctness procedure to be carried out and also to revise the configurations of the trace files. The Valid-Invalid protocol outperformed the MOESI protocol when random trace files were used which is a point of concern. The caches cannot expect randomness as they are based on programming attributes and the coherency attribute is a result of programming efforts. We therefore recommend a revisit on the trace files and an increase in the range including the types of trace files to be used by the simulator.

We have not taken into consideration issues of increasing the cache bandwidth. As a future area of research and improving the cache performance we have to consider various cache optimizations schemes and also record the data for the memory accesses. The implementation of various cache optimizations will bring an increase in program complexity
of the cache simulator. Concurrency has been a major programming issue during the execution of the simulator. When we implemented the SystemC simulator we had Error (115), which did not allow us to start the simulator with two or more drivers. We have actually resolved this error by implementing SC_SIGNAL_WRITE_CHECK=“DISABLED” at the start of each simulation involving more than one processor but we recommend that we have to create an environment variable that allows for explicit parallelism to occur during the simulation.

We also recommend the use of a wide range of cache coherency protocols rather than choosing only one type of each category. As SystemC can be implemented in the multi-platform environment and the simulator exhibits the characteristics of the hardware being simulated, we will in the try the simulator in different multiprocessor environments. However this has been a learning curve for us and this research is useful in multiprocessor design.

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PUBLIC, PRIVATE AND NGO PARTNERSHIP PROGRAM IN FARMERS TRAINING IN NEPAL

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Abstract
Agriculture is the backbone of national economy, which contributes more than 35 percent of the national GDP in the Nepalese economy. Farmer training is regarded as one of the main tools to increase knowledge and skills of farmers to enhance production of agricultural crops. The government of Nepal has established several offices for training farmers, not only for free of cost, but also with allowances to attain the training. However, satisfactory results did not come as expected for increasing production and productivity of agricultural crops. Two types of training were conducted by the government office, The Central Vegetable Seed Production Centre, Khumaltar, Lalitpur, Nepal for farmers. A regular training was conducted by the centre solely with government norms and conditions by providing allowances to the participants. Another training was also jointly conducted by a private institute for profit, an NGO called Team for Nature and Wildlife (TNW), responsible for assessing the needs and social mobilization and the centre itself to provide service and expertise in the same venue. After comparing and analyzing the trainings, jointly organized training was found to be much more effective, economical, and sustainable for a long run and is recommended for future consideration as well.

Keywords: Nepal, Public, Private, Training, Vegetable

INTRODUCTION
Agriculture is the backbone of national economy of many developing countries, including Nepal, which contributes more than 35 percent in national GDP of Nepalese economy. Training is the acquisition of knowledge, skills, and competencies as a result of the teaching (Wikipedia). According to Agriculture Training Directorate (2012), a farmer training is regarded as one of the best tools for skill development and knowledge transfer, which helps to change the attitude of farmers for more agriculture crops production. It is an effective tool to convert general farmers into commercial growers and agriculture entrepreneurs into agriculture industrialists. Generally, agriculture training courses are designed for farmers and
entrepreneurs to provide theoretical knowledge and practical skills for several aspects of commercial agriculture, including production, processing, marketing, etc. To train farmers in the field of agriculture, the government of Nepal has established the Agriculture Training Directorate (ATD) in a central level under the Department of Agriculture (DOA). There are 5 regional agriculture training centers (RATC) under ATD throughout the country in each region, covering all 75 districts in Nepal. ATD and RATC conduct several trainings throughout the year in different aspects of agriculture for agriculture technicians and farmers for free of cost. Moreover, the government pays all expenses including travelling and daily expenses to all participants in the respective trainings. Similarly, some government farms under DOA such as The Central Vegetable Seed Production Centre (CVSPC), Khumaltar, Lalitpur, Central Horticulture Centre (CHC), Kirtipur, Kathmandu, etc. also conducted central level trainings in specific subject relevant to their farm, such as vegetable and fruit farming in Khumaltar and Kirtipur respectively.

Compared to other countries, stagnant production and productivities of almost all crops of Nepal reveals that only the public institutes are unable to improve agriculture development as envisaged by the government. After the realization of participation of the private sector in several development activities, particularly after restoration of democracy in Nepal, almost all the concerned authorities agreed on the concept of privatization. Private schools and universities in the education sector, private clinics, and hospitals in health sectors, privatization of the aviation sector, etc are some radical examples of successful stories of privatization in Nepal. Community forestry of Nepal is a good example of successful projects of the world implemented in the concept of a public private partnership model. Despite some of the good examples of successful private programs, Nepal has also experienced bitterness by the failure of projects in agriculture like privatization of some horticulture farms and stations. Almost all privatized horticultural farms either come back to the government's hands or are nonfunctional, unable to meet their objectives.

After analyzing the pros and cons of the public, private as well as the NGOs programs in Nepal, particularly in the agriculture sector, public, private and NGO sectors are unable to meet the targeted objectives in satisfactory level by the inability to solve the problems of farmers to increase production and productivity as expected.

By considering these facts, the government of Nepal has implemented the third concept, i.e. neither fully public nor fully private, so called Public Private Partnership (PPP) model. The PPP model was found effective when compared to the previous concept of only public or only private programs separately however; this model also ignored the role of social sector in developmental works. To implement the new concept of tripod involvement of public, private and NGO, for the first time in Nepal, Central Vegetable Seed Production Centre (CVSPC), Khumaltar, Lalitpur, has initiated the vegetable training programs targeting the educated youths of the country. Initially, bilateral agreements were made together with an NGO called Team for Nature and Wildlife (TNW) and later with a private company, “Prangaric Pathshala (Organic School)” to implement the new concept in a 3-day long commercial vegetable production and entrepreneurship development training course. In this paper, comparison of the trainings was done related to vegetable development under a new concept conducted by TNW and “Prangaric Pathshala” with the technical support of CVSPC. A similar training that was conducted solely by CVSPC was studied thoroughly. The main purpose of this paper is to recommend the best training model in agriculture development for the future. The objective of this study is to compare vegetable development training provided by the public (CVSPC) sector together with the jointly organized training public, private, and social organizations NGO for commercial vegetable farming and to recommend
new concept for future consideration. The three different types of roles have been played by 3 different stakeholders to make a complete package of training i.e. the public sector (CVSPC) as a service provider with enough technical knowhow, a business oriented company “Prangarik Pathshala” for profit making and an NGO (TNW) for social mobilization.

METHODS AND PROCEDURES

To complete this study, one-year data were collected from the records of the training conducted by The Central Vegetable Seed Production Centre (CVSPC) and the data compiled from 12 trainings jointly conducted by “Prangarik Pathshala”, an NGO Team for Nature and Wildlife (TNW) with technical support from CVSPC. Different aspects were analyzed to compare the two different types of training. “Training A” is defined as the training provided to vegetable growers conducted by the public sector i.e. The Central Vegetable Seed Production Centre (CVSPC), in accordance with government rules and regulations. CVSPC is a government farm under The Department of Agriculture (DOA), located in Khumaltar, Lalitpur, Nepal. Likewise, “Training B” is defined as training provided to the vegetable growers or intended to grow vegetables jointly conducted by 3 different type of organizations i.e. a company called “Prangarik Pathshala”, an NGO called Team for Nature and Wildlife (TNW) with technical support from the public organization CVSPC, implemented with the new concept of involvement of the public, private, and social sector.

RESULTS

Participants:
Selection of participants for training A is done only through the concern District Agriculture Development Office (DADO), whereas in the case of training B, participants were informed by advertising in the Kantipur Daily Newspaper, posters and also through monthly magazines related to agriculture like HIPAT as well as in electronic media like Facebook. No publicities or advertisements were made to invite trainees in the case of training A, instates official letters were send to the concern DADO for the selection of participants. From the interaction and discussion, it was found that, most of the peasants participating in training A were aged, less wealthy and less educated, but were the experienced ones in vegetable farming, however; in the case of participants of training B, young, educated, wealthy but less experienced participants were the attendants of the training.
The total number of participants and the average number of participants per training also varied drastically in both of the trainings. 20 participants were selected from DADO to participate in training A, but in case of training B, so far a minimum of 17 and a maximum of 39 participants have attended. Within a year of 12 trainings, a total of 322 trainees have already participated in the training course, making an average of about 27 participants per training in the case of training B.

**Nature of Trainees and Motivation:**

All of the participants were selected and motivated by DADO to participate in the training. Training A was mandatory, whereas training B was voluntary. Education level, age, and experience in farming also drastically differed in both training participants. Participants of training A were less educated, older, and simply literate, but pursued experience in vegetable farming. On the contrary, training B participants were younger, more educated (more than 50% participants were graduates), and had less experience in vegetable farming.

**Punctuality and Sincerity:**

Instructors as well as trainees were more punctual and sincere in class in the case of training B than in training A. However, participants were more loyal in training A because of the money paid to them; moreover, they did not have concern towards the quality of teaching and also hesitated to complain because of their greed for money to be earned.
contrary, in the case of training B, participants showed towards the quality of trainers, classes, but often complained because they thought that their money is not properly valued.

**Participation in Class Discussion:**
Most of the participants of training B actively participate in the class discussions and also were more attentive and curious; however in case of training A very few participants has found involved in class discussion.

**Training Schedule, Number, and Length of Training:**
The training schedule is fixed in the case of training A whereas training is scheduled as per trainees' needs and wants in the case of training B. Likewise, the number of trainings per year is limited i.e. once a year for training A whereas in case of training B, the number of trainings per year is not limited but varies in accordance with the demand of the trainees. Generally, a 6-day long training is conducted for training A and a 3 day-long training is conducted for training B. Similarly, the timing of training is also different in both of the cases. Four classes were accommodated from 10:30 AM to 4:30 PM per day in the case of training A, whereas 6 classes per day were adjusted in the case of training B (from 9 o’clock in the morning to 5:00 o’clock in the evening).

![Fig 2: Trainees of Training B inside Classroom](image)

**Geographical Coverage:**
Participants of training A were selected by DADO from only 5 districts of Nepal whereas training B was attended by people from 48 districts. Moreover, one participant from The USA and 2 from Sikkim, India were also actively involved in training B.
Expense and Budget of Training:
The fee for participating in the training A is free. In addition to that, each participant gets travel and daily allowance (TA/DA) to participate the training A. But trainees have to bear all the expenses together with NRs. 2000/- as the admission fee for the 3-day package in the case of training B. Normally, the participants attended training to earn money and to visit Kathmandu in the case of training A whereas participants attained the training to get knowledge and skills in the case of training B. The training package comprises of a book related to commercial vegetable farming, tea, lunch packages, a copy, a pen, a half-day tour and a certificate of participation. The total cost of training is fixed according to government norms and the allocated annual government budget i.e. NRs. 200000/- per training in the case of training A (1 US $ = 88 Nepalese Rupees (NRs.). The cost of training varies according to market price in the case of training B. By calculating the average cost for the 12 trainings, on average, about NRs. 43755/- was needed to conduct the training with 27 participants in the case of training B, which is about NRs. 1621/- per trainee but it was NRs. 10000/- per head in the case of training A, which is more than 6 times as expensive. From the experience, on one hand, it is found that the organizer of training A tried to minimize the expenses of the training to save money for personal benefit, whereas, the organizer of training B tried to minimize the expenses of the training to save money for organizational benefit. Similarly, organizer tried to minimize the number of participants to save money for personal benefit in case of training A whereas in case of training B, the organizer tried to maximize the number of participants to earn money for organizational benefit.

Table 1: Total Cost per Training

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<th>S N</th>
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<td>Trainees</td>
<td>27</td>
<td>1621</td>
<td>43755</td>
</tr>
<tr>
<td></td>
<td>Per Participant Cost Training A</td>
<td>Trainees</td>
<td>20</td>
<td>10000</td>
<td>200000</td>
</tr>
</tbody>
</table>

NRs.=Nepalese Rupees. About 88 NRs. is equivalent to 1 US$.

Revenue Collection:
No revenue is collected in the case of training A, however; it is mandatory to deposit a revenue of NRs. 1000/- per day in terms of training hall rent for training B, but this is not necessary for training A. Therefore, training organized by the government spent NRs 200000/- per training to provide travel and daily allowance together with all facilities for each participant. In contrary to this, training B deposited NRs. 3000/- of revenue from every...
batch. Within a one year time period, a total of NRs. 36000/- of revenue had already been collected from training B.

**Value for Money:**
By analyzing the situation and participants’ personal behavior and psychology, it is found that, value for money is less in the case of training A, whereas value for money is found to be very high in the case of training B. All of the participants of training B are happy after getting training and more than 50 % of the trainees have started commercial vegetable venture.

**Methodology and Use of Teaching Tools:**
Several methodologies such as pre and post tests, trainer’s evaluations, participatory approaches, all types of organic, as well as inorganic fertilizers, solid, liquid, granules, fertilizers; insecticides, fungicides, herbicides, biozymes, plant growth regulators, etc. were displayed in the case of training B. Similarly, horticultural tools and equipments, sprayers, grass cutters, different types of polythene sheets, bags and plastics, crates, etc were displayed, used and were tried for making the training more effective and interesting. Trainees were acquainted with those tools in the case of training B, but no such things have been displayed and used in the case of training A. Likewise, teaching tools like PowerPoint is mandatory for training B, but organizers of training A seldom use it.

| Table 2: Comparison of Two Different Types of Training |
|-----------------|-----------------|-----------------|
| **SN** | **Activities** | **Training A** | **Training B** |
| 1 | Selection of trainees by | DADO | Self |
| 2 | Motivation | DADO | Self |
| 3 | Nature of training | Mandatory | Volunteer |
| | Punctual and sincere | Less | High |
| 4 | Participants age (generally) | Old | Young |
| 5 | Education status of trainees (generally) | Less educated | more educated |
| 6 | No. of participants | Fixed (20) | Flexible (17 to 39) |
| 7 | Experience of trainees in vegetable farming | More | Less |
| 8 | Geographical coverage | Targeted 5 districts | All Nepal (anywhere), so far participants from 48 districts |
| 9 | Foreigners participants | No | Yes 3 (US 1 and India 2) |
| 10 | Fee for participants | Free | Self paid |
| 11 | Value for money (Fee) | No matter | Highly valued |
| 12 | TA/DA | Provided | Not provided |
| 13 | Participants attain training mainly to get | Money and visit | Knowledge and skills |
| 14 | Revenue collection per training | No collection | Collection NRs 3000/- |
| 15 | Cost of training | Fix (according to allocated budget) | Varies (according to market price) |
| 16 | Organizer try to minimize expenses because | To save money for personal benefit | To save money for organizational benefit |
| 17 | Organizer try to | Minimize participants to save money for personal benefit | Maximize participants to earn money for organizational benefit |
| 18 | Schedule of training | Almost fixed | Flexible according to trainees need |
| 19 | Number of classes per day | 4 | 6 |
| 20 | Daily class starts and end | 10:30 AM start and 4:30 PM | 9:00 AM start and 5:00 PM |


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</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Fixed, once or twice a year</td>
<td>Often 6 days</td>
<td>Less participatory</td>
<td>Seldom</td>
<td>Hierarchy and quota</td>
<td>No matter</td>
<td>Rs 1000/- per class including tax</td>
<td>Low</td>
<td>Only office</td>
<td>Less</td>
<td>Less</td>
<td>Never</td>
<td>No</td>
<td>Inferior</td>
</tr>
<tr>
<td>22</td>
<td>Flexible (depends on demand) at least 12 times a year</td>
<td>Often 3 days</td>
<td>More participatory</td>
<td>obligatory</td>
<td>Expertise</td>
<td>More happy to get more classes and fame</td>
<td>Rs 1500/- per class including tax</td>
<td>High</td>
<td>Outside the office as well (NARC, CEAPRED, CHC Kirtipur, etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
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</tbody>
</table>

**Instructors/Trainers:**
Most of the instructors or trainers of training B are outsiders, are experienced, and are educated as compared to those of training A. In training B, only one of the technicians is an undergraduate but is well experienced, with experience of more than 24 years in vegetable farming and another 9 trainers are either M.Sc or Ph.D. degree holders. About 5 trainers are undergraduates in training A. It is because of the fact that, the classes were divided according to the hierarchy and staff of office by considering income for the instructors, but in the case of training B, classes were divided according to the subject matter specialist and expertise without considering the income for trainers. Likewise in the case of training A, all of the trainers are from their respective offices, whereas in the case of training B, trainers are from several organizations like CVSPC, NGO called Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED), The Nepal Agriculture Research Council (NARC), Central Horticultural Centre (CHC), freelancer, etc.

**Gender and Ethnicity:**
Although womens’ role in agriculture development is significant in Nepal, men have dominated in the attendance of the course. Within one year, only 32 out of 322 i.e. about 10 % women have participated training B and 290 i.e. about 90 % participants were men. Likewise out of 20 participants, only 3 women i.e. 15 % have attended training A and other 85 % were men. This shows that women are still out of access to attend trainings in Nepalese society. Similarly, out of 322 participants, 18 (6 %), 114 (35 %) and 190 (90 %) participants have attended training B by schedule cast, schedule tribe and other higher-class people respectively. In a similar manner, in the case of training A, 3, 7 and 10 participants i.e. 15 %, 35 %, and 50 % respectively have represented the schedule cast, schedule tribe and other higher-class people. It reveals that, lower cast people are not able to attend trainings followed by schedule tribe and higher-class people are always ahead. Likewise, women seem to be disadvantaged and are not accessible for trainings as compared to men.
Class Routine and time Table:
Only four classes were conducted daily in the case of training A however, 5 to 6 classes were organized in training B. Mostly, classes started from 9 O’clock in the morning and ended at 5 to 5:30 PM with about 8 hours per day schedule in case of training B. Class starts from 10:30 AM and ends at 4:30 PM i.e. only 6 hours classes were maintained in the case of training A. Class attendance was not maintained for training B, whereas attendance was taken for training A on a regular basis, which is essential for auditing.

Table 3: Details of Training Conducted Within a Year

<table>
<thead>
<tr>
<th>Training Lot</th>
<th>Training Duration (Days)</th>
<th>No of Participants</th>
<th>Sex</th>
<th>Ethnicity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>1</td>
<td>3</td>
<td>28</td>
<td>3</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>18</td>
<td>2</td>
<td>16</td>
<td>1</td>
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<td>24</td>
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<td>22</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>23</td>
<td>0</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>21</td>
<td>3</td>
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<tr>
<td>6</td>
<td>3</td>
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<td>1</td>
<td>16</td>
<td>0</td>
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<tr>
<td>7</td>
<td>3</td>
<td>21</td>
<td>2</td>
<td>19</td>
<td>1</td>
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<td>8</td>
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<td>39</td>
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<td>38</td>
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<tr>
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<td>28</td>
<td>2</td>
<td>26</td>
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<tr>
<td>12</td>
<td>3</td>
<td>31</td>
<td>4</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>322</td>
<td>32</td>
<td>290</td>
<td>18</td>
</tr>
</tbody>
</table>

Participants %  | 10 | 90 | 6 | 35 | 59 |
Total 48 districts covered

Training conducted by 3 stakeholders jointly CVSPC, Organic School and TNW i.e. Training B


Post Training Performance:
Three meetings were held at Khumaltar conducted by The National Farmers Forus (NFF), in which trainees from training B participated along with other invitees, but no trainees from training A have participated in such events. A farmer’s federation called The NFF was also established by the participants of training B for the welfare of farmers. The organization was registered on 2012/08/07 in the District Administration Office, Kathmandu and Social Welfare Council, Kathmandu, Nepal as a not for profit making foundation.

Visit and Enquiry from Trainees:
After the completion of the training course, most of the participants of training B frequently visited the office in Khumaltar to get suggestions, necessary assistance as needed together with telephone enquiry often, but in case of training A, no one has visited Khumaltar and no phone calls have been received so far.
Knowledge and Skills Implementation in the field:
With regard to frequent meetings and interaction with the trainees, it is found that more than 50% of trainees in training B have been implementing their knowledge and skills in the field. They have started commercial activities, such as fresh vegetable production, pesticide free vegetable farming, establishment of agro-vets, vegetable nursery, high quality compost production, vegetable shop, etc in commercial scale, which was hardly done by the trainees of training A.

CONCLUSION
By analyzing the two different types of training i.e. government organized training and training organized by the government with the collaboration of private companies and the social sector i.e. an NGO, the training organized jointly was found to be more effective, economically viable and was sustainable for a longer run as compared to one solely organized by government. To provide effective training in sustainable ways, joint venture with public, private and social organizations are needed to get united to provide paid training in the future for agriculture development, particularly for educated youth who have started farming or who intend to start farming in the near future.

REFERENCES
GENDER ROLE IN AGRICULTURE, CLIMATE CHANGE AND FOOD SECURITY IN THE SAHEL BELT OF WEST AFRICA: APPLICATION OF POISSON AND NEGATIVE BINOMIAL REGRESSION

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Abstract
The Sahel belt of West Africa is high vulnerability to poverty and hunger, especially during periods of drought and other climatic adversities. This paper analyzed the impacts of gender role in agriculture and climate change exposure on monthly food shortages. The data were collected by the the Climate Change, Agriculture and Food Security (CCAFS) from 281 farmers from Burkina Faso and Mali using multi-stage sampling procedures. Descriptive statistics, Poisson regression and Negative Binomial regression were used for data analysis. The results show that average food cropland owned were 9.0227 and 2.8266 hectares in Mali and Burkina Faso respectively while 58.87 percent and 24.29 percent of the farmers indicated that men did most of the works in raw food production. Also, 24.11 percent and 43.57 percent of the households noticed more erratic rainfall in Mali and Burkina Faso, respectively, while 16.31 percent and 36.43 percent reported less overall rainfall. The regression results showed that owned grazing land, more frequent flood, reduction in ground water level, men dominances in cash crop production, fruit production and vegetable production significantly increased the log of months with shortage due to cash (p<0.10), while community grazing land, more overall rainfall, household size, business cash income, men dominances in fodder and large livestock production significantly reduced it (p<0.10). It was concluded that recognition of the contributions of women to food production in the Sahel can facilitate a process for understanding and devising livelihood strategies to mitigate the impacts of climate change.

Keywords: Food security, Poisson regression, Negative Binomial regression, Sahel belt, West Africa.

Introduction
The Sahel belt of West Africa is geographically located between the Sahara desert in the north and Sudanian savannahs in the south. It extends into the land areas of Mauritania, Senegal, Burkina Faso, Nigeria, Mali, Niger and Chad (Senock and Pieper, 1990). Its northern part has an average annual rainfall of between 100 and 200mm, while the southern part has 500 to 600mm. Insufficient rainfall depicts shortness of cropping season which is usually 1-2 months in the north and 4-5 months in the south (Nicholson, 2013). As far back as 5000 BC, history has it that local rice and sorghum were domesticated in the Sahel belt (Chauhan, undated). Agriculture therefore remains the most dominant economic activity of the people. Although confronted with some limitations in
resource utilization and productivity, agriculture ensures production of adequate food, which is the basic need of man. It also generates employment and contributes at least 40 percent of the Sahel’s Gross Domestic Product (GDP) (World Bank, 2011).

There is diversity of prevailing farming systems and crop-livestock combinations based on differences in agro-ecological conditions. However, the predominant farming systems include mono-cropping, mixed cropping and mixed farming with livestock closely integrated into crop cultivation. Livestock contribute significantly to GDP of the belt, accounting for 20 to 30 percent of the agricultural GDP. In Burkina Faso, 15 percent of the national GDP is derived from livestock with more than 90 percent of the rural population (Zampaligré, 2012). It had been estimated that the belt has about 60 million domestic animals and 160 million cattle and small ruminants, respectively (CILSS, 2010). However, in Burkina Faso, livestock population had been estimated at 11.3 million, 7.5 million and 7.9 million head of goats, sheep and cattle respectively. Also, transhumant Fulani groups managed 70 percent of the cattle (MRA, 2005).

The belt is characterized by extreme climatic variability, which often makes it a hot spot for seasonal and distress hunger. Since 1970s, different episodes of drought had been experienced with food shortages that beckoned for international assistances. As noted by Raynaut et al (1997), these droughts have portrayed the belt as the epitome of a major environmental emergency, ever before climate change became an issue of international discourse. Similarly, the forces of land degradation due to agricultural intensification, pastoral transhumance and erratic rainfall have confined agricultural activities in the Sahel belt to few areas of land suitability and water availability. The low productivity of the soils in many part of the arid region makes intensification a persistent cropping system with a very high risk of soil degradation.

Recurring droughts have strengthened the interconnectivity between low agricultural productivity and chronic poverty in the Sahel belt. No doubt, this is a region where both men and natural resources exhibit significant vulnerability. Fragility of the natural resource base portends a risk to the welfare of the people since majority live at the threshold of poverty. The interplay of climate change with several environmental and climatological parameters presents a dived process of agricultural development that is perfectly bedeviled by environmental stressors. The risk of desertification is always high and several interventions have been sought in order to reverse the awkward trend. In many instances, persistent poverty makes it absolutely difficult for farmers to adopt soil conservation methods, or make any investment on their farms. These situations have confined agricultural operations in the Sahel to a very low productivity and significant threats to food security (World Bank, 2011).

A major challenge facing African policy makers is utilization of sparse natural resources in the Sahel belt in a manner that sets forth a sustainable platform for eradication of hunger and poverty (FAO, 2010). Inability to access sufficient food for daily nutritional requirements is a pervasive problem in the Sahel region. This definitely undermines the health, productivity and survival of people (Smith et al, 2006). When food consumed is of inadequate quality and quantity to provide the body’s requirements of energy, protein, fat, and vitamins, malnutrition is bound to result. These issues are pathetic because food is the basic need of man and its essentiality for mankind survival cannot be over-emphasized. Policy makers have therefore advocated for provision of adequate and sufficient food as a prioritized development agenda that must be pursued tenaciously. In the Sahel belt, recurring hunger due to crop production failure is
disturbing efforts at setting in motion a sustainable agenda for economic growth and development.

Therefore, several adaptation mechanisms have been initiated and integrated into the framework of households’ livelihoods as dictated by several socio-economic, institutional and environmental constraints. Some of these have evolved as livelihood strategies devised from historic time and transferred as vital indigenous knowledge systems that are critical for human habitation of the ecosystems. Specifically, besides crop cultivation, animal husbandry is a means of livelihood that is inextricably intertwined with the communal, social and economic lifestyles of the people. In some instances, it is a subsystem of our socioeconomic life that is practiced as few free range animals that are kept in the backyards to specialized breeds of animals that are confined to pasturelands or raised in a nomadic pastoralism and transhumance (Holl, 1998).

Furthermore, in the Sahel belt, farming is a livelihood system consisting of many gender-related roles. Specifically, farmers grow some crops and keep livestock as coping strategies against seasonal hunger. In some instances, animals are obviously assets that can serve as a means of wealth storage, which can be converted for cash in any emergency situation (CILSS, 2009). Involvement of women in Sahelian agriculture therefore covers all aspects of crop and livestock production. Although rarely acknowledged, women’s role in agriculture can be distanced from the context of culturally inclined gender divides.

Increase in rural poverty along with fragility of the agro-ecological environment portends a critical need for women to contribute their quotas for ensuring households’ survival. In livestock husbandry, women have major roles to play in feeding, milking, and processing of other animal products. World Bank (1995a) found that the role that is played by Sahelian women in agriculture cannot be underestimated. It was found that 93 percent and 78 percent of active women worked in agriculture in Burkina Faso and Mali, respectively. Another study found that women in Sahel may work on the farm for an average of 16 hours, which is about three hours higher than men’s (World Bank, 1995b). Women have also got to feature as home manager and producers of food when their husbands have migrated to the cities. In some instances, women constitute over 19 percent of rural households’ heads (FAO, 2011). This paper assesses gender role in Sahelian farming and determines the factors explaining experience of food shortages based on the CCAFS baseline data. In the remaining parts of the paper, materials and methods, results and discussions, and conclusion have been discussed.

Materials and Methods

Data and sampling procedures

The data were collected by the Climate Change, Agriculture and Food Security (CCAFS) (http://www.ccafs.cgiar.org/). The data probed into different aspects of rural livelihoods and the impacts of climate change that are felt by rural households. Data were collected from Burkina Faso, Mali and Niger from locations that fall into the Sahel belt. However, respondents from Niger were excluded from the analysis because none of them supplied information on land ownership which constitutes part of the independent variables in the econometric modelling. Multi-stage sampling method was used in selection of the respondents. At the first stage, one location was selected from each of the countries from where seven villages were randomly selected. At the final stage, households were selected for interview 20 per village. However, 141 respondents
completed the survey in Mali, while 140 did from Burkina Faso. Therefore, data used in this study comprised of information from 281 rural households from 14 villages.

**Model Specifications**

The data were analyzed with the Poisson and Negative Binomial regression models. The choice of these approaches was informed by the nature of the dependent variables as a count variable. In this study, the aspect of the questionnaire where households were asked to indicate the number of months they were unable to meet their food needs was used to analyze food shortages. This may be subjective quite well, but it shows in some ways struggles by households to meet food needs and may present better information than mere computation of food poverty line based on monthly or annual food consumption, without a clear understanding of the spread of those expenditures.

The number of months that households could not meet the basic needs of food was decomposed into two. The first measured inability of the households to meet households’ food requirements due to shortage in cash for food consumption given that home production constituted the major source for that month. The second captured inability to supplement food requirements with home production given that most of food consumed in that month were purchased from markets.

Poisson regression was specified to avoid biasness and inefficiency of the estimated parameters if Ordinary Least Square (OLS) regression method had been used. A Poisson distribution model is specified as a random variable $Y$ with parameter $\mu$ that has integer values $y = 0, 1, 2, 3, 4 \ldots$ and probability

$$Pr\{Y = y\} = \frac{e^{-\mu} \mu^y}{y!} \text{ for } \mu > 0$$

The models take the form of

$$\ln Y_c = \alpha + \beta_j \sum_{j=1}^{k} X_k$$

$$\ln Y_p = \delta + \rho_j \sum_{j=1}^{k} X_k$$

In equations 2 and 3, $\beta_j, \delta$ and $\rho_j$ are the estimated parameters. $Y_c$ and $Y_p$ are the dependent variable respectively measured as number of months without sufficient food due to inadequate cash to supplement home production and months without sufficient food due to inadequate production to supplement purchased food. Also, $X_k$ are the independent variables which are owned food crop land area (ha), rented food crop land areas (ha), community food crop land (ha), owned grazing land (ha), rented grazing land (ha), community grazing land (ha), owned land degraded (ha), more overall rain (yes = 1, 0 otherwise), more drought (yes = 1, 0 otherwise), more frequent flood (yes = 1, 0 otherwise), more strong winds (yes = 1, 0 otherwise), later start of rain (yes = 1, 0 otherwise), earlier start of rain (yes = 1, 0 otherwise), higher temperature (yes = 1, 0 otherwise), lower ground water (yes = 1, 0 otherwise), climate change help (yes = 1, 0 otherwise).
otherwise), has radio (yes = 1, 0 otherwise), has TV (yes = 1, 0 otherwise), has cell phone
(yes = 1, 0 otherwise), has bicycle (yes = 1, 0 otherwise), has motorcycle (yes = 1, 0
otherwise), has car (yes = 1, 0 otherwise), household size, household members less than 5
years, household members more than 5 years, formal education (yes = 1, 0 otherwise),
men do most work in raw food production (yes = 1, 0 otherwise), men do most work in
food processing (yes = 1, 0 otherwise), men do most work in production of other cash
crops (yes = 1, 0 otherwise), men do most work in fruit production (yes = 1, 0 otherwise),
men do most work in vegetable production (yes = 1, 0 otherwise), men do most work in
fodder production (yes = 1, 0 otherwise), men do most work in large livestock production
(yes = 1, 0 otherwise), men do most work in small livestock production (yes = 1, 0
otherwise), men do most work in livestock processing (yes = 1, 0 otherwise), men do
most work in fish production (yes = 1, 0 otherwise), men do most work in timber
production (yes = 1, 0 otherwise), men do most work in fuel wood production (yes = 1, 0
otherwise), cash obtained from employment on someone else’s farms (yes = 1, 0
otherwise), cash obtained from other paid employment (yes = 1, 0 otherwise), cash
obtained from business (yes = 1, 0 otherwise), cash obtained from gifts (yes = 1, 0
otherwise), cash obtained from other paid environmental services (yes = 1, 0 otherwise),
cash obtained from government, other payments (yes = 1, 0 otherwise), cash obtained
from loans from banks (yes = 1, 0 otherwise), cash obtained from other informal sources
(yes = 1, 0 otherwise) and cash obtained from renting of machinery (yes = 1, 0
otherwise).

Because of the inherent assumption that the mean and variance of a Poisson
distribution are the same, the conventional assumption of homoscedasticity cannot hold.
The analysis is therefore done with the Maximum Likelihood Estimation (MLE). The
likelihood function for \( n \) independent Poisson observations can be expressed as

\[
\log L(\beta) = \sum_{i=1}^{n} y_i \ln(\mu_i) - \mu_i - \log(y_i!)
\]

The goodness of fit for the model is judged from the deviance goodness of fit which can
be computed as:

\[
\text{Deviance} = 2 \sum_{i=1}^{n} y_i \ln \left( \frac{y_i}{\mu_i} \right) - (y_i - \mu_i)
\]

where \( n \) is the number of observations. If the value is statistically significant (p<0.05),
other covariates should be added in order to get a Poisson distribution since the null
hypothesis indicating that the distribution is Poisson had been rejected. Otherwise, a more
appropriate method would be the negative binomial regression. Because the assumption
of Poisson was rejected for model II (home production deficiency), the Negative
Binomial regression was used. In STATA, a likelihood ratio test statistics of alpha equal
to zero was generated, which if statistically significant implies that the Negative
Binomial regression model is better than Poisson regression.

Results and Discussions
Profiles of farmers’ socioeconomic characteristics and land ownership
Table 1 shows the demographic characteristics of the farmers. It shows that 75.18 percent of the farmers from Mali had formal education; attended at least primary education. In Burkina Faso it was 68.57 percent that had formal education. Unlike low literacy level expected in many rural areas, many farmers in the selected locations were quite educated, at least attended primary school. The table also shows that in Mali, average household size was 17.01, while that for Burkina Faso was 11.51. Also, average number of household members that were less than five years in Mali was 3.78, while that for Burkina Faso was 2.08. Average number of household members that were more than 60 years old was 1.14 in Mali and 0.96 for Burkina Faso. These findings point to the fact that high fertility may be a major cause for persistent poverty in the Sahel belt. In some instances, farmers demand large family sizes in order to utilize them as family labour. However, as resources degrade and family size increases, returns from using them as family may not be able to cope with ever increasing needs of food, shelter, education, health etc. Therefore, in many cases, large household find it difficult to meet the daily requirements of food. Pootset al (2013) noted that across many Sahelian regions, demand for children is very high and the policy environment seems not to be tactically addressing the issue. Guengant (2011) also submitted that although child mortality had declined in Africa, family size is yet to follow the same trend. In Sahel belt, the pressure of population growth, which is the highest in the world is motivated by polygamy, early marriage, unwanted pregnancies and generally low use of contraceptives (Pootset al, 2013; May, 2012).

The table also shows the sources of incomes obtained by the farmers. This reveals that 33.33 percent and 24.29 percent of the households from Mali and Burkina Faso, respectively, had income by working on someone else’s farms. Also, 25.53 percent and 10.71 percent had incomes from other paid employment from Mali and Burkina Faso, respectively. Income from business was obtained by 64.54 percent and 40.00 percent of the households from Mali and Burkina Faso, respectively. Gift items were received by 19.86 percent and 28.57 percent of the households from Mali and Burkina Faso, respectively. Incomes were realized by 2.84 percent and 2.14 percent of the households from Mali and Burkina Faso respectively by involvement in environmental services. Also, 37.59 percent and 56.03 percent of the households from Mali obtained loans from formal and informal sources, respectively. In Burkina Faso, formal and informal credits were obtained by 11.43 percent and 37.14 percent, respectively. Machinery renting yielded incomes for 11.35 percent and 14.29 percent of the households from Mali and Burkina Faso, respectively. The general perspective of the income sources of the farmers revealed diversified livelihoods. This is expected in a situation where there is higher vulnerability to several ecological and environmental stressors.

Table 1 also shows the land owned by the farmers. It shows that in Mali and Burkina Faso, average personal food crop land were 9.0227 and 2.8266 hectares respectively. Also, average land areas that were used for food crop production from rented lands were 0.0603 hectare and 0.3518 hectare in Mali and Burkina Faso respectively. Average grazing land areas in Mali and Burkina Faso were 0.5610 and 1.5625 hectares, respectively. Degraded land areas were average of 0.9021 and 0.7494 in Mali and Burkina Faso, respectively. Land is a critical resource for farm activities. The results are quite pointing at wide difference between average land owned by farmers in the two countries. Another interesting aspect however is that the standard deviation of
personal land in Mali (6.86464) is higher than that in Burkina Faso; reflection very high inequality in the distribution.

Table 1: Socioeconomic characteristics of farm households

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mali</th>
<th>Burkina Faso</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic characteristics</strong></td>
<td>Mean</td>
<td>Std Dev.</td>
</tr>
<tr>
<td>Households’ demographic characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in household</td>
<td>17.0142</td>
<td>15.03994</td>
</tr>
<tr>
<td>Number of HH members &lt; 5yrs</td>
<td>3.7801</td>
<td>3.42072</td>
</tr>
<tr>
<td>Number of HH members &gt; 60yrs</td>
<td>1.1418</td>
<td>1.26819</td>
</tr>
<tr>
<td>Formal education</td>
<td>0.7518</td>
<td>0.43352</td>
</tr>
<tr>
<td>Sources of income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash from employment on someone else’s farms</td>
<td>0.3333</td>
<td>0.47309</td>
</tr>
<tr>
<td>(yes = 1, 0 otherwise)</td>
<td>0.2553</td>
<td>0.43759</td>
</tr>
<tr>
<td>Cash obtained from business (yes = 1, 0 otherwise)</td>
<td>0.6454</td>
<td>0.48010</td>
</tr>
<tr>
<td>Cash obtained from gifts (yes = 1, 0 otherwise)</td>
<td>0.1986</td>
<td>0.40035</td>
</tr>
<tr>
<td>Cash obtained from other paid environmental services</td>
<td>0.0284</td>
<td>0.16662</td>
</tr>
<tr>
<td>(yes = 1, 0 otherwise)</td>
<td>0.0355</td>
<td>0.18560</td>
</tr>
<tr>
<td>Cash obtained from loans from banks (yes = 1, 0 otherwise)</td>
<td>0.3759</td>
<td>0.48608</td>
</tr>
<tr>
<td>Cash obtained from other informal sources (yes = 1, 0 otherwise)</td>
<td>0.5603</td>
<td>0.49812</td>
</tr>
<tr>
<td>Cash obtained from renting of machinery (yes = 1, 0 otherwise)</td>
<td>0.1135</td>
<td>0.31830</td>
</tr>
<tr>
<td>Land ownership</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land dedicated to food crops in last 12 months</td>
<td>9.0227</td>
<td>6.86464</td>
</tr>
<tr>
<td>- owned land</td>
<td>0.0603</td>
<td>0.30750</td>
</tr>
<tr>
<td>Did HH use communal land for food crops in</td>
<td>0.0993</td>
<td>0.30012</td>
</tr>
<tr>
<td>last 12 months?</td>
<td>0.5610</td>
<td>1.16605</td>
</tr>
<tr>
<td>Land dedicated to grazing in last 12 months</td>
<td>0.0000</td>
<td>0.00000</td>
</tr>
<tr>
<td>- owned land</td>
<td>0.3546</td>
<td>0.48010</td>
</tr>
<tr>
<td>Did HH use communal land for grazing in</td>
<td>0.9021</td>
<td>1.20750</td>
</tr>
<tr>
<td>last 12 months?</td>
<td>0.0000</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

Source: Author’s computations from CCAFS baseline data

Allocation of farm activities across gender

Table 2 shows the percentage distribution of farm activities that were carried out by men and women in the households. It shows that in Mali and Burkina Faso, 58.87 percent and 24.29 percent of the interviewed households indicated that men did most of the works in raw food production. No households indicated that women did most of the farm activities in relation to raw food production in Mali, but 1.43 percent did in Burkina Faso. Although involvement of women in agriculture had been widely acknowledged, constraints in access to production resources often constitute some limitations. FAO (2011) noted that although women do not generally possess the requisite strength for tilling and ploughing of farm land, they are actively involved in weeding and crop harvesting. Involvement of men in food production is traditionally favoured because they are reckoned for land ownership. In some instances, women are allowed to use the land belonging to her husband when he migrates due to unfavourable climate or for any other reasons to find better sources of livelihoods in the cities. The fragility of land in Sahel belt presents a situation where access to it often determines the fortune of the households (World Bank, 1995b; FAO, 2011). Therefore, it may be difficult for women to participate
more in raw food production due to lack of adequate access to fertile land, farm inputs and capital. These constraints had been noted to also predispose women to higher vulnerability to drought and other changes in climate.

Processing of agricultural products constitutes one of the major sources of livelihoods for women in Sahel. The results in table 2 show that 20.00 percent and 68.09 percent of the households indicated that women did most of the crop processing works in Burkina Faso and Mali, respectively. Women are generally expected to perform most activities in food processing. The results are further pointing to the fact that in Burkina Faso, 70.00 percent of the households indicated that several members of the households participate in farm produce processing. The results also show that in cash crops, 4.29 percent and 23.57 percent of the households indicated that the men did most of the works in production of other cash crops. In Mali, 8.51 percent of the households indicated that the women contributed most to cash crop production.

Furthermore, in Mali, women contributed more to fruit production. Specifically, 20.57 percent and 2.84 percent of the households indicated that women and men respectively contributed most to fruit production. The observed trend is different in Burkina Faso where the percentage of men that contributed most to fruit production (13.57 percent) is higher than the women (0.71 percent). Also, in Burkina Faso, more households (13.57 percent) indicated that women did most farm activities in vegetable production than those that indicated men (6.43 percent). But in Mali, 60.99 percent of the households indicated that women did most of the farm activities in vegetable production.

Collection of fodders is an activity for livestock production. The results show that men were more involved in this activity. In Mali, while 72.34 percent of the households indicated that men did most of the works in fodder collection, 47.14 percent indicated same in Burkina Faso. No household in Mali indicated that women were carrying out most of the works in fodder production, while 2.14 percent indicated it in Burkina Faso.

Also, men did most of the works in large livestock production with 53.19 percent in Mali and 32.14 percent in Burkina Faso. Similarly, in small livestock production, 28.57 percent of the households from Burkina Faso and 40.43 percent from Mali indicated that men did most of the works. However, involvements of women in small livestock production are higher than it was in large livestock production. In Burkina Faso and Mali, 8.57 percent and 7.09 percent of the households respectively indicated that women did most of the works in small livestock production. However, while more households (26.43 percent) in Burkina Faso indicated that women did most of the works in livestock processing, men did most of livestock processing works (31.91 percent) in Mali. This is a reflection of the type of animals involved because women may not be able to carry out a lot of activities in the processing of large livestock like cattle. Also, in fish production, 6.38 percent of the respondents from Mali indicated that men did most of the works.

Furthermore, the results show that men were more involved in timber production in Burkina Faso (20.71 percent) than in Mali (6.38 percent). However, women were doing most of the works in fuel wood production in the two locations with 60.71 percent in Burkina Faso and 34.75 percent in Mali. Timber production is an activity that requires a lot of strength and men are always found in this business. However, fuel wood gathering is considered as women job in many rural setting. Desertification is making it difficult for women to gather fuel wood. In some instances, time devoted for fuel wood gathering has increased, thereby reducing available time for other productive activities.
Since women are responsible for cooking food, it is sometimes their sole responsibility to find the needed fuel wood.

Table 2: Percentage distribution of farm activities across gender involvements

<table>
<thead>
<tr>
<th>Job description</th>
<th>Burkina Faso</th>
<th>Mali</th>
<th>Several/others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw food production</td>
<td>24.29</td>
<td>1.43</td>
<td>74.29</td>
</tr>
<tr>
<td>Food processing</td>
<td>10.00</td>
<td>20.00</td>
<td>70.00</td>
</tr>
<tr>
<td>Production of other cash crops</td>
<td>4.29</td>
<td>4.29</td>
<td>91.43</td>
</tr>
<tr>
<td>Fruit production</td>
<td>13.57</td>
<td>0.71</td>
<td>85.71</td>
</tr>
<tr>
<td>Vegetable production</td>
<td>6.43</td>
<td>13.57</td>
<td>80.00</td>
</tr>
<tr>
<td>Fodder production</td>
<td>47.14</td>
<td>2.14</td>
<td>50.72</td>
</tr>
<tr>
<td>Large livestock production</td>
<td>32.14</td>
<td>1.43</td>
<td>66.43</td>
</tr>
<tr>
<td>Small livestock production</td>
<td>28.57</td>
<td>8.57</td>
<td>62.86</td>
</tr>
<tr>
<td>Livestock processing</td>
<td>7.86</td>
<td>26.43</td>
<td>65.71</td>
</tr>
<tr>
<td>Fish production</td>
<td>0.00</td>
<td>0.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Timber production</td>
<td>20.71</td>
<td>0.71</td>
<td>78.57</td>
</tr>
<tr>
<td>Fuel wood production</td>
<td>3.57</td>
<td>60.71</td>
<td>35.71</td>
</tr>
</tbody>
</table>

Source: Author’s computations from CCAFS baseline data

Climate change issues observed by rural households

The Sahel is one of the regions that had suffered severely from several changes in some climatic parameters. Table 3 shows the distribution of the respondents based on climate related problems. It shows that 24.11 percent and 43.57 percent of the households noticed more erratic rainfall in Mali and Burkina Faso, respectively. Also, 16.31 percent and 36.43 percent of the households in Mali and Burkina Faso respectively reported less overall rainfall. The percentage that reported more overall rainfall in Mali and Burkina Faso were 1.42 percent and 2.14 percent, respectively. More frequent drought was reported by 10.64 percent and 25.00 percent of the households from Mali, respectively. Rainfall variability is the most prominent form of climate change in Sahel belt. FAO (2011) noted that erratic nature of rainfall now constitutes other environmental problems in the form of acidification and desertification. These are of utmost concern to inhabitants of Sahel because acute disturbances in weather parameters are perfectly correlated to hunger because of poor agricultural yields.

Potts et al (2013) submitted that some projections indicated more rainfall in Sahel though the increases may come as flash floods. The results show that more frequent flood was reported by 5.00 percent of the households from Burkina Faso. While no household reported strong winds in Mali, it was reported by 22.86 percent of the households from Burkina Faso. Late commencement of rains was reported by 12.06 percent and 34.29 percent of households in Mali and Burkina Faso, respectively. Also, higher temperature and low ground water were respectively reported by 22.14 percent and 31.43 percent of the households from Burkina Faso. Experiences of climate related crises in the past five years were reported by 68.09 percent and 82.86 percent of the households in Mali and Burkina Faso, respectively.

Table 3: Percentage distribution of climatic change issues noticed by rural households

<table>
<thead>
<tr>
<th>Climate change observed</th>
<th>Mali</th>
<th>Burkina Faso</th>
</tr>
</thead>
<tbody>
<tr>
<td>More erratic rainfall</td>
<td>24.11</td>
<td>43.57</td>
</tr>
<tr>
<td>Less overall rainfall</td>
<td>16.31</td>
<td>36.43</td>
</tr>
<tr>
<td>More overall rainfall</td>
<td>1.42</td>
<td>2.14</td>
</tr>
<tr>
<td>Event</td>
<td>Value1</td>
<td>Value2</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>More frequent droughts</td>
<td>10.64</td>
<td>25.00</td>
</tr>
<tr>
<td>More frequent floods</td>
<td>2.84</td>
<td>5.00</td>
</tr>
<tr>
<td>Strong winds</td>
<td>0.00</td>
<td>22.86</td>
</tr>
<tr>
<td>Later start of the rains</td>
<td>12.06</td>
<td>34.29</td>
</tr>
<tr>
<td>Earlier start of the rains</td>
<td>0.00</td>
<td>6.43</td>
</tr>
<tr>
<td>Higher temperatures</td>
<td>0.00</td>
<td>22.14</td>
</tr>
<tr>
<td>Lower groundwater table</td>
<td>0.00</td>
<td>31.43</td>
</tr>
<tr>
<td>Has HH faced climate related crisis in last 5yrs</td>
<td>68.09</td>
<td>82.86</td>
</tr>
<tr>
<td>Did HH receive assistance for climate related crisis</td>
<td>4.26</td>
<td>11.43</td>
</tr>
</tbody>
</table>

Source: Author’s computations from CCAFS baseline data

**Impact of gender role and climate change exposure on food shortages**

Table 4 shows the factors influencing number of monthly food shortages based on production and cash deficiencies. The results of the Poisson regression was selected for cash deficiency model (equation 2) because the defiance goodness of fit statistics was insignificant (p>0.10). However, that was not the case for the second model (production deficiency). Therefore, Negative Binomial regression was used in order to correct for over dispersion in the values of the dependent variable. Superiority of results from the Negative Binomial model over Poisson model was confirmed by the statistical significance of Likelihood-ratio of alpha (p<0.01). However, the selected models properly fit the data as revealed by the statistical significance (p<0.01) of the Likelihoods Ratio Chi-Square computed from the log likelihood function.

Several parameters were statistically significant in the two models (p<0.10). In the Poisson model, if household size increases by one unit, the log of months with food shortages due to cash deficiency will reduce by 0.1055. The impact of household size on food shortages can be explained from the fact that large family size can boost agricultural production due to conversion of householdmembers to family labour. Jayne et al (1989) found that small farm households in Sahel could not use animal traction in land preparation. Jaeger (1984) found that in Burkina Faso, families using AT were about twice as large as those not using. However, where production resources are limited, large household size can imply food shortages if excess labour does not translate into more food production. The parameters of number of household members that are less than 5 years are with positive and negative signs in the Poisson regression and Negative Binomial model, respectively. However, the parameters of household member that were more than 60 years old are with positive sign in the two models, though only statistically significant (p<0.05) in the Poisson model. This is expected because these people represent dependants for which an increase by one person would increase the log of number of food shortages by 0.5631. The parameter of education is also statistically significant (p<0.05) in the Negative Binomial model. This shows that households with formal education had the log of months with food shortages due to insufficient cash reduced by 0.3273. Education is expected to increase ability of rural households to explore technological innovations and market opportunities. Gubbles (2013) noted that educated pastoralists, especially women, are able to increase family incomes, have access
to better nutrition, access better health facilities and send back remittances from off-farm employment.

None of the climate-related variables that were included in the Negative Binomial model was statistically significant (p>0.10). This is not expected, but may be a reflection of the generally fewer significance of many of the variables in that model. It may also reflect the fact that farmers were adapting with some positive results. In the Poisson model, however, some of the parameters were statistically significant (p<0.05). The results showed that those that reported more overall rainfall had their log of total months with food shortages due to cash deficiency would reduced by 3.6830. The impact of more rainfall in an arid land will be determined by the distribution of the rains. If it is concentrated on few days, flooding can result with serious impacts on crops. However, increase in rainfall can have overall positive impact on agricultural outputs since rainfall in generally lower than it is required for farming.

Also, the parameter of drought is statistically significant (p<0.01) and implies that those that reported drought had log of months with food shortages due to inadequate cash being lower by 4.7147. Although drought is expected to impact households’ welfare negatively, the extent of its impact depends on households’ preparedness and availability of adequate adaptation mechanisms. Similarly, those that reported flood have the log of the number of months with food shortages due to cash being significantly higher (p<0.05) by 3.2239. This is expected because flooding can reduce households’ income through destruction of crops and animals. Farmers that reported low ground water also had the log of the months with food shortages being significantly higher (p<0.01) by 1.8231. This is also expected because reduction of water table implies crops can die off after germinating. This will increase production cost and reduce crop yields. Also, those households that received help due to exposure to adverse climatic situation in the past five years to the survey had the log of the months with food shortages due to cash limitations being significantly higher (p<0.01) by 1.8975.

The parameters of own food cropland are with negative sign in the two models, but was only statistically significant (p<0.01) in the production deficiency model. This shows that if the owned food cropland increased by one hectare, the log of the number of months when households recorded food shortages due to insufficiency of home food production would decrease by 0.0544. This is expected because availability of suitable land is paramount for food security. The estimated parameters for rented food cropland are statistically insignificant (p>0.10), though with negative sign. However, the parameter of community food crop land in the food shortages as a result of cash deficiency is with positive sign and statistically insignificant. The parameter of community food crop land in the production deficiency model is with negative sign and statistically significant (p<0.10). This implies that increase in the community food crop land by one hectare will lead to reduction of the log of months where food shortages are had due to insufficient home production by 0.5409. This is also expected because availability of suitable land from community can enhance food production. A major problem in Sahel belt is that
perpetual degradation of land resources is making expansion of agricultural land to be on marginal land.

However, the parameters that were estimated for owned grazing land in the two models are with positive sign, although only that for the Poisson regression is statistically significant (p<0.01). This implies that a unit increase in the land areas devoted to own grazing land will increase log of months with food shortages due to cash insufficiency by 0.3202. The parameters of community grazing land areas are with negative sign in the two models although only that for Poisson regression is statistically significant (p<0.01). This implies that increase in the community land areas for grazing by one hectare will lead to reduction of the log of months with shortage of food due to insufficient cash by 2.1729. This shows that livestock husbandry is directly dependent on communal pasture land. Availability of this in quality and sufficient hectares will reduce food shortages as a result of insufficient cash to supplement home production.

Some variables were included to capture ownership of asset by the households. These include radio, television, cell phone, bicycle, motorcycle and car. The manner in which these can influence production may not be clearly defined. However, it is evident that they may connote access to better information about production technologies, climate change, market access, among others. The results show that in the Poisson model, households that own radio had the log of the months with food shortage due to cash problem being significantly higher (p<0.05) by 3.0239. Similar finding was recorded for ownership of television where the farmers that owned it had the number of months with food shortages being significantly higher (p<0.05) by 1.3358. However, the parameter has negative sign in the Negative Binomial model, showing that those with access to television had the months with food shortages due to production deficiency significantly lower (p<0.05) by 0.6465. Cell phone ownership parameter in the Negative Binomial regression is statistically significant (p<0.05) and implies that farmers that owned cell phone had the log of the months with food shortages due to production deficiency being higher by 0.4253.

The gender-related variables that were included were dummy variables capturing more involvement of men in certain farm activities. In the Negative Binomial model, the parameter of men did most work in crop processing is with positive sign and statistically significant (p<0.10). This implies that the households where men did most of the works in food processing had the number of months with food shortages due to cash deficiency increased by 0.4186. This is expected because food processing can be better done by women. Therefore, returns from farming may not be optimized when women are not available to participate in processing. Also, the parameters estimated for variables of men did more work in production of other cash crops, vegetable production, fruit production, small livestock production and timber production are with positive sign and statistically significant (p<0.05) in the Poisson model. These results imply that households where men did most works in those activities have their log of month with food shortages increased. However, the parameters of men did most works in large livestock production,
fodder production and wood production are statistically significant (p<0.05) and with negative sign. These imply that the log of number of months with food shortages due to cash deficiency reduce with those variables.

Some of the parameters of sources of income variables are statistically significant (p<0.10). Specifically, cash from business, gifts and informal credits had negative parameters which show that those obtaining incomes from those sources have lower log of months with food shortages due to cash deficiency. However, the parameters of income from government payments and informal sources are with positive parameters that show that those with these income sources have higher log of months with food shortages due to cash deficiency.

Table 4: Results of Poisson and Negative Binomial Regression

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Poisson model (Cash deficiency)</th>
<th>Negative Binomial model (Production deficiency)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td></td>
</tr>
<tr>
<td>Owned food crop land area (ha)</td>
<td>-0.1233</td>
<td>-1.44</td>
</tr>
<tr>
<td>Rented food crop land areas (ha)</td>
<td>-0.1059</td>
<td>-0.22</td>
</tr>
<tr>
<td>Community food crop land (ha)</td>
<td>0.7392</td>
<td>1.30</td>
</tr>
<tr>
<td>Owned grazing land (ha)</td>
<td>0.3202</td>
<td>4.94</td>
</tr>
<tr>
<td>Rented grazing land (ha)</td>
<td>-9.4624</td>
<td>0.00</td>
</tr>
<tr>
<td>Community grazing land (ha)</td>
<td>-2.1729</td>
<td>-3.29</td>
</tr>
<tr>
<td>Owned land degraded (ha)</td>
<td>-0.0241</td>
<td>-0.13</td>
</tr>
<tr>
<td>More overall rain (yes =1, 0 otherwise)</td>
<td>-3.6830</td>
<td>-2.55</td>
</tr>
<tr>
<td>More drought (yes =1, 0 otherwise)</td>
<td>-4.7147</td>
<td>-3.06</td>
</tr>
<tr>
<td>More frequent flood (yes =1, 0 otherwise)</td>
<td>3.2239</td>
<td>2.37</td>
</tr>
<tr>
<td>More strong winds (yes =1, 0 otherwise)</td>
<td>-1.2247</td>
<td>-0.28</td>
</tr>
<tr>
<td>Later start of rain (yes =1, 0 otherwise)</td>
<td>0.4600</td>
<td>0.94</td>
</tr>
<tr>
<td>Earlier start of rain (yes =1, 0 otherwise)</td>
<td>-0.1357</td>
<td>-0.15</td>
</tr>
<tr>
<td>Higher temperature (yes =1, 0 otherwise)</td>
<td>1.8729</td>
<td>0.43</td>
</tr>
<tr>
<td>Lower ground water (yes =1, 0 otherwise)</td>
<td>1.8231</td>
<td>2.9</td>
</tr>
<tr>
<td>Climate change help (yes = 1, 0 otherwise)</td>
<td>1.8975</td>
<td>3.25</td>
</tr>
<tr>
<td>Has radio (yes = 1, 0 otherwise)</td>
<td>3.0239</td>
<td>2.25</td>
</tr>
<tr>
<td>Has TV (yes = 1, 0 otherwise)</td>
<td>1.3358</td>
<td>2.21</td>
</tr>
<tr>
<td>Has cell phone (yes = 1, 0 otherwise)</td>
<td>-0.0010</td>
<td>0</td>
</tr>
<tr>
<td>Has bicycle (yes = 1, 0 otherwise)</td>
<td>-0.7962</td>
<td>-1.33</td>
</tr>
<tr>
<td>Has motorcycle (yes = 1, 0 otherwise)</td>
<td>-0.7528</td>
<td>-1.56</td>
</tr>
<tr>
<td>Has car (yes = 1, 0 otherwise)</td>
<td>-15.0754</td>
<td>0</td>
</tr>
<tr>
<td>Household size</td>
<td>-0.1055</td>
<td>-3</td>
</tr>
<tr>
<td>Household members less than 5 years</td>
<td>0.4836</td>
<td>4.17</td>
</tr>
<tr>
<td>Household members more than 5 years</td>
<td>0.5631</td>
<td>2.54</td>
</tr>
<tr>
<td>Formal education (yes = 1, 0 otherwise)</td>
<td>0.3176</td>
<td>0.56</td>
</tr>
<tr>
<td>Men do most work in raw food production (yes = 1, 0 otherwise)</td>
<td>-0.7927</td>
<td>-0.88</td>
</tr>
<tr>
<td>Men do most work in food processing (yes = 1, 0 otherwise)</td>
<td>1.5113</td>
<td>1.12</td>
</tr>
<tr>
<td>Men do most work in production of other cash crops (yes = 1, 0 otherwise)</td>
<td>2.3963</td>
<td>2.17</td>
</tr>
<tr>
<td>Men do most work in fruit production (yes = 1, 0 otherwise)</td>
<td>1.0767</td>
<td>2.09</td>
</tr>
<tr>
<td>Men do most work in vegetable production (yes = 1, 0 otherwise)</td>
<td>1.7821</td>
<td>3.22</td>
</tr>
<tr>
<td>Men do most work in fodder production (yes = 1, 0 otherwise)</td>
<td>-2.1350</td>
<td>-5.04</td>
</tr>
</tbody>
</table>
Conclusion

This paper analyzed the impacts of gender role in agriculture and climate change exposure on monthly food shortages. Some farmers reported some changes in climate that were already observed. There is therefore the need for ensuring that farmers are further assisted with daily climate forecasts, which would ensure preparedness and impact mitigation. The findings have pointed at promotion of basic education among the farmers as a way of increasing agricultural production for all-year round food security.

Although large family size favoured food security in the results, the extent of its sustainability in many years to come cannot be guaranteed given the state of environmental degradation in the region.

It was found that promotion of more involvement of women and other household members in cash crop production, fruit production and vegetable production would lead to reduction in food shortages. These call for agricultural extension support for more reach of women and provision of favourable environment that ensures adequate access by women to production resources. In conclusion, the fragile nature of natural resources in the Sahel belt of West Africa demands adequate policy initiatives to guarantee all-year round supply of food. Persistent droughts had marked the country as hot spots for food aids and other development assistance. Also, recognition of the contributions of women to food production in the Sahel can facilitate a process for understanding and devising livelihood strategies to mitigate the impacts of climate change.

Source: Author’s computations from CCAFS baseline data
Acknowledgement: Permission to use the comprehensive dataset by the Climate Change, Agriculture and Food Security (CCAFS) is gratefully acknowledged. Opinions expressed in this paper are however those of the author.

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World Bank (2005). Rural Women and Agricultural Extension in the Sahel


THE EFFECT OF E-WEB TECHNOLOGY APPLICATION IN AFRICAN MARKET

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ABSTRACT

In this paper, the study of E-web technology application in African market in the last 12 years is welcome. This is to address the periodical dropping in the use of E-web for designing, hosting, searching for items and products, online and offline banking, web facilities and tools application, internet control, browsing and accessing. The experiment was performed on different samples collected from the internet statistics on global market, wikipedia network on African market, individual samples, Google network, NGO’s and Nigerian journalist. The validation and analysis were conducted on Pentium IV Laptop, 120GB, Hard disk, 4GB Processor, 3.2 RAM and Microsoft office package.

KEYWORDS: E-Web, Internet, Market, Technology, Package, Application, Facility

1. INTRODUCTION

E-Web technology in a broad sense is the electronic technology and innovative application in the use of web tools and facilities, computer aided design (CAD), computer assisted instruction (CAI), internet creation and the management of information from one point to another which required web document in standard format such as HTML and JAVA script.

E-web technology application was enkindled by computer expert, programmers and software specialist to serve the people in accessing the nearest information in the world and Africa market in buying and selling online goods and services. Some of the dynamic web content technology includes ASP, ASP.NET, Semantic, W3C Semantic, Java technology, Microsoft web matrix, Silver light, JQuery, Visual Studio Light switch etc. The African market has been on the look for technology that would enhance the market in trading, buying and selling commodities and invisible goods. The effect of this web technology has not been deeply felt since the last 12 years in Africa and the emerging market. Moreover, there are literature updates to this effect which highlight some research done on web application in African and around the world.
Mattos [1] pioneered web technology. He reported that more than half of the population of the world can not take advantage of web technology in the merging market in the last 20 years and internet access is still expensive and is not available due to poor infrastructure in some African countries while Doomen [2] implemented the right web technology choice for business application. In his report, there are some advantage and disadvantage in using different web technologies for building green-field business application. For any business application to be adopted, the right tools for the right job must be chosen.

Further more, Hang [3] developed the application of web technology in Electronic commerce. In the paper, a new model distribution for E-commerce architecture was presented for web technology, which aimed at integration and inter-operation between different platforms. These applications are supported by those open criterions and technologies involving XML, SOAP, WSDL and UDDL while Doyle and Videira [4] pioneered the survey of technologies for web application development. They reported that web-based application developers face dizzying array of platform, Languages, Frame works and technical artifacts to choose from. They surveyed, classified and compared technologies supporting web application development and also Ossenbruggen et al [5] implemented Smart style: combining RDF semantics with XML document transformations. They reported that document web (XML- based) and semantic web (RDF-based) methods are often surprisingly hard to integrate when the role of (RDF) semantics in selecting, structuring and styling (XML) content were analyzed.

2. PROBLEM
This section highlight the problems associated with the effect of E-web technology application in African market for the past 12 years.

POVERTY IN AFRICA

The major problem that limits the use of E-web technology application in Africa market is poverty. The rate of poverty in Africa is so high that people can no longer think of new ideas and innovation in the market. About 62% of African countries are poor. This poverty has eaten dip to the extent that majority of the people living in different African countries lack money to feed than demanding for web applications from oversea. African market is under poverty siege as there are low trading and few buyers. The effect of poverty has hindered E-web technology application in the open market and has created a big vacuum between the African market and the global market. The use of E-web application can no longer be encouraged as people remain in poverty state.

LACK OF INFORMATION

“If you are not informed you will be deformed”. This is a popular saying in broadcasting media. Information exchange on E-web technology application is lacking in Africa. Over the past 12 years, the means of generating information in Africa has reduced. The broadcasting media; Radio, Television and the print media are not totally transformed and fit for information collection. E-web technology application that required the collection of data’s inform of sound, video, audio, SMS, MMS are not available. Also sourcing for information from the internet is still very low in Africa compared to the other world. The World Wide Web (www), a web facility and tool for linking browser to satellite and the outside world is not properly exploited in Africa over the past 12 years and this brings a concern to the African market and
also the collection and analysis of data that required E-web technology applications are not well utilized for information update and transmission in the African market.

2.3 UNDERCIVILIZATION PROBLEM

A country that is not civilized is said to be undercivilized. The word civilization can be measured by the rate of new technology, ideas and innovation adopted and applied to promote and transform once life. Majority of the African countries are undercivilized, that is why the use of E-web technology application remain static and low in percentage. The use of E-web technology application especially the internet should be an eye opening in Africa market to other world but rather is the opposite. Trading in African market that should be linked with internet access and other E-web technology application has never been exploited. The old ways of doing things have engulfed the mind of the marketers, Forex traders, jobbers and the shareholders in African market. To be frank, African market would not be 100% exploited without the use of E-web technology application. The question now asked? How can E-web technology application change the market and make us civilized.

2.4 EXPENSIVE INTERNET FACILITY

In Africa, internet facilities are very expensive to afford. The installation of internet in various homes can’t be afforded by families in Africa. About 68% of the families in Africa can’t afford internet installation, a branch of E-web technology application, because it is costly and expensive. The African market required E-web technology (internet applications) for online banking, Forex trading, payment of E-banking money and online marketing which should be operated from various homes with the Laptops or Desktops connected to the internet but rather we have the opposite in African market. The question asked is “How many people, individual and family can afford internet facilities in their homes”? This is a question that required urgent attention and solution as soon as possible in Africa.

2.5 COMPUTER AND PHONE ILLITERATE

About 53% of the populations in Africa are computer and phone illiterate. Computers have existed for more than 20 years in Africa and also phone have existed for more than 15 years and both computer and phone facilities are yet to be exploited. Many African countries lack computer ideas, experience and knowledge and also on phone application. The various facilities that link E-web technology application in computer and phone are underutilized in Africa market because of lack of formal education and training. About 40% of the illiteracy comes from the rural dwellers. A countless number of them have not seen and torch computer and phone. They believed that “Only the rich and literate people use and operate computer and phone in the society”. This is a big problem that must be tackled in African market.

2.6 LACK OF LOCAL CONTENT AND QUALITY

The local content for the establishment of E-web technology application is not readily available in African market. Different quality of E-web packages that should promote web technology in Africa countries is lacking. The total idea of providing local content and quality for internet access and phone accessories are also not available in the African market. The market in Africa is not competitive as such because most of
the contents are imported from other countries outside Africa. There are limited to none local content for companies and industries to tap from on E-web technology and few to none quality web packages in the African market. The more we lack local content and quality for E-web technology application, the more the market depreciate in size, technology and online marketing in Africa.

3. PROPOSED SOLUTION
This section highlights the recommended solution to all the problems mentioned in this paper concerning the effect of E-web technology application in African market.

ESTABLISHMENT OF WEB TECHNOLOGY CURRICULUM IN SCHOOLS
In civilized countries, E-web technology applications are being studied in High schools, Colleges, Polytechnics and Universities in their various curriculums but in Africa there is no such establishment. The adoption of E-web technology curriculum in High school, Colleges, Polytechnics and Universities program or scheme would go along way in curbing the effect of E-web technology application in African market. This curriculum would cut across 1st and 2nd semesters in Polytechnics and Monotechnics and Universities from year 1 to year 4 or 5 and 2nd term in High school and Colleges and finally, 3rd term in basic 1 to 3. The implementation of this E-web technology curriculum would eliminate the gap between the civilized and undercivilized and lunch the youth to new innovative, ideas, creativity and adopt the use of E-web technology application in African market.

ERADICATION OF POVERTY IN AFRICA
About 63% of the countries living in Africa are poor. There are not enough of basic amenities, social amenities, money, jobs and facilities that would allow E-web technology implementation. Poverty has eaten dip in the mind of people. The use of E-web technology application can only have effect when poverty is eradicated. As a solution, the government should help the people by creating jobs, basic amenities, and social amenities, build more study centers, schools, universities and even colleges. Poverty should be eradicated to give room to E-web technology that would promote African market. When people are poor, they can’t afford E-web technology application packages and installation, even internet which is the nearest to the people would be baseless when jobs are not created and people can’t get money to afford them. If this factor above is eradicated, E-web technology application in Africa market would then be effective.

ESTABLISHMENT OF INTERNET INFRASTRUCTURE BY THE GOVERNMENT
A country without adequate provision of infrastructure by the government would always lack. Internet would not be established except infrastructure that would aid their usage is provided. The percentage of families that can provide internet infrastructure for their children are not more than 23% of the total population in Africa. It is the right of the government to ensure the provision of internet infrastructure and installation for proper use. The government can partner with telecommunication internet providers and NGO’s that can provide infrastructure to the people to allow E-web technology application in African market. When this internet infrastructure are established and operated, it would encourage E-web technology and more people would learn and the African market would boom and internet access and usage would increase.
FORMAL TRAINING ON COMPUTER AND PHONE WEB FACILITY

For E-web technology application to be active in African market, computer and phone web facilities training should be conducted. Many of the rural dwellers can’t operate computer and phone facilities in order to exploit the E-web packages. Some of the youth in the urban area lack the idea behind E-web technology application on phones and computer because of lack of formal training. In online forex trading, computer facilities that would aid robotic web technology application on forex trading should be provided at cheaper price. This package would teach, train and direct a beginner on forex trading. Tutorial and formal training should be encouraged and made easy in their usage. As many of the African country are moving into cashless economy before the next 10 years, the use of mobile payment or mobile money should be encouraged and formal training on such should be taught that would aid E-web technology in the open market. By so doing, the E-web technology application that required computer and phone accessories would be encouraged and the listed problems would be solved.

ADOPTING CIVILIZED CULTURE ON E-WEB TECHNOLOGY

African culture is meant for African people and civilized culture is meant for civilized people. Some of the civilized culture can be borrowed into African culture. This is because African is not totally a bed of rose. Some of the civilized culture that must be implemented for E-web technology to grow strongly in African market includes;

1. Implementing E-Educational culture and learning.
2. Adopting western E-marketing strategies and culture
3. Linking E-web technology to all economic sector.

As was mentioned in section 2.3, the implementation of E-web technology would aid civilization in Africa and the open market. In as much as these listed civilized cultures are applied, it would make the market grow, increase the use of E-web packages and make Africans to be familiar with other culture.

3.6 PROVISION OF LOCAL CONTENT AND QUALITY

As mentioned in section 2.6, local contents are readily not available but can be researched for their location. There would be unlimited raw materials in Africa that could be tapped when the government allows companies, industries, experts and foreign partners to tap and adopt ways of importing the local content to the country. The provision of E-web technology local content and quality would go a long way in encouraging ideas, innovations on internet access, internet optimization, online marketing, local facilities and accessories. Above all, when government in Africa allows local content to be import and research are carried out, it would solve the problem of inadequate E-web technology in African market.
4. RESULT AND DISCUSSION

This section highlights the results analyzed on the effect of E-web technology application in the African market. The results depend on the validation and samples collected from a few African countries from 1999 to 2011.

Table 1: The percentage effect of E-web technology application in the African market.

<table>
<thead>
<tr>
<th>S/N</th>
<th>COUNTRY</th>
<th>IA (%)</th>
<th>LQ (%)</th>
<th>IG (%)</th>
<th>UC (%)</th>
<th>WS (%)</th>
<th>CP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SOUTH AFRICA</td>
<td>58</td>
<td>66</td>
<td>63</td>
<td>40</td>
<td>67</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>NIGERIA</td>
<td>40</td>
<td>46</td>
<td>31</td>
<td>52</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>CAMEROON</td>
<td>43</td>
<td>48</td>
<td>44</td>
<td>50</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td>4</td>
<td>GHANA</td>
<td>45</td>
<td>50</td>
<td>40</td>
<td>48</td>
<td>52</td>
<td>54</td>
</tr>
<tr>
<td>5</td>
<td>ALGERIA</td>
<td>47</td>
<td>52</td>
<td>51</td>
<td>53</td>
<td>57</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>EGYPT</td>
<td>51</td>
<td>54</td>
<td>57</td>
<td>42</td>
<td>58</td>
<td>52</td>
</tr>
<tr>
<td>7</td>
<td>KENYA</td>
<td>55</td>
<td>52</td>
<td>50</td>
<td>52</td>
<td>60</td>
<td>62</td>
</tr>
<tr>
<td>8</td>
<td>ZAMBIA</td>
<td>48</td>
<td>50</td>
<td>38</td>
<td>59</td>
<td>50</td>
<td>59</td>
</tr>
<tr>
<td>9</td>
<td>TANZANIA</td>
<td>53</td>
<td>60</td>
<td>58</td>
<td>48</td>
<td>61</td>
<td>49</td>
</tr>
<tr>
<td>10</td>
<td>MOROCCO</td>
<td>46</td>
<td>51</td>
<td>44</td>
<td>49</td>
<td>54</td>
<td>51</td>
</tr>
<tr>
<td>11</td>
<td>MAURITIUS</td>
<td>56</td>
<td>65</td>
<td>53</td>
<td>43</td>
<td>63</td>
<td>45</td>
</tr>
<tr>
<td>12</td>
<td>GUINEA</td>
<td>38</td>
<td>41</td>
<td>28</td>
<td>63</td>
<td>48</td>
<td>68</td>
</tr>
</tbody>
</table>
TABLE 1: Represents the validation data sampled and analyzed on the effect of E-web technology application in African market. In the percentage of internet accessibility, there was a mixed increase and decrease from South Africa to Dr. Congo. In the availability of local content and quality, South Africa has the highest with 66%, Nigeria 46% and Dr. Congo with the least 40%, while in availability of internet infrastructure by the government, Guinea has the lowest in percentage with 28%, South Africa with 63% and Nigeria the 3rd lowest with 31%. From 2004 to 2011, the highest undercivilized country is Dr. Congo with 66% and the lowest of them all is South Africa with 40%.

In the provision of E-web information service, Nigeria has 50%, Kenya 49%, Dr. Congo is the least with 45% and South Africa 67% as the highest. Finally, in the percentage level of computer and phone web illiterate, Nigeria has 60%, the lowest is South Africa with 43% and the highest is Dr. Congo with 70%.
Figure 2: The validation pie chart of IA (%)

Figure 3: The validation pie chart of LQ (%)

Figure 4: The validation pie chart of IG (%)
Figure 1: Represents the graph of E-web technology application in African market. From the graph the blue part of IG (%) in Dr. Congo has the lowest percentage with 25% and the green part of CP (%) in Dr Congo has the highest percentage with 70%.

Figure 2, 3, 4, 5, 6, 7 represent the pie chart validation of the effect of E-web technology application in African market. The yellow spot is South Africa, the Red spot is Nigeria, the Light blue spot is Cameroon, the pink spot is Ghana, the Light pink spot is Algeria, the Light blue spot is Egypt, the green spot is Kenya, the Light yellow spot is Zambia, the Blue spot is Tanzania, the Brown spot is Morocco, the Light yellow spot is Mauritius, the dark green spot is Guinea and finally the Light Red spot is Dr. Congo.

CONCLUSION
We have sampled, analyzed and validated the data’s collected from the research on the effect of E-web technology application in African market. The result did not specialize on the open market but on the effect of E-web technology application that could help the market. The result from the proposed solution has shown to be competent, effective, robust and authentic. The verification procedure was compared with other processes and found to be 100% adequate and genuine. The future paper expected includes Web technology in mobile money system in Africa.

REFERENCES

EXTENT OF COMMUNITY PARTICIPATION IN THE PROVISION OF SCHOOL PLANT IN THE ADMINISTRATION OF PUBLIC SECONDARY SCHOOLS IN ENUGU STATE

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Abstract
The study examined the extent of community participation in the provision of school plant in the administration of public secondary schools in Enugu State. One research question and one null hypothesis guided the study. Descriptive survey research design employing simple random sampling was used to sample 7211 of all the principals and classroom teachers from both rural and urban schools in Enugu State: Out of which 702 respondents responded to the study. The instrument used for data collection was questionnaire. The questionnaire was face validated by experts in the field of education, a reliability co-efficient of 0.73 was obtained using croanbach alpha method of determining internal consistency of the instrument. The research question was answered using mean and grand mean while the hypothesis was tested using t-test statistics. The result revealed that the extent of community participation in the provision of school plant in public secondary schools in Enugu State was low. Significant differences did not exist in the mean perception scores of principals and teachers regarding the extent of community participation in provision of school plant in the public secondary schools in Enugu State. It was recommended among other things that regular interactive programmes for instance radio-link and meet the people-tour should be conducted for both the principals and community representatives, the need for provision of school plant in schools.

Keywords: Extent, community participation, administration, school plant, public secondary school.

Introduction
Extent in this study means low far the members of the community have been contributing in the affairs of public secondary school administration as regards to provision of school plant for effective teaching and learning. In this study also, community participation in school administration is the involvement of the community to achieve educational goals and objectives. Education at secondary school level is defined by Federal Republic of Nigeria (2004), as the form of education children receive after primary education and before the tertiary stage. The broad aims of secondary education as stated in the Federal Republic of Nigeria (2004) include preparation for useful living within the society and preparation for higher education. In the
Policy document, it is stated that government welcomes the participation of voluntary agencies and communities in the establishment and management of secondary schools. This is because the provision of education has become very expansive not to be left for the government alone. The school and community are two inspirable entities which are mutually dependent on one another. In Nigeria and indeed in many other African countries, the typical image of a community is that of a medium sized rural village with a close-knit group of inhabitants, largely, self contained with every body knowing and standing in accepted relationship with one another. (Amujiri, 2000).

Ngoka (2003), observed that a community is a body of people living in the same locality and having a common cultural and historical heritage and the willingness to work together. He identified some of the agencies within the communities through which effective and efficient school-community relationships are maintained. They include Parents Teachers Association (PTA) School Based Management Committee (SBMC), Social Clubs, Old Student’s Association, Board of Governors and Women Association. In the same vein, Nwangwu, (2007), observed that a school does not exist in isolation. It exists in social setting, in other words, it is an integral part of the community in which it is situated. This therefore means that the community as well as the general public in one way or the other owns and supports the school. He further stated that as a result of this support, these people deserve to be informed on regular basis on the progress and activities of the school. Both the school and the community have tremendous influence on the character and behaviour of the youths. The school as well as the community should understand and appreciate the need for mutual co-existence. There is, therefore, absolute need to create opportunities and forum where views on school policies, programmes, activities are discussed.

Administration is generally defined as the process of working with and through others to efficiently accomplish organizational goals (Aguba, 2009). In the words of Veig in Olewe (2007), sees administration as a determined action taken in pursuit of conscious purpose. It is the systematic ordering of affairs and the calculated use of resources, aimed at making those things happen which we want to happen simultaneously preventing developments that fail to square with our intentions. It is the marshaling of available labour and materials in order to gain that which is desired at the harvest cost of energy, time and money.

Public secondary schools as used in this study refer to all the secondary schools that are owned, financed and managed by the Enugu State government. The school is the agent of socialization after the home. Therefore, the school exists for the community and the community exists and acts as clients to the school. This is because without the community, there would not be the school.

Okwor (2008), emphasized the need for cooperation between the school and the community in the education of children because the school and the community are symbiotically related. Advocating move on the importance of home-school cooperation, Akubue – 1992 in Igbo (2002) stated that whilst few would doubt that the main influence of child’s life is his home that of the school is a good second home. The closer the cooperation between these two the happier the child and more successful his development in every respect. Therefore, school community relations is a series of planned activities and media through which the school seek to learn about the community. These activities include informing the community about and interpreting when necessary, the purpose, programmes, problems and needs of the schools.
The school plant in this study is defined to include the site, the buildings, equipment and all facilities of a school (Olaturosun 2005 in Onyene 2007). To say that such plant of most schools in Enugu State is dilapidated, inadequate and unmaintained condition is stating the obvious. It is basic that adequate provision and maintenance of school plant enhance effective teaching and learning. No level of education can survive in the absence of physical facilities. The Federal Republic of Nigeria (2004) realized the value of physical facilities in schools when it stated that “government will ensure that schools are properly equipped to promote sound and effective teaching, and in particular that suitable textbooks and libraries are provided for schools”. However, the extent to which government has succeeded in schools where enough facilities are lacking. Okpala (2005) commented that it is disheartening that in our school today, you find nothing but dull uninviting sagging roof and colourless dilapidating walls. As he said, it is under this appalling physical condition that students and teachers are squatting in the name of education. He suggested that school buildings should be well built and attractive as well as equipped. He also concluded that lack of facilities is a serious contributory factor hindering teachers with initiatives and zeal from making use of audio-visual aids and this has made teachers to develop a non-challant attitude towards their work.

In a similar view, Okoro (2008), stated that most of the physical facilities in schools are grossly inadequate as a result of the population explosion in primary and secondary schools. Okoro stated further that very often two classes are placed in one room and the classroom space is in most cases inadequate and that seats and tables are in short supply and the children are uncomfortable. He said that as a result of this, quality education is sacrificed and standard fails. He therefore opined that the PTA and school board of governors should help to generate funds for physical facilities especially at this point in time when economic depression has adversely affected the finances both the federal and state government.

Air waves and print media are on daily basis inundated with reports on high incidence of mass failure of secondary school students in various examinations conducted by the West African Examinations Council (WAEC), National Examination Council (NECO) and the Joint Admissions and Matriculation Board (JAMB). Personal experience has shown that the ugly situation is necessitated by poor provision of school plant in most secondary schools and constant reports of vandalization and theft of the existing facilities in the schools in Enugu State.

All these point to the fact that government can no longer bear the burden alone. The community is expected to participate actively in the administration of secondary schools but what remains uncertain is the extent of its involvement. This forms the problem of the study, which focuses on the extent of community participation in the provision of school plant in the administration of public secondary schools in Enugu State.

**Purpose of the Study**

The purpose of the study was to assess the extent of community participation in the provision of school plant in the administration of public secondary schools in Enugu State. Specifically, the study sought to:

Investigate the extent of community participation in the provision of school plant.
Research Question

To what extent does the community participate in the provision of school plant?

Hypothesis

The course of this study, a hypothesis was tested at .05 level of significance and an appropriate degree of freedom.

There is no significance difference in the mean perception scores of principals and teachers on the extent of community participation in the provision of school plant.

Method

The design of the study was descriptive survey research design because it concentrated on discussing events as they were without any interference on what was observed. The population for study was 7211 of all the principals and classroom teachers from both rural and urban schools in Enugu State.

The instrument for data collection was a 6-itemed four point scale response option questionnaire, with a response format of very great extent (VGE), great extent (GE) low extent (LE), very low extent (VLE) and a numerical value of 4, 3, 2 and 1 respectively. The instrument was validated by three experts in the field of Education. Based on their comments, some items were reconstructed. The reliability of the instrument was determined using croanbach’s alpha formula and internal consistency reliability co-efficient of 0.73 was obtained. The questionnaire was administered to the principals and classroom teachers during their monthly meetings in their various schools with the help of trained research assistants.

The research question was analyzed using mean and grand mean, while the hypothesis was tested at .05 level of significance using t-test statistics. The decision rule was as follows. Any item with mean 2.50 and above was accepted which shows that the community participated in the provision of school plant in the administration of public secondary schools to a great extent; while those below 2.50 were not accepted, which indicates that community participated in the provision of school plant to a low extent. Where the calculated t-value was equal or greater than the critical value of 4, the null hypothesis was rejected but if less than the critical t-value, it was not rejected.

Results

The results of the data analysis were presented in tables according to the research question and hypothesis.

Research Question

To what extent does the community participate in the provision of school plant?

Table 1: Mean scores of respondents one extent of community participation in
provision of school plant.

<table>
<thead>
<tr>
<th>S/N</th>
<th>ITEMS</th>
<th>$\bar{X}$</th>
<th>SD</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Principals allowance community to repair facilities that are available in the school</td>
<td>2.80</td>
<td>1.00</td>
<td>GE</td>
</tr>
<tr>
<td>2</td>
<td>The community provides the erection of needed facilities</td>
<td>1.82</td>
<td>0.90</td>
<td>LE</td>
</tr>
<tr>
<td>3</td>
<td>The school maintains existing school plant, facilities with the help of the community.</td>
<td>1.78</td>
<td>0.89</td>
<td>LE</td>
</tr>
<tr>
<td>4</td>
<td>The community provide facilities live furniture to the school</td>
<td>1.73</td>
<td>0.81</td>
<td>LE</td>
</tr>
<tr>
<td>5</td>
<td>The community donate lands freely for school use.</td>
<td>1.71</td>
<td>0.82</td>
<td>LE</td>
</tr>
<tr>
<td>6</td>
<td>The community participate in the security of the school properties.</td>
<td>1.99</td>
<td>0.92</td>
<td>LE</td>
</tr>
<tr>
<td></td>
<td><strong>Grand Mean</strong></td>
<td><strong>1.97</strong></td>
<td><strong>0.98</strong></td>
<td>LE</td>
</tr>
</tbody>
</table>

**Key GE = Great Extent**

The table shows that a grand mean of 1.97 was obtained. This is an indication that community participation in the provision of school plant in their administration of public secondary schools in Enugu State was to a low extent.

**Testing of Null Hypothesis**

There is no significant difference in the mean perception scores of principals and teachers on the extent of community participation in the provision of school plant.

**Table 2:** t-test analysis of significant difference between the mean scores of principals and teachers on the extent of community participation in the provision of school plant.

<table>
<thead>
<tr>
<th>Respondents</th>
<th>n</th>
<th>$\bar{X}$</th>
<th>SD</th>
<th>df</th>
<th>t-cal</th>
<th>t-critical</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principals</td>
<td>30</td>
<td>1.86</td>
<td>0.89</td>
<td></td>
<td>1.29</td>
<td>1.96</td>
<td>Do not Reject H0</td>
</tr>
<tr>
<td>Teachers</td>
<td>672</td>
<td>2.08</td>
<td>1.02</td>
<td>700</td>
<td>1.29</td>
<td>1.96</td>
<td></td>
</tr>
</tbody>
</table>

The table shows that t-value is 1.29 and the critical value of $t$ was 1.96 since the calculated value of $t$ was less than the critical value of $t$, the null hypothesis was not rejected. This means that no significant difference exist between the mean perception scores of principals and teachers regarding the extent of community participation in the provision of school plant.

**Discussion of Findings**

The finding from the research question revealed that extent of community participation in the provision of school plant in public secondary schools in Enugu State was low. This is in the with Okpala (2005) who reported that it is disheartening that in our schools today, one finds nothing but dull university sagging roofs and colourless dilapidating walls. He further stated that it is under the appalling physical conditions that our children and their teachers are squatting in the name of education for teaching and learning. In the same vein, Okoro (2008) was of the
opinion that most of the physical facilities in school today are grossly inadequate as a result of population explosion in our secondary schools. And that very often two classes are placed in one room and the classroom space in most cases are inadequate and that seats and tables are in short supply and the children are uncomfortable.

The result from the null hypothesis tested at .05 level of significance showed that there was no significant difference between the mean perception scores of principals and teachers regarding the extent of community participation in provision of school plant in public secondary schools in Enugu State. This was in agreement with the earlier findings of Bosah (1990) that most of the public secondary schools were inadequate provided for, play grounds were ill-equipped, poor library facilities, poor provision of utilities, classrooms and administrative facilities were in poor conditions. This may be as a result of low participation of members of the community in the provision of school plants in public secondary schools.

Conclusion

The findings showed that, due to non participation of community members in the provision of school plant, most of the buildings in public secondary schools are dilapidated and sagging.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. The government including the State Ministry of Education and Post Primary School Management Board (PPSMB) should as a matter of urgency make provisions for constant seminars/workshops and conferences for principals and community members on the need for effective community participation in the administration of schools. This will also enhance teaching and learning and effective school administration and management.

2. The Enugu State Chapter of All Nigerian Conference of Principals (ANCOPs) should encourage their members to attend seminars/workshops/conferences where they will be exposed to erudite scholars in the education industry.

3. Institutions/Non-Governmental Organizations (NGOs) that run programmes on school management should also ensure that community participation in the administration of schools are cardinal aspect of their training programmes especially as it concerns provision of school plant.

References


A NEW MATHEMATICAL INVENTORY MODEL UNDER FUZZY STOCHASTIC INFLATIONARY CONDITIONS

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Abstract
In most of the earlier literature dealing with inventory problems in deterministic, probabilistic or fuzzy environment, researchers have considered inflation as constant, stochastic or fuzzy. This is the first study that determines ordering policy under fuzzy stochastic inflationary conditions. In this study, the inflation is considered as a uniformly distributed continuous fuzzy random variable. This inventory system is formulated with two models, which are derived under the assumption that the objective of inventory management is to minimize: (1) average annual cost or (2) discounted cost. The numerical examples are used to illustrate the theoretical results.

Keywords: Inventory, Inflation, discounted cost, average annual cost, Expected value of fuzzy random variable

1. INTRODUCTION
Analysis of the inventory systems in the literature is carried out using two methods. First procedure, determines optimal values of the control variables by minimizing the average annual cost and the other (and in theory more correct) method determines the optimal ordering policy by minimizing the discounted value of all future costs. Mirzazadeh (2011) is shown that there is a negligible difference between these approaches for the inventory system under stochastic inflationary conditions with deterioration over time and shortages. This study extends Mirzazadeh’s work under the fuzzy random framework assuming the inflation as a uniformly distributed continuous fuzzy random variable.

Since 1975, a series of papers appeared that considered the effects of inflation on the inventory system. Buzacott (1975) developed an economic order quantity model with inflation under different types of pricing policies. Misra (1979) dealt with a discounted cost model and included internal (company) and external (general economy) inflation rates for various costs associated with an inventory system. Sarker and Pan (1994) surveyed the effects of inflation and the time value of money on order quantity with finite replenishment rate. Some efforts on inflationary inventory systems for variable demand have been made by Uthayakumar and Geetha (2009), Maity (2010), Vrat and Padmanabhan (1990), Datta and Pal (1991), Hariga (1995), Hariga and Ben-Daya (1996), and Chung (2003).
There are several studies of deteriorating inventory models under inflationary conditions. In general, deterioration is defined as decay, damage, spoilage, evaporation, obsolescence, pilferage, loss of utility or loss of marginal value of commodity that results in decreasing usefulness. Most of physical goods undergo decay or deterioration over time, the examples being medicine, volatile liquids, blood banks, and others. Wee (1993) and Chung and Tsai (2001) derived an inventory model for deteriorating items with the demand of linear trend taking into account the time value of money. Further efforts on inflationary inventory systems for deteriorating items have been made by Wee and Law (2001), Chen and Lin (2002), Chang (2004), Yang (2006), Moon et al. (2005), Maiti et al. (2006), Lo et al. (2007), Dey et al. (2008), Hsieh and Dye (2010), Sana SS (2010), Su et al. (1996), Chen (1998), Sarker et al. (2000), Yang et al. (2001), Liao and Chen (2003), Balkhi (2004b) and Balkhi (2004a), Hou and Lin (2004), Hou (2006), Jaggi et al. (2006), Yang (2006) and (2010), Chern et al. (2008).

In above cases, it has been implicitly assumed that the rate of inflation is known with certainty. Yet, inflation enters the inventory picture only because it may have an impact on the future inventory costs, and the future rate of inflation is inherently uncertain and unstable. Horowitz (2000) presented an EOQ model with a normal distribution for the inflation rate. Mirzazadeh and Sarfaraz (2006) discussed multiple-items inventory system with a budget constraint and the uniform distribution function for the external inflation rate. Mirzazadeh et al. (2009) presented stochastic inflationary conditions with variable probability density functions (pdfs) over the time horizon and the inflation dependent demand rate. The developed model, also, implicates to a finite replenishment rate, finite time horizon, deteriorating items with shortages. The objective is the minimization of the expected present value of costs over the time horizon. Mirzazadeh (2010a) assumed the inflation is time-dependent and demand rate is assumed to be inflation-proportional. Mirzazadeh (2010b) proposed an inventory model with stochastic internal and external inflation rates for deteriorating items and allowable shortages.

However all the above mentioned works are in the probabilistic framework. In these models, the uncertainty inherent in reality is accounted for but the imprecision arising due to vague information is not considered. Now to capture this imprecision, fuzzy set theory has come to be widely applied in the study of various inventory models in general and the inflationary inventory system in particular. Maity and Maiti (2008) developed a numerical approach to a multi-objective optimal inventory control problem for deteriorating multi-items under fuzzy inflation and discounting. Roy et al. (2009) presented an inventory model for a deteriorating item with displayed stock dependent demand under fuzzy inflation and time discounting over a random planning horizon. Another research has been performed by Ameli et al. (2010) with considering an economic order quantity model for imperfect items under fuzzy inflationary conditions.

However as mentioned earlier, the probabilistic models do not consider any imprecision in the model environment while the fuzzy models do not consider any random fluctuations that are so intrinsic to the inventory parameters. Thus this paper is developed to account for both these types of uncertainties and the inflation is considered as a uniformly distributed continuous fuzzy random variable. This inventory system is formulated with two models, which are derived under the
assumption that the objective of inventory management is to minimize: (1) average annual cost or (2) discounted cost.

The rest of this paper is organized as follows. Section 2 outlines the preliminary concepts that are used for model building purposes. In section 3, notations and assumptions are given which are used to develop the proposed model. In Section 4, the objective functions using the expected average annual cost method and the expected discounted cost method are derived. Section 5, provides a numerical example to clarify how the proposed models are applied. Finally, conclusion remarks are interpreted.

2. PRELIMINARY CONCEPTS

In order to consider the fuzziness of an inventory problem, we need the following definitions and property relative to this study.

Recently, in order to define expected value operator of fuzzy variable, the set function Cr, called credibility measure was defined as Liu and Liu (2002).

**Definition 2.1 (Liu and Liu (2002)).** Let \((\Gamma, P(\Gamma), Pos)\) be a possibility space. The set function \(Cr\) defined by

\[
Cr(A) = \frac{1}{2} \left( 1 + Pos(A) - Pos(A^c) \right), \quad A \in P(\Gamma)
\]

is called a credibility measure.

**Definition 2.2 (Liu (2004)).** Let \(\varepsilon\) be a fuzzy variable defined on the possibility space \((\Gamma, P(\Gamma), Pos)\). Then its membership function is defined by

\[
\mu(x) = Pos\{\gamma \in \Gamma \mid \varepsilon(\gamma) = x\}, \quad x \in \mathbb{R}
\]

**Definition 2.3 (Liu and Liu (2002)).** Let \(\varepsilon\) be a fuzzy variable. The expected value of \(\varepsilon\) is defined as

\[
E(\varepsilon) = \int_0^{\infty} Cr(\varepsilon \geq r)dr - \int_{-\infty}^0 Cr(\varepsilon \leq r)dr
\]

provided that at least one of the two integrals is finite.

**Definition 2.4 (Liu and Liu (2003)).** Let \(\varepsilon\) be a fuzzy variable on the credibility space \((\Gamma, P(\Gamma), Cr)\), and \(\alpha \in (0, 1]\). Then

\[
\varepsilon^\alpha = \inf\{x|\mu(x) \geq \alpha\} \quad \text{and} \quad \varepsilon^\alpha = \sup\{x|\mu(x) \geq \alpha\}
\]

**Definition 2.5 (Hong (2009)).** Let \(\varepsilon\) be a fuzzy variable, and \(g: \mathbb{R} \to \mathbb{R}\) a strictly increasing function. If the Lebesque integrals

\[
\int_0^1 g(\varepsilon'_{\alpha})d\alpha \quad \text{and} \quad \int_0^1 g(\varepsilon''_{\alpha})d\alpha
\]

are finite, then

\[
E[g(\varepsilon)] = \frac{1}{2} \int_0^1 [g(\varepsilon'_{\alpha}) + g(\varepsilon''_{\alpha})]d\alpha
\]

where \(\varepsilon'_{\alpha}\) and \(\varepsilon''_{\alpha}\) are the \(\alpha\)-optimistic value of \(\varepsilon\) respectively.

**Definition 2.6 (Liu and Liu (2003)).** Let \((\Omega, A, P)\) be a probability space and \(F_v\) is a collection of
fuzzy variables defined on possibility space \((\Gamma, P(\Gamma), \text{Pos})\). A fuzzy random variable is a mapping \(\varepsilon: \Omega \rightarrow Fv\), such that for any Borel subset \(B\) of \(R\), \(\text{Pos}\{X(\omega) \in B\}\) is a measurable function of \(\omega\).

For any fuzzy random variable \(\varepsilon\) on \(\Omega\), for each \(\omega \in \Omega\), the expected value of the fuzzy variable \(\varepsilon(\omega)\) is denoted by \(E[\varepsilon(\omega)]\) which has been proved to be a measurable function of \(\omega\) (see [25]), i.e., it is a random variable. Given the expected value of the fuzzy random variable, \(\varepsilon\) is defined as the mathematical expectation of the random variable \(E[\varepsilon(\omega)]\).

**Definition 2.7** (Liu and Liu (2003)). Let \(\varepsilon\) be a fuzzy random variable defined on the probability space \((\Omega, A, P)\). Then, the expected value of \(\varepsilon\) is defined as

\[
E(\varepsilon) = \int_{\Omega} \left[ \int_{0}^{+\infty} \text{Cr}(\varepsilon(\omega) \geq r)dr - \int_{-\infty}^{0} \text{Cr}(\varepsilon(\omega) \leq r)dr \right] \text{Pr} \, d\omega
\]  

(7)

**Definition 2.8** (Hao et al. (2008)). Let \(\varepsilon\) be a triangular fuzzy random variable such that for each \(\omega\)
\[
\varepsilon(\omega) = (X(\omega) - \alpha', X(\omega), X(\omega) + \beta')
\]

is a triangular fuzzy variable with the following possibility distribution function:

\[
\mu_\varepsilon(x) = \begin{cases} 
\frac{x - X(\omega) + \alpha'}{\alpha'}, & \text{if } X(\omega) - \alpha' \leq x \leq X(\omega) \\
\frac{-x + X(\omega) + \beta'}{\beta'}, & \text{if } X(\omega) \leq x \leq X(\omega) + \beta' \\
0, & \text{otherwise}
\end{cases}
\]  

(8)

Where \(\alpha' > 0, \beta' > 0\), and \(X\) is a random variable. Then for each \(\omega\), according to definition 2.3, the expected value is \(E[\varepsilon(\omega)] = \frac{(4X(\omega) - \alpha' + \beta')}{4}\). Moreover, by using definition 2.7, we have

\[
E[\varepsilon] = \frac{4E[X(\omega) - \alpha' + \beta']}{4}
\]  

(9)

**Definition 2.9.** Let \(\varepsilon\) be a triangular fuzzy random variable such that for each \(\omega\)
\[
\varepsilon(\omega) = (X(\omega) - \alpha', X(\omega), X(\omega) + \beta')
\]

is a triangular fuzzy variable, \(g: R \rightarrow R\) a strictly increasing function, and \(f(x)\) the probability density function of \(X\). Then for each \(\omega\), according to definition 2.5, the expected value \(E[g(\varepsilon(\omega))] = \frac{1}{2} \int_{0}^{1} [g(\varepsilon_x'(\omega)) + g(\varepsilon_x''(\omega))]dx\), where \(\varepsilon_x'(\omega) = (X(\omega) - \alpha') + \alpha' x\) and \(\varepsilon_x''(\omega) = (X(\omega) + \beta') - \alpha' x\). Moreover, by using definition 2.7, we have

\[
E[g(\varepsilon)] = \int_{0}^{1} \left[ \frac{1}{2} \int_{0}^{1} [g(\varepsilon_x'(\omega)) + g(\varepsilon_x''(\omega))]dx \right] f(x) dx
\]  

(10)

3. ASSUMPTIONS AND NOTATION

3.1. Assumptions

The mathematical models in this paper are developed based on the following assumptions:
1. The inflation rate is a fuzzy random variable.
2. The demand rate is known and constant.
3. Shortages are allowed and fully backlogged.
4. The replenishment is instantaneous and the replenishment cycle is the same for each period.
5. The initial inventory level is zero.
6. The time horizon is infinite.
7. A constant fraction of the on-hand inventory deteriorates per unit time, as soon as the item is received into inventory.

3.2. Notation

The following notations are used:

\( \hat{i} \): The difference between the discount (cost of capital) and the inflation rate which is fuzzy random variable

\( f(\hat{i}) \): The probability density function (p.d.f.) of \( \hat{i} \)

\( D \): The demand rate per unit time

\( \theta \): The constant deterioration rate, where \( 0 < \theta < 1 \)

\( C_m \): The inventory holding cost (for \( m=1 \)) and shortage cost (for \( m=2 \)) per unit per time at time zero

\( C \): The per unit purchase cost of the item at time zero

\( A \): The ordering cost per order at time zero

\( T \): The replenishment time interval

\( k \): The proportion of time in any given inventory cycle which orders can be filled from the existing stock

\( EAC(k, T) \): The expected average annual costs

\( ED\text{c}(k, T) \): The expected present value of costs

Additional notations will be introduced later.

4. THE MODEL FORMULATION

Mizazadeh (2011) compared the optimal ordering policies derived by the average annual cost and the discounted cost methods under stochastic inflationary conditions. In the next sections, these methods are developed by considering inflation as a fuzzy random variable following uniform distribution.

4.1. The Average Annual Cost Model

The first model is mathematically represented as follows. Let \( ACR(k, T), ACP(k, T), ACH(k, T) \) and \( ACS(k, T) \) denote the annual cost of the ordering, purchasing, carrying and shortage, respectively. Then \( EACR(k, T), EACP(k, T), EACH(k, T) \) and \( EACS(k, T) \) denote expected value of them, respectively. Mizazadeh (2011) obtained the average annual costs as bellows:

\[
AC(k, T) = ACR(k, T) + ACP(k, T) + ACH(k, T) + ACS(k, T)
\]

where

\[
ACR(k, T) = \left[ 1 + \frac{i(1 - T)}{2} \right] A / T
\]

\[
ACP(k, T) = c \left[ D\left( e^{\theta kT} - 1 \right) + DT(1 - k) \right] \left[ 1 + \frac{i(1 - T)}{2} \right] / T
\]

\[
ACH(k, T) = \left[ c_2 DT \left( e^{\theta kT} - \theta kT - 1 \right) \right] \left[ 1 + \frac{i(1 - T)}{2} \right]
\]
Here the inflation is taken as fuzzy random variable following uniform distribution. As inflation is influenced by many factors, it is very difficult to determine a precise value of inflation rate for actual market. Therefore, inflation is treated as fuzzy random variable (FRV) of the form:

\[ \varepsilon(\omega) = (i(\omega) - \alpha', i(\omega) + \beta'), \quad 0 < \alpha' < i(\omega), \beta' > 0, \]

where \( i \) is \( U(a,b) \) and \( \alpha' \) and \( \beta' \) are the left and right spread respectively. Since \( i \) is \( U(a,b) \), the probability density function is given as below:

\[
f(i) = \begin{cases} 
\frac{1}{b-a}, & a < i < b \\
0, & \text{otherwise} 
\end{cases}
\]

When the parameter \( i \) becomes FRV, the average annual costs \( \bar{A}(k,T) \) is also a FRV which expected value is expressed as follows:

\[ \bar{E}\bar{A}(k,T) = \bar{E}\bar{ACR}(k,T) + \bar{E}\bar{ACP}(k,T) + \bar{E}\bar{ACH}(k,T) + \bar{E}\bar{ACS}(k,T) \]

Where:

\[ \bar{E}\bar{ACR}(k,T) = \left[ 1 + \frac{E[i](1-T)}{2} \right] \frac{A}{T} \]

\[ \bar{E}\bar{ACP}(k,T) = \frac{c \left[ D\left( e^{\theta k T} - 1 \right) + DT(1-k) \left[ 1 + \frac{E[i](1-T)}{2} \right] \right]}{\theta^2} \]

\[ \bar{E}\bar{ACH}(k,T) = \left[ \frac{c_1 DT \left( e^{\theta k T} - \theta k T - 1 \right)}{\theta^2} \right] \left[ 1 + \frac{E[i](1-T)}{2} \right] \]

\[ \bar{E}\bar{ACS}(k,T) = \left[ \frac{c_2 DT(1-k)^2}{2} \right] \left[ 1 + \frac{E[i](1-T)}{2} \right] \]

Let \( \varepsilon \) be a triangular fuzzy random variable such that for each \( \omega \), \( \varepsilon(\omega) = (i(\omega) - \alpha', i(\omega), i(\omega) + \beta') \) is a triangular fuzzy variable with the following possibility distribution function:

\[
\mu_{\varepsilon}(\omega) = \begin{cases} 
\frac{x-i(\omega)+\alpha'}{\alpha'}, & \text{if } i(\omega) - \alpha' \leq i \leq i(\omega) \\
\frac{-x+i(\omega)+\beta'}{\beta'}, & \text{if } i(\omega) \leq i \leq i(\omega) + \beta' \\
0, & \text{otherwise} 
\end{cases}
\]

According to definition 2.8 \( E[\bar{i}] \) is obtained as follows:

\[ E[\bar{i}] = E[\varepsilon] = \frac{4E[X] - \alpha' + \beta'}{4} \]

where \( E[X] = \frac{a+b}{2} \)
Finally, by substituting each $E[I]$ in the (18), (19), (20), and (21) with Equation (23), the expected average annual cost ($E\bar{AC}(k,T)$) is given according to Equation (17).

### 4.2. The Discounted Cost Method

The second model is mathematically represented as follows. Considering $DCR(k,T)$, $DCP(k,T)$, $DCH(k,T)$ and $DCS(k,T)$ as the present value of the ordering, purchasing, carrying and shortage cost, respectively. Then $EDCR(k,T)$, $EDCP(k,T)$, $EDCH(k,T)$ and $EDCS(k,T)$ denote expected value of them, respectively. Mirzazadeh (2011) derived the total discounted cost of the system as follows:

$$DC(k,T) = DCR(k,T) + DCP(k,T) + DCH(k,T) + DCS(k,T)$$

(24)

where:

$$DCR(k,T) = A \cdot \left[ \frac{1}{1 - e^{-i\tau}} \right]$$

(25)

$$DCP(k,T) = \frac{cD}{\theta} \left( e^{\theta kT} - 1 \right) \left[ \frac{1}{1 - e^{-i\tau}} \right] + cDT(1 - k) \left[ \frac{1}{1 - e^{-i\tau}} - 1 \right]$$

(26)

$$DCH(k,T) = \frac{c_1 D}{\theta} \left[ \theta \left( e^{-ikt} - 1 \right) + i \left( e^{\theta kT} - 1 \right) \right]$$

(27)

$$DCS(k,T) = -\frac{c_2 D}{i^2(1 - e^{-i\tau})} \left[ T(i - k\bar{i}) + 1 \right] e^{-i\tau} - e^{-ikt}$$

(28)

When the parameter $\bar{i}$ becomes FRV, the total discounted cost of the system ($\bar{DC}(k,T)$) is also a FRV which expected value is expressed as follows:

$$E\bar{DC}(k,T) = E\bar{DCR}(k,T) + E\bar{DCP}(k,T) + E\bar{DCH}(k,T) + E\bar{DCS}(k,T)$$

(29)

where:

$$E\bar{DCR}(k,T) = AE \left[ \frac{1}{1 - e^{-i\tau}} \right]$$

(30)

$$E\bar{DCP}(k,T) = \frac{cD}{\theta} \left( e^{\theta kT} - 1 \right)E \left[ \frac{1}{1 - e^{-i\tau}} \right] + cDT(1 - k) \left[ E\left[ \frac{1}{1 - e^{-i\tau}} \right] - 1 \right]$$

(31)

$$E\bar{DCH}(k,T) = E \left[ \frac{c_1 D}{\theta} \left[ \theta \left( e^{-ikt} - 1 \right) + i \left( e^{\theta kT} - 1 \right) \right] \right]$$

(32)

$$E\bar{DCS}(k,T) = -\frac{c_2 D}{i^2(1 - e^{-i\tau})} \left[ T(i - k\bar{i}) + 1 \right] e^{-i\tau} - e^{-ikt}$$

(33)

As introduced in previous section, in this section inflation is assumed as a fuzzy random variable following uniform distribution and $\bar{\epsilon}$ is a triangular fuzzy random variable such that for each $\omega$, ...
\( \varepsilon(\omega) = (i(\omega) - \alpha', i(\omega), i(\omega) + \beta') \) is a triangular fuzzy variable. According to definition 2.9, the expected value of fuzzy random variable is obtained as follows:

\[
E[g(\varepsilon)] = \int_{\Omega} \left[ \frac{1}{2} \int_0^1 g(c'_a(\omega)) + g(c''_a(\omega)) \right] f(x) dx
\]

where, for each \( \omega \), according to definition 2.4, \( \varepsilon' \) and \( \varepsilon'' \) are given as follows:

\[
\varepsilon'(\omega) = (i(\omega) - \alpha') + \alpha \alpha' \quad \text{and} \quad \varepsilon''(\omega) = (i(\omega) + \beta') - \alpha \beta'
\]

According to Equation (34), expected values that are presented in Equations (30), (31), (32), and (33) are given as follows:

\[
E[DCR(k, T)] = E[g(\varepsilon)] = AE \left[ \frac{1}{1-e^{-iT}} \right] = A \int_a^b \left\{ \frac{1}{2} \int_0^1 \frac{1}{1-e^{-(i-\alpha'+\alpha \alpha')T}} + \frac{1}{2} \int_0^1 \frac{1}{1-e^{-(i+\beta'-\alpha \beta')T}} \right\} f(i) di - 1
\]

\[
E[DCP(k, T)] = \frac{cD}{\theta} (e^{\theta kT} - 1) E \left[ \frac{1}{1-e^{-iT}} \right] + cDT(1-k) \left[ E \left[ \frac{1}{1-e^{-iT}} \right] - 1 \right] = \frac{cD}{\theta} (e^{\theta kT} - 1)
\]

\[
E[DC(k, T)] = E[cD\theta(\varepsilon^{-kT} - 1) + \theta(e^{\theta kT} - 1)] = E[cD\theta(\varepsilon^{-kT} - 1) + \theta(e^{\theta kT} - 1)]
\]

\[
E[DCS(k, T)] = E \left[ -c_2 D \left( T(i - kT) + 1 \right) e^{-iT} - e^{-iKT} \right]
\]

Thus, the total expected discounted cost of the system \( E[DC(k, T)] \) is given according to Equation (29).

### 5. Numerical Example

To illustrate the models described in Section 4, the following numerical example is discussed. Let us choose the following values for the parameters: \( D=1000 \) units/year, \( A=60 \) /order, \( c=1 \) /unit, \( c_1=0.2 \) /unit/year, \( c_2=2.1 \) /unit/year, \( \theta=0.25 \), \( i=(i(\omega)-0.05, i(\omega), i(\omega)+0.05) \) where \( i \) follows
$U(0.11,0.15)$ with $f(i)=25, \ 0.11 \leq i \leq 0.15$. Using these parameter values, the optimal solution of the models is obtained and the results are illustrated in Table 1.

<table>
<thead>
<tr>
<th>Method</th>
<th>$k$</th>
<th>$T$</th>
<th>EAC($k,T$)$^*$</th>
<th>EDC($k,T$)$^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual cost method</td>
<td>0.8268</td>
<td>0.87</td>
<td>1233.5496</td>
<td>-</td>
</tr>
<tr>
<td>Discounted cost method</td>
<td>0.3532</td>
<td>0.51</td>
<td>-</td>
<td>9907.7912</td>
</tr>
</tbody>
</table>

Figure 1 and Figure 2 show changes in the objective functions for average annual cost method and discounted cost method respect to $k$ and $T$.

6. CONCLUSION

In the existing literature, inventory models under inflationary conditions are developed under the assumption of constant, stochastic and fuzzy inflation rates. In the real word especially for long term investment, the inflation rate will be increase in high uncertainty condition and therefore, in this study for the first time the inflation is considered as a uniformly distributed continuous fuzzy random variable. The above mentioned system is derived with considering two methods: (1) minimizing average annual cost or (2) minimizing discounted cost. The numerical example is given
to illustrate the theoretical results. The numerical example shows that there is a little difference between these two approaches.

Also it is to be noted that a continuous fuzzy random variable with uniform distribution has been used to model the inflation in this paper. It may be interesting to consider other continuous distribution functions, viz. the normal distribution, as a scope for future research.

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RESEARCH, TECHNOLOGY TRANSFER AND SOCIO-ECONOMIC DEVELOPMENT IN NIGERIA: SOME LESSONS FROM THE ASIAN ECONOMIES

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ABSTRACT
Like most developing countries, Nigeria had made various efforts at acquiring foreign technology to drive the development processes in the country. While technology transfer efforts have been very successful in the Asian economies, especially in China, South Korea, India and Malaysia, it has not been successful in Nigeria. The difference in the level of success in the technological advancement between the Asian economies and Nigeria is in the approach or method adopted by the economies. While the Asian economies adopt the cram, copy or “steal” and replicate through intensive research to achieve innovation and patent rights, Nigeria adopt the traditional method of negotiated agreement of technology transfer with owners of technologies. The result is that whereas the Asian economies are making significant progress in acquiring technologies, Nigeria suffers deprivation in the acquisition of technology. The paper argues that Nigeria cannot acquire foreign technologies through negotiated agreements; therefore, if Nigeria must acquire technologies, she must tow the line of the Asian economies. Also, it asserts that Nigeria must deliberately establish high-tech research institutions and invest significantly in the development of her human capital/resources. This is what the Asian economies have done differently.

Keywords: Nigeria, Technology transfer, negotiated agreements, cram, Asian economies, research and development.

Introduction

The desirability of African countries, especially Nigeria, to acquire advanced and modern technologies to aid their development processes need not be overemphasized. Over the years, Nigeria has made efforts to increase and improve local production, particularly in the manufacturing sector, through the acquisition of foreign technologies. Prominent among them is the adoption of the import substitution industries policy in the 1970s and early 1980s. Yet, in the twenty-first century, Nigeria has not been able to improve its technological base in the different sectors of the society. It is not therefore surprising to see Nigeria grappling with providing the basic necessities of life such as water, food, electricity, roads, etc for its citizenry. As Mansfield (1975:373) has argued, one of the fundamental processes of influencing or improving the economic performance of nations and firms is technology transfer. According to Ramanathan (2009), economists have long recognized the fact that transfer of technology is at the heart of the process of economic growth (and development), and that the progress of both developed and developing countries depends very strongly on the extent and efficiency of such transfer.
In the past three decades, many Asian and Latin American countries (some of which are called the “Asian tigers” and others part of the BRICKS nations) had experienced technological break-through in the different sectors of their societies and had improved the living conditions of their citizenry. These break-throughs were not achieved via voluntary transfer of technology from the transferors (owners) to these nations (buyers or transferees) neither were they accidental. Rather these advancements in technology were gotten via concerted efforts and investments in research and development in the tertiary institutions, research institutes and production factories in these countries. Hence, the rapid improvement of these nations in the global development index or placement. The main objective of this paper is to examine or x-ray the challenges of technology transfer in Nigeria over the years in different sectors of the society. The paper would argue that owners of technologies do not and will not always voluntarily and/or willingly transfer such technologies to others. Rather technologies are “stolen” (that is capture) through concerted efforts at copy and replication, and investments in research and development. Thus, to acquire modern and advanced technologies Nigeria must toe the line of the Asian economies, especially China. This view would be developed in some greater details in the course of the discussion. The rest of the paper would be developed under the following headings: the concept of technology transfer, technology transfer and socio-economic development, technology transfer: the Asian experience, Nigeria and the dilemma of technology transfer, the role of research in technology transfer, lessons from the Asian economies, and conclusion.

The Concept of Technology Transfer

Technology is defined in terms of high-level manpower in scientific, technical and engineering fields, and expenditure on research and development as a percentage of Gross Domestic Product (Ake, 1984:106). Technologies, most often, are invented or developed in one country but utilized and enjoyed in different parts of the world. The processes through which technology invented in one part of the world is utilized or enjoyed in other parts of the world is what is generally referred to as technology transfer or technology diffusion. Bozeman (2000:629) sees technology transfer as the movement of know-how, technical knowledge, or technology from one organizational setting to another. This implies that it is not merely the movement of product(s) that is technology transfer but also the knowledge of its use and application. Mittleman and Pasha (1997:19) present a somewhat broader view of the concept technology transfer, which states that it is the movement of knowledge, skill, organization, values and capital from the point of generation to the site of adaptation and application. Here, the site of adaptation and application could be within a country or outside the country. Manfield (1975:373) made an important classification of technology transfer which classified technology transfer into vertical and horizontal technology transfer. Vertical transfer refers to the transfer of technology from basic research to applied research to development and then to production respectively, while horizontal transfer of technology implies the movement and use of technology used in one place, organization or context to another place, organization or context (Ramanathan, 2009:5). It is important to note that movement in the “context” of technology involves concerted investment in research and manpower. Souder (1987) describes vertical transfer as internal technology transfer and horizontal transfer as external technology transfer. He further describes vertical transfer as a managerial process of passing technology from one phase of its life cycle to another. According to Ramanathan (2009:5), this elaboration is vital because it serves to reinforce the fact that it may be possible to horizontally transfer technology at any stage of the technology life cycle. The methods of technology transfer vary across sectors and disciplines, therefore it is conceived differently by different scholars. According to Carl (1985:13), the term technology transfer is used in two ways in development literature. First, the transfer of technology between countries; and second, the transfer of technology from the suppliers/inventors to the buyers/users of such technology within a country (for example exchange between organizations in Nigeria or China). The focus of this paper
is on the first commonly referred to as international technology transfer. In this regard, Hayami and Ruttan (1971) have identified three stages of technology transfer, i.e. material transfer, design transfer and capacity transfer. Material transfer involves the transfer of products through trade; design transfer is characterized by the transfer of designs of factories and blue prints that can facilitate the production of products by the transferee locally; and capacity transfer involves the transfer of the ability, the know-how (skills and competence), etc are developed in the local personnel to modify and develop new products or improve on existing products and the production processes. As Carl (1985:13) observes, in this stage (that is capacity transfer) research and development (R&D) are central to the transfer processes. Indeed, this is the stage or point technology would be said to have been transferred or acquired.

Most models of technology transfer in literature seem to suggest that technology transfer or diffusion is only possible through a negotiated agreement between the owners or suppliers of technology and receivers or buyers of technology. For instance, the Bar Zakay model believes that for technology transfer to be possible there must be an agreement between the donor/transferrer and recipient/transferee anchored on a project management approach (Ramanathan, 2009:8). According to Ramanathan (2009:8), in this model the activities to be carried out are specified in details and the importance of both the donor and recipient acquiring the skills to undertake technological forecasting, long-range planning and gathering of project-related intelligence is emphasized. Similarly, the Behrman and Wallender Model proposed a seven stage process for international technology transfer that may be of great relevance to multinational corporations. These stages among others include: manufacturing proposal and planning to arrive at decisions regarding location and preparing a business case including good resource assessments; deciding the product design technologies to be transferred; specifying details of the plant to be designed to produce the product and other aspects related to construction and infrastructure development; adapting the process and product if needed and strengthening production systems to suit local conditions; and providing external support to strengthen the relationship between the transferrer and transferee. As Ramanathan (2009:9) has observed, the major weakness of this model is that, during the first three stages the transferrer develops the technology transfer project with little involvement of the transferee thereby reinforcing dependency. How then will it be possible for the recipient or transferee to understand or grasp the technicalities involved in the technology? Furthermore, Keller and Chinta (1990:36), assert that effective technology transfer hinges to a large extent on how the transferrer and transferee manage the obstacles that hinder transfer and strengthen ways that would facilitate the transfer. The facilitating initiative or ways refer to the willingness of the partners to device strategies to achieve a “win-win” outcome (Ramanathan, 2009:12). The obstacles could be legal, political, social, economic, cultural and technological. In addition, the UNIDO (1996) model seems to buy the Bar Zakay’s project management approach, when it argues that, in the manufacturing sector, once the need for a technology transfer project is established, the steps of search, evaluation, negotiation, contract execution, and technology adaptation and absorption should be sequentially done to ensure effectiveness.

All the above models and many others not mentioned in this work appear to suggest that technology transfer is only possible through a negotiated agreement between the transferrer and the transferee. But this is not always true and not always the case in developing nations acquiring technology from the developed nations. It is my argument that most of the Asian countries that have experienced rapid growth and industrial development “stole” their technologies. The question is: if technology transfer is only possible through negotiated agreements, how did nuclear technology get to the Chinese, Indians, Pakistanis, North Koreans and Iranians in the face of the Non-Proliferation Treaty and strong opposition from the West? The simple answer is that they “stole” it. It was never transferred willingly or voluntarily or on a negotiated agreement from the western powers to these Asian nations. Obviously, while it is true that the western nations are
willingly to share agricultural technology and other obsolete technologies, they are very unwilling to share medical, manufacturing, space, information technology and other high-technologies with the third world. For the developing nations to acquire advanced technologies they have to “steal” or capture them in some cases. The method/approach of doing this would be explained later in the work.

**Technology Transfer and Socio-Economic Development**

Improving the living conditions and productivity levels of the citizens in a country is very significant to its development. Studies have shown that technology transfer is an important means through which substantial social and economic development could be achieved in the developing nations. The benefits of technology transfer include industrialization, job creation, increase in income, improved productivity, poverty reduction, etc. For instance, the acquisition of foreign technologies by the East Asian newly industrialized nations; coupled with domestic “technological learning” (that is, efforts and ability to accumulate the capability to change technologies) have been the major factors in their rapid socio-economic development. It is important to note that the wave of industrialization experienced in the Latin American and East Asian countries was to a very large extent due to technology transfer. This led to rapid growth of the manufacturing sector which created jobs in these countries. In China, for example, following the partial liberalization of the economy in 1978, the labour-intensive industries gave way to capital and technology-intensive production. Consequently, as Fu and Gao (2007:26) observed, gross industrial output (GIO) of China increased tremendously with total gross industrial output increasing from 54947 million Yuan in 1995 to 85674 million Yuan in 2000 and 251,620 million Yuan in 2005. Also, Sachs (2005:15) noted that with technology diffusion India experienced information technology revolution, which created jobs for dozens of young women who are specialists in medical data transcription. According to him, these women earn about $250 to $500 US dollar a month, depending on their experience. He added that, their income is more than twice the earnings of a low-skilled industrial sector worker in India and perhaps eight times the incomes of an agricultural labourer.

With regard to increase levels of production technology transfer has been very effective in many countries across the world. For example, with the introduction high yield varieties of crops under the Green Revolution agricultural programme many economies adopted and adapted foreign technologies to enhance their productivity. According to Sachs (2005:259-260), sacred of the possibility of widespread hunger because of the rapid increase in global population, the Rockerfeller Foundation took the initiative in developing and promoting high-yield varieties (HYVs) of staple crops in Mexico, Asia and different parts of the world. The HYVs of wheat developed by the Foundation’s Institute were used in Mexico immediately after World War II. Mexico went from a large net importer of grain to a major net exporter between 1944 and 1960. Similarly, India went from producing eleven million metric tons of wheat in 1960 to twenty-four million tons in 1970, thirty-six million tons in 1980 and fifty-five million tons in 1990 (Sachs, 2005). Other crops for which HYVs had been developed in like manner are rice and potato, to mention a few. Furthermore, in the area of improving health care drugs, vaccines, etc produced in one part of the world are used in other parts to treat and control diseases, especially in the developing nations.

Indeed, technology transfer has been the basis for the East Asian countries leap into global prominence in the production of toys, cars, footwears, garments, spear parts, electronics, etc. Nonetheless, studies have shown that the ability of developing countries to use technology transfer to develop their domestic capacities (allowing such countries to reap the social and economic benefits of existing technologies) have been mixed (WACC, 2000). Obviously, there are wide variations between countries and between sectors within individual countries. As WACC (2000) has observed, “the disparities between-and-within developing countries in
benefiting from technology transfer and the accumulation of domestic technological capability is far from straightforward”. Simply put, more technology transfer agreements do not necessarily automatically translate to more technological and economic development. This is so because some nations understood the politics and dynamics of technology transfer better than others. Put differently, while some developing nations concentrate on the process of technology transfer agreements to acquire foreign technologies (which in most cases the owners are not sincerely willing to transfer), others simply capture/spy/steal the technologies they need and replicate, innovate and modify them through intensive and extensive investments in research locally. This, essentially, accounts for the differences noticed in the level of technological and economic development among developing nations.

Technology Transfer: The Asian Experience

Most of the Asian countries vigorously pursued the acquisition of foreign technologies to grow their economies immediately after World War II and in the 1960 and 1970 periods. The methods adopted were multi-dimensional and recorded various degrees of success. Essentially, the “spy, copy or steal and replicate approach” (not discussed in development literature) was the most effective. For instance, in the early 1950s, Japan had a disadvantage in producing capital-intensive goods. According to Aggarwal (2010:32) the Japanese government adopted a policy of fostering particular industries for rebuilding and modernizing the industrial sector. Sule-Kano (2000) asserts that the policy which the Japanese government adopted was one in which many Japanese were sent to the United States of America and Europe to study in their institutions and work in their factories so as to acquire the necessary knowledge and skills. To Sule-Kano the method of learning by the Japanese was the “Cram method”, which essentially involves cramming or copying in details the technologies, so as to replicate them upon return to Japan. The method paid-off as Japan became industrialized using foreign technologies brought in by the Japanese returnees. While it is true that foreign direct investments (FDIs), direct investments by multinational corporations (MNCs), licensing arrangements and original equipment manufacturing (OEM) channels/methods of technology transfer were also employed in transferring foreign technologies to Japan the capture/cram and replicate method was the most successful. This was why the Japanese rapidly came into prominence in the manufacturing sector, especially automobiles and electronics. It is important to note that if these manufacturing concerns were produced through licenses, arrangements, MNCs, FDIs and OEM, the products would carry the brand name of the parent companies. Products like Toyota, Nissan, Honda, Sony, Toshiba, etc bearing Japanese brand names show their independence and Japan’s ownership of the technologies. There is no doubt that automobile technologies used in these products were gotten from Europe and USA.

The Chinese experience with technology transfer was not very different with that of the Japanese. Though the FDIs, MNCs, Licensing arrangements and OEM channels were used, it was the Chinese returnees who actually brought foreign technologies to China. As Sachs (2005:163) asserts, China had the benefit of overseas Chinese communities which acted as foreign investors and role models. Fu and Gao (2007:27) disclosed that in China technology transfer or spillover through FDIs and other conventional methods to indigenous firms are limited. A study carried out by Nolan in 2002 shows that after more than a decade as a joint venture partner to Volkswagen, Shanghai Auto had no capacity at all to compete as an independent carmaker. Similarly, Hu and Jefferson (2002) observe that in the Chinese electronics industry there was significant productivity depression rather than positive spillover effects of FDIs on domestic firms. China’s technological advancement and innovation were enhanced due to deliberate government policy in the establishment of high-tech industrial development zones (HIDZs) which engage in intensive research and development (Fu and Gao, 2007:27-28). Indeed, Chinese professionals working in the USA and Europe have
been variously accused of spying or involved espionage activities trying to “steal” different technologies in the USA and Europe. Recently, it was reported that Chinese hackers stole business secret (technology) from a “high-tech” firm in Taiwan (Nigerian Info News, 2013). Usually, these Chinese returnees come back with skills and knowledge which they replicate and innovate through intensive research.

The Indian experience is not different from the above two countries examined. Essentially, Indians, who studied and work in Europe and America returned home and replicated their skills and technical expertise domestically thereby transferring technologies to local industries. Discussing the Indian situation, Sachs (2005:179) asserts that Indians who graduated from the Indian Institute of Technology (IIT) migrated in large numbers to the USA, worked in world-class information technology (IT) firms and after many years returned and established IT firms in India. According to him, by the late 1990s India’s centres of IT operations, in the cities of Bangalore, Chennai, Hyderabad and Mumbai, were the new destinations for major companies looking for software engineering, data transcription services, computer graphics, back-office processing, computer-aided design and a myriad of other IT-based activities. Obviously, India plays a prominent role in the global IT industry. India has also made waves in the health sector, benefiting substantially from “medical tourism”. Indian pharmaceutical companies have developed drugs and vaccines through technologies acquired from foreign firms. Recently, through intensive research, an Indian Pharmacy produced a modified version of a Swiss drug giant, Novartis cancer drug, Glivec, for which Indian Supreme Court rejects the petition of Novartis a parent request in the production of the drug in India (the generic version of the cancer drug produced by the Indian pharmacy is known as Imatinib Mesylate 100 and 400mg).

Obviously, these Asian countries have made significant technological advancement through concerted efforts at research and development and investment in manpower development. It is important to note that replicating, innovating, and modifying foreign technologies in these Asian countries was possible because governments in these countries invested heavily infrastructure, human capital and research and development, and put in place relevant policies to achieve specific set goals in this regard. Indeed, the absorptive capacity of the personnel in the recipient country is critical to the process of receiving and localizing foreign technology. According to Tran (2003:261) the absorptive capacity in Asia has increased considerably. It is not therefore, surprising that the three Asian countries studied made significant advances in their drive toward the acquisition of foreign technologies. To Tran, the capacity for technology absorption is a synthesis of the educational and skill levels of the labour force, the availability of local entrepreneurship, and the government’s ability to maintain a stable political and macroeconomic environment. In this regard upgrading the educational system is emphasized in any country that wishes to acquire foreign technology.

Nigeria and the Dilemma of Technology Transfer

Over the years, since the country’s independence in 1960, Nigeria has made frantic efforts to achieve technological advancement. These efforts were most visible in the adoption of the import substitution industrialization (ISI) strategy and the Green Revolution agricultural programme. The ISI was aimed at fostering a national economy fairly independent of the rest of the world (Aderemi, 2002:8). It was characterized with the establishment of production/assembly plants in the country; to assemble or manufacture product in the country for the domestic market initially and later for export. This was aimed at conserving foreign exchange, diversifying the economy, create employment and acquire the technology in the process. Consequently, Peugeot, Volkswagen, etc established their assembling plants in Nigeria. However, as Ake (1984:146) noted, the ISI strategy failed largely because of policy disarticulation. On the other hand, the Green Revolution Programme was an initiative of the Rockefeller Foundation geared towards developing and
promoting high-yield varieties (HYVs) of staple crops so as to ensure global food security (Sachs, 2005:259). Nigeria was among the developing countries that implemented the Green Revolution Programme in the 1980s. While Green Revolution succeeded in India, Mexico and other third world countries it failed woefully in Nigeria.

Considering the importance of technology to growth and development, Emeagwali (2010) argues that for Nigeria to achieve development the one hundred million young Nigerians whose weapon is knowledge must develop their intellectual capital in order to build a stronger Nigeria using technology. At present, efforts at the acquisition of foreign technologies seem not to be working. This is because, the approach the Nigerian government has adopted in its attempt to achieve technology transfer seems to suggest that technologies can only be transferred through patent and licensing agreements with multinational corporations and through foreign direct investments. All the governments’ efforts at technology transfer since the 1960s tow these lines. The end product of these processes is MNCs establishing their organizations in the country, produce their products/commodities for the consumption of the Nigerian people without Nigerians acquiring the technical and managerial skills and know-how. While it is true that the people benefit from these activities, technology cannot be said to have been transferred. In other words, technology cannot be said to have been transferred if the owners of the technology are those utilizing it in a foreign country, as has been the case in Nigeria. Technology can only be said to have been transferred when the local people (in this case Nigerians) acquire, adopt, absorb and utilize it on their own. As Ake (1984:106) has argued, technological capability is defined in terms of the technological innovation as reflected in patents granted. Simply put, for Nigerians to be said to have acquired a particular technology, they must have made an innovation in the production of a commodity/product and have the patent for that product. For example, in Thailand, the makers of “Est” after partnering with American beverage giants Coca-Cola and Pepsi for some time, the Thai partners adopted and modified the technology to produce their local alternative called “Est” for which they have the patent. At present, Est control 19 percent of the Soda market in Thailand, with Coca-Cola and Pepsi having 50 percent and 31 percent respectively (Aljazeera News, 2013).

Indeed, the acquisition of foreign technologies and development of indigenous technologies have been a great challenge to Nigeria. It is not therefore surprising that after over half a century of oil exploration and production, Nigeria still depends on foreign expertise for oil drilling activities in the country. Similarly, despite the fact that Nigeria is a huge market for cell phone, with 115 million people using GSM in the country, none of the cell phones is produced in the country. The National Office for Technology Acquisition and Promotion (NOTAP) asserts that Nigeria has spent over ₦300 billion on technology transfer agreements in a 10 years period (Business News, 2011). Yet, in our hospitals most medicines are imported, the equipment are imported; in the banking sector most of electronic gadgets, software, etc are imported and almost 100 percent of machinery used in our industries are imported. Nigerians have not been able to significantly acquire foreign technologies using the technology transfer agreement model, yet the government is still bent on adopting that approach. For example, after the disappearance of Nigeria’s Communication Satellite (NIGCOMSAT1), the Nigerian government replaced it with NIGCOMSAT1R. The government then entered into an agreement with the builders of the new satellite to train Nigerian engineers so that they too can become satellite builders in future (Osuagwu, 2011:12). The Executive Commissioner for Engineering and Standards, Nigeria Communication Commission, Bashir Gwandu, asserts that the government was in search of satellite companies to build a second satellite, but would only be interested in companies that would transfer technology to Nigerian engineers (Osuagwu, 2011:12). What has become clear from the above is that over all these years, the Nigerian government has not understood that owners of technologies do not willingly
transfer technology, rather those interested in acquiring technologies “steal” them, as was the case with most Asian economies. A Business News reporter puts it this way:

If you open your gate as a country for people to bring their technology, money and know-how to come and make money in your country and depart, you are not doing well. What you should do is to use a “magnate” to capture their technology and managerial know-how and be made better. The graduates from our institutions are those magnates, but if the magnates are bad what can we do? So the education system has to push it. By now it should be Nigerians exploring our oil, designing our refineries. By now we should not allow one drop of crude to leave; let us refine them in this country. That is where the jobs are but we are not taking this opportunity… (Business News, 2011).

The Role of Research in Technology Transfer

One of the indices of developing or underdeveloped economy is technological backwardness or low technological advancement. Technologies are not acquired by accident, rather they are acquired through concerted efforts at research by tertiary institutions and research institutes. Discovery of new technologies, improving on existing ones and perfecting acquired technologies require concerted efforts and commitment in research at tertiary institutions, research institutes and production factories. According to Nelsen (2003:301) universities and other institutions are the main sources of researches that lead to the development of technologies and lead compounds that are developed into new products (for example, drugs and vaccines). To Nelsen, the primary ways in which universities disseminate their discoveries are through publications and the training of students. A study carried out by Bozeman (2006:634) involving over 1200 universities, industries and government laboratories, disclosed that 23 percent of university laboratories view technology development as a major mission, compared to 51 percent of government laboratories. Furthermore, Bozeman’s study reveals that whereas 70 percent of university laboratories see basic research as a major mission, 42 percent of government laboratories do. With regards to technology transfer to industrial organizations the study indicated that 40 percent of university laboratories were involved in technology transfer and 51 percent of government laboratories do.

For technologies to be commercialized the universities, research institutes and industrial organizations must work in synergy. Technological knowledge itself is disseminated by universities via publication but the commercial use of some of that knowledge is restricted by patents to companies to whom the universities grant licenses (Nelsen, 2003:302). It is such patent that encourages companies to fund research and development (R&D) in tertiary institutions. Funding is very important for R&D activities to be sustainable and successful. In developed economies governments and private companies substantially fund research despite the risk involved in it. For example, though the US government in principle does not support “cloning of babies”, the Clinton administration gave a research institute $50 million dollar for stem-cells research just to acquire the technology and knowledge (Harry and Ikiriko, 2013:116). On the other hand, in most developing economies private companies’ collaboration with tertiary institutions in funding research is almost absent, only the government does. Nelsen (2003:302) observes that university research is usually at so fundamental a level (embryonic level) that investment in development involves substantial risk, because at this point neither the technical practicability nor the market acceptability of the invention is proven. According to Nelsen, more inventions will fail than will reach the market, particularly in the medical field; therefore companies will be willing to take on the risk of funding at the embryonic stage if they will be protected from potential competitors through the exclusive use of the patent. Thus most universities believe that the primary
The purpose of their technology transfer activities is to induce investment in university technology by private businesses to bring products based on the technology to the public (Nelsen, 2003:302). Bozeman (2000:635) asserts that the share of university R&D supported by industry has increased. According to him, in 1970, only 2.6 percent of university R&D was supported by industry, but by 1990 that percentage was up to 6.9. The increase in industry supported university R&D created new university–industry R&D centres during the period, 1970 – 1990. Cohen, et al (1993), reveal that as at 1990 there were an estimated 1056 university–industry R&D centres in the US.

To achieve rapid technological advancement the Asian economies mentioned above financed research and development in their tertiary institutions and established research zones. In this regard, China for example, established the high-tech industrial development zones (HIDZs). According to Fu and Gao (2007:27), the HIDZs is one of the important policy measure that has been introduced deliberately to enhance technological advancement and innovation in China. They disclosed that after about 15 years of their introduction, HIDZs shared half of China’s high-tech product of the gross industrial output and one third of China’s high-tech product export in 2005. Fu and Gao (2007:28) further disclosed that, the main advantage of the HIDZs is their intensity of R&D, and their expenditure on R&D in 2002 stood at 31.4 billion RMB Yuan and shares 24.4 percent of China’s total expenditure on R&D. In the next four years, HIDZs expenditure on R&D tripled to 105.4 billion Yuan and the share rose to 35.1 percent in 2006. Indeed, these statistics make the HIDZs very important innovation entities in China, especially in the area of R&D. It is not surprising therefore to see China make giant strides in manufacturing, space technology, etc, etc. Today, China from a relatively underdeveloped or developing economy status is the second largest economy in the world. China did not attain this height by accident but through concerted efforts at research and innovation in science and technology. Indeed, breakthroughs in technology are transferred across the country and across sectors in the economy. Such is the story of the Asian economies. So what can Nigeria learn from the experiences of these Asian countries.

**Lessons from the Asian Economies**

Most of the Asian countries examined above were former colonies that got their independence at about the same time with Nigeria, except perhaps China, which was not a former colony. In the 1960s and 1970s they share the same or similar development characteristics with Nigeria. However, today they are far ahead of Nigeria in the global development ranking. The question is: What have they done differently from Nigeria? We will attempt to answer this question later in this section. Emeagwali (2010), in a piece titled “Africa Must Innovate or Perish”, asserts that scientific discoveries lead to technological inventions and are the foundations of knowledge: the knowledge that must precede the development of new products, services, industries, jobs, and new wealth. In other words, what Emeagwali is saying is that without breakthrough in research resulting in scientific discoveries and technological advancement there can never be development in the continent at large and Nigeria in particular. Thus, he asserts:

In human history, technological development and economic growth have gone hand-in-hand. A nation that is second to none in science is second to none in economic power. The grand challenge for African scientists is to make discoveries and inventions that can be domesticated and diffused into the continent’s economy… It’s innovation and technology that create new products, which in turn, create new wealth that alleviates poverty.
Recently, participants at a national workshop on “Packaging Research and Development (R&D) and Inventions for the Market”, organized by the National Office for Technology Acquisition and Promotion (NOTAP) in collaboration with Islamic Education, Scientific and Cultural Organization (ISESCO) have decried the weakness in institutional frameworks for effective technology transfer in Nigeria (NOTAP, 2012). The participants observed that the weakness in capacity to turn scientific outputs to be industrially applicable had led to high consumption of foreign technologies by the general public, industries and other vital sectors of the Nigeria economy. Obviously, Nigeria has not been successful in achieving technology transfer, since Nigerians have not been able to adapt, modify and make innovation on available foreign technologies in the economy. The question is: why has technology transfer eluded Nigeria all these years? The simply answer is faulty assumption of the methods of technology transfer. From all indications, the National Office for Technology Acquisition and Promotion (NOTAP) still assumes/believes in acquiring technologies through technology transfer agreements with owners of such technologies. This has been proven to be faulty assumption and approach. As earlier argued, technology is acquired through research and not by voluntary transfer by owners through transfer agreements. And this is what Nigeria has been doing differently from the Asian economies.

The lessons Nigeria should learn from the Asian economies are broadly classified into two. First, the Asian economies purposely invested in human capital development so as to produce the right mix of manpower covering the different sectors of their economies. For example, South Korea’s per capita expenditure on education in 1970 was 9.1 US dollars and attained 71 percent literacy rate, while India spent 1.58 US dollars per capita on education and recorded 30 percent literacy rate, and Malaysia spent 16.4 US dollars per capita and attained 55 percent literacy rate in 1970. By 2000, they all improved their expenditure on education. South Korea increased to371.4 US dollars and achieved 98 percent literacy rate, India increased hers to 13.77 US dollars and recorded 60 percent literacy rate, and Malaysia increased hers to 223.4 US dollars and attained 90 percent literacy rate (World Development Indicators, 2001 and World Development Report, 1982). During the same period, that is in the year 2000, Nigeria’s per capita expenditure on education was 0.7 US dollars (The African Debt Report, 2000). Recently, a UNESCO report disclosed that 1 out of 5 Nigerian children is out of school. Indeed, the report indicated that Nigeria top the list of countries with out of school children in the world. This is the first thing the Asians have done differently from Nigeria. They created a solid human capital base that helped in driving their economies to greater height. And this will take us to the second thing they have done differently.

The second is deliberate investment in research and development (R&D). The human capital/resources of these countries, so well trained, traveled to Europe and America for further studies and also worked in the production factories, learn by doing externalities, crammed the technologies, returned home and replicated the knowledge/technologies they have acquired through research. The Asian governments established specific institutions for these activities through which foreign technologies were adapted, modified and innovations made to secure patents. Good examples are the India Institute of Technology (IIT) where rigorous IT based activities were carried out and the Chinese HIDZs where high-tech research activities are carried out. All these contribute to the technological advancement of the Asian countries mentioned in this study. Today, China is a very strong technological giant in the world. The Chinese recently launched their space craft by sending 15 Chinese astronauts to space from Chinese soil.
Nigeria should learn and adopt the Asians approach to the acquisition of foreign technology if Nigeria must become one of the 20 largest economies as envisaged by our leaders. There is no gainsaying the fact that the method of technology transfer adopted by the policymakers in Nigeria has not worked, so a new method, in this case the methods of the Asians, must be adopt sincerely and honestly so as to achieve good result. In addition, Nigeria must fund education properly to create the required human capital base, as was the case in the Asian countries. Poor funding of education (and to a large extent health care, the other element in human capital development) has been a very serious factor in the nation’s development pursuit. It is adequate funding of education that would create those Emeagwali (2010) describes as “foot soldiers”, whose weapon is knowledge that would capture the needed technologies to industrialize the Nigerian economy. This the government must do if we must acquire foreign technologies, develop indigenous technologies and become industrialized nation to create jobs for our teeming youth population.

Conclusion

Over the years, Nigeria has made frantic efforts to acquire foreign technologies so as to bring development to its citizenry. Yet the country is still very backward technologically. Some of the Asian economies which were at par with Nigeria in the 1970s are now far ahead of Nigeria technologically and had attained significant socio-economic development. The paper argued that the reason for the difference in the level of technology and socio-economic development between Nigeria and the Asian economies such as South Korea, India, China, Malaysia, etc, is the method they adopted in their technology transfer efforts. While Nigeria depends on the traditional method of negotiated agreements with owners of technologies to effect transfer, the Asian countries adopt a non-conventional method of cram, copy or “steal” and replicate through intensive and extensive research and innovation, hence, the rapid technological advancement of these nations. Essentially, they invest heavily in research and development in their universities and other tertiary institutions and specifically established research institutes in their nations. Therefore, the conclusion of this paper is that, Nigeria must toe the line of the Asian economies mentioned in the study, if it really wants to acquire foreign technologies. This is because the traditional methods adopted over the years have failed and will continue to fail. Indeed, for Nigeria to acquire foreign technology the government must establish specifically targeted high-tech institutions; invest heavily in research and development, and substantially fund universities and other tertiary institutions in the country. This is what the Asian economies have done differently from Nigeria, and that is what is responsible for their rapid technological advancement and development.

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ABSTRACT

A deterministic ordinary differential equation model for the dynamics of malaria transmission that explicitly integrates the demography and life style of the malaria vector and its interaction with the human population is developed and analyzed. The model is different from standard malaria transmission models in that the vectors involved in disease transmission are those that are questing for human blood. Model results indicate the existence of nontrivial disease free and endemic steady states, which can be driven to instability via a Hopf bifurcation as a parameter is varied in parameter space. Our model therefore captures oscillations that are known to exist in the dynamics of malaria transmission without recourse to external seasonal forcing. Additionally, our model exhibits the phenomenon of backward bifurcation. Two threshold parameters that can be used for purposes of control are identified and studied, and possible reasons why it has been difficult to eradicate malaria are advanced. Our main objective is to develop a mathematical model for the dynamics of malaria transmission, which takes into consideration the population dynamics of the malaria vector and how these vectors interact with the human population.

Keywords: Vector demography and life style, system equations, oscillations, malaria control, and backward bifurcation.

INTRODUCTION

Malaria is one of the leading causes of morbidity and death of humans in many parts of the world and its impact has been felt for decades. Malaria disease constitutes a major health menace in many developing countries especially Nigeria and other sub-Saharan African countries. 2010 WHO report shows that an estimated 225 million cases, leading to about 781,000 malaria related deaths (90% in Africa) occurred in 2009. Most of the deaths were children under five years of age.

In addition to being the paramount source of morbidity and mortality in malaria endemic regions, malaria also weakens the active and potential work force, thereby influencing economic
growth negatively in the affected areas. Hence, continuous research to find ways to effectively control the disease will save lives for future generations and improve the economic conditions of the nations at risk.

The disease, malaria, is caused by a micro-parasitic organism of the genus *Plasmodium*. *Plasmodium falciparum* is the most pernicious species of the malaria parasite and is transmitted indirectly from human to human by the female *Anopheles* sp. mosquito as it persistently quest for blood within the human population by biting humans to obtain the blood that she needs for the development of her eggs. During each successful blood meal sortie, a female *Anopheles* mosquito may pick up the form of the parasite that is transmissible from humans to mosquitoes (called gametocytes) from an infectious human or deposit the form of the parasite that is transmissible from mosquitoes to humans called sporozoites to the human who may be susceptible or already infected. Thus, a bite from an infectious female *Anopheles* mosquito can initiate the human phase of the parasite’s life cycle that will culminate with the production of gametocytes in the human’s blood system, or initiate the vector space, which will culminate with the release of sporozoites into the mosquito’s salivary glands. Therefore, the *plasmodium* parasite has an intricate life process, well adapted with one part invested within the vector host. Consequently, any mathematical model for malaria must consider this fact.

Many mathematical models and paradigms have been proposed and geared towards understanding the biology, and dynamics of malaria transmission, starting with the pioneering work of Sir Ronald Ross, through the introduction of the notions of super infection and acquired immunity by continuing exposure and other variations of the central theme that the mosquito has a human biting habit. Some recent models on malaria have instead focused on the malaria parasite as the basic unit of study. Availability of breeding sites for the mosquito is one of the factors that affect the developmental stages of the Plasmodium sp. parasite. Our main objective is to develop a mathematical model for the dynamics of malaria transmission, which takes into consideration the population dynamics of the malaria vector and how these vectors interact with the human population.

The *Anopheles* mosquito undergoes complete metamorphosis and the average life span of the flying adult mosquito ranges from 2 – 3 weeks. Like any other disease vectors, the mosquito is capable of locating humans and attempting as many times as possible to feed on the blood of the targeted humans. In the course of interaction with a human during a typical attempt, the mosquito may emerge victorious by acquiring the much-needed blood meal, fail and go in for another attempt or may be killed. Nourishment is usually followed by resting and a choice of breeding site where the mosquito eventually lays its eggs. Hence, the feeding and reproductive habit of the malaria vector (taking a blood meal, resting, laying eggs and then going in for another blood meal...) constitute a major factor to be considered when designing malaria transmission models and consequently, malaria intervention strategies.
THE MOSQUITO MODEL SYSTEM (SIS)

We will consider the (SIS) model for the mosquito vector population.

Where S – Represent the susceptible class and I – Represent the infectious class. To capture the life style of the mosquito vector in the model, the vector population is divided into three biologically realistic compartmental classes representing physiological status.

U – This variable is the class of fed and reproducing vectors returning from human habitats to vector breeding sites.

V – This variable is the class of unfed and resting vectors present at vector breeding sites.

W – This represent the class of unfed vectors questing (or foraging) for food (blood meal) in human habitats.

Note that type V vectors comprise previously fertilized female vectors at the breeding site that have just laid their eggs and all unfertilized, unfed and non-questing female vectors that are swarming at the breeding site (some of these are the newly emerging vectors). This new feature is being introduced into malaria and other mosquito borne disease model.

THE MODEL PARAMETERS AND DERIVATION

The mathematical model will take the form of a non-linear system of ordinary differential equations involving both the human and vector populations. The equations are derived based on the additional fact that, in the presence of the malaria disease in the populations, both mosquitoes and humans can infect each other upon contact. While infected humans can recover from the malaria infection, it is assumed that once a mosquito is infected, it remains infected until death. To capture the life style of the mosquito vector in the model, the vector population is divided into three biologically realistic compartmental classes representing physiological status. The model derivative uses a restricted form of homogeneous mixing based on the idea that the mosquito has a human biting habit. We assume that all new born humans and newly emerged mosquitoes are susceptible (no vertical transmission) see Fig 1. Flow from susceptible humans to infectious humans is as a result of contact between the susceptible humans, $S_h$ and an infectious questing vector $I_w$. Recruitment of new susceptible humans is from birth at the rate $\lambda_h$ and death rate $\mu_h$ or due to malaria infection $\gamma_h$. The transmission rate of the parasite from mosquitoes to humans depends on the interaction between susceptible humans $S_h$ and infectious questing mosquitoes $I_w$. When an infectious vector successfully takes blood meal from a susceptible human with contact rate $\beta_h$, the human becomes infectious.
### TABLE 1. MODEL VARIABLES AND DEFINITIONS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_h(t)$</td>
<td>Susceptible humans at time $t$</td>
</tr>
<tr>
<td>$I_h(t)$</td>
<td>Infected/infectious humans at time $t$</td>
</tr>
<tr>
<td>$N_h(t)$</td>
<td>Total human population at time $t$</td>
</tr>
<tr>
<td>$S_u(t)$</td>
<td>Susceptible vectors of class $u$ at time $t$</td>
</tr>
<tr>
<td>$S_v(t)$</td>
<td>Susceptible vectors of class $v$ at time $t$</td>
</tr>
<tr>
<td>$S_w(t)$</td>
<td>Susceptible vectors of class $w$ at time $t$</td>
</tr>
<tr>
<td>$I_u(t)$</td>
<td>Infected/infectious vectors of class $u$ at time $t$</td>
</tr>
<tr>
<td>$I_v(t)$</td>
<td>Infected/infectious vectors of class $v$ at time $t$</td>
</tr>
<tr>
<td>$I_w(t)$</td>
<td>Infected/infectious vectors of class $w$ at time $t$</td>
</tr>
<tr>
<td>$N_{mv}(t)$</td>
<td>Total vector population at time $t$</td>
</tr>
</tbody>
</table>

### TABLE 2. SYSTEM PARAMETERS REPRESENTING THE TRANSITION RATES

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_v$</td>
<td>The rate at which successfully fed vectors return to breeding site.</td>
</tr>
<tr>
<td>$a_v$</td>
<td>The rate at which vectors are attracted to human habitats.</td>
</tr>
<tr>
<td>$\mu_h$</td>
<td>Natural human death rate</td>
</tr>
<tr>
<td>$\mu_{u,v,w}$</td>
<td>Natural mosquito death rate from each mosquito population class</td>
</tr>
<tr>
<td>$\lambda_h$</td>
<td>Human birth rate</td>
</tr>
<tr>
<td>$\lambda_v$</td>
<td>Mosquito birth rate</td>
</tr>
<tr>
<td>$r_h$</td>
<td>Recovery rate amongst humans</td>
</tr>
<tr>
<td>$\beta_v$</td>
<td>Flow rate from susceptible questing mosquitoes to susceptible or infectious humans.</td>
</tr>
<tr>
<td>$\beta_h$</td>
<td>Flow rate from infectious questing mosquitoes to susceptible or infectious humans</td>
</tr>
<tr>
<td>$p$</td>
<td>Probability that a type $S_w$ vector successfully take a blood meal from a susceptible human</td>
</tr>
<tr>
<td>$q$</td>
<td>Probability that a type $S_w$ vector successfully takes blood meal from an infectious human</td>
</tr>
<tr>
<td>$p_1$</td>
<td>Probability that a type $I_w$ vector successfully takes a blood meal from an infectious human</td>
</tr>
<tr>
<td>$q_1$</td>
<td>Probability that a type $I_w$ vector successfully takes a blood meal from a susceptible human.</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Proportion of emerging adult mosquito at the breeding site that are female</td>
</tr>
</tbody>
</table>
THE SCHEMATIC DIAGRAM OF THE MODEL WITH VITAL DYNAMICS (Fig. 1)
THE HUMAN MODEL SYSTEM (SEIR)

To illustrate a periodic oscillation in the dynamics of malaria transmission, we will consider this model:

S – The susceptible class, E – The exposed class which has been infected but is not yet infectious which is also known as the latent carriers. I – The infectious class and R – The recoverd class. These variables are continuously dependent on time \( t \). All variables and parameters in the human system will carry the subscript \( v,u \) or \( w \) depending on the physiological status of the vector.

POPULATION SIZE

Let \( N_h(t) \) and \( N_{mv}(t) \) denote the total human and vector populations. Thus at any time \( t \) we have humans of type \( S_h(t), E_h(t), I_h(t), \) and \( R_h(t) \), and vectors of type \( S_v(t), S_w(t), S_u(t), I_v(t), I_w(t), \) and \( I_u(t) \) such that

\[
N_h(t) = S_h(t) + E_h(t) + I_h(t) + R_h(t)
\]  

(1)
\[ N_{mv}(t) = S_v(t) + I_v(t) + S_w(t) + I_w(t) + S_u(t) + I_u(t) \]  \hspace{1cm} (2)

However assuming \( E_h(t) \) dynamics as insignificant we have the equation for the total human population as:

\[ \frac{dN}{dt} = (\lambda_h(N_h) - \mu_h(N_h))N_h - \gamma_h I_h \]  \hspace{1cm} (3)

With the same assumption we derive

**THE HUMAN MODEL SYSTEM EQUATIONS**

\[ \frac{ds_h}{dt} = \lambda_h(N_h)N_h + r_h I_h - \beta_h(N_h)S_h I_w - \mu_h(N_h)S_h \]  \hspace{1cm} (4)

\[ \frac{dl_h}{dt} = \beta_h(N_h)S_h I_w - (\mu_h(N_h) + r_h + \gamma_h)I_h \]  \hspace{1cm} (5)

**THE MOSQUITO MODEL SYSTEM EQUATIONS**

We account only for the vector populations involved in disease transmission, the female vectors, by setting \( \lambda_v = \eta \lambda_v \), where \( \eta \in (0,1) \) is a constant.

Reproduction rate \( R(t) = S_v(t) + I_v(t) \)

\[ = a_v \lambda_v(S_u(t))S_u(t) + a_v \lambda_v(I_u(t))I_u(t) \]  \hspace{1cm} (6)

Where \( S_v(t) \) are offspring from susceptible vectors and \( I_v(t) \) are offspring from infected vectors while the infection force is \( \alpha_v(N_h) \)

\[ \frac{d(S_v)}{dt} = a_v [\lambda_v(S_u)S_u + \lambda_v(I_u)I_u] + a_v S_u - (\mu_v + \alpha_v(N_h))S_v \]  \hspace{1cm} (7)

\[ \frac{d(I_v)}{dt} = a_v I_u - (\mu_v + \alpha_v(N_h))I_v \]  \hspace{1cm} (8)

\[ \frac{d(S_w)}{dt} = a_v (N_h)S_v - (\mu_w + \beta_v S_h + \beta_v I_h)S_w \]  \hspace{1cm} (9)

\[ \frac{d(I_w)}{dt} = \alpha_v(N_h)I_v - (\mu_w + \beta_h S_h + \beta_h I_h)I_w \]  \hspace{1cm} (10)

\[ \frac{d(S_u)}{dt} = p \beta_h S_h S_w - (a_v + \mu_u)S_u \]  \hspace{1cm} (11)
Together with the following equations for the total populations:

\[
\frac{d(I_u)}{dt} = p_1 \beta_h S_h I_w + q_1 \beta_h I_h I_w + q \beta_v I_h S_w - (a_v + \mu_u)I_u \\
\]

Summing up Eqs (7 - 12) we obtain the equation that governs the total vector population

\[
N_{mv} = a_v \lambda_v(S_u)S_u + a_v \lambda_v(I_u)I_u + p_1 \beta_h S_h I_w + q_1 \beta_h I_h I_w \\
-(1 - p)\beta_v S_h S_w - (1 - q)\beta_v I_h S_w - (\beta_h S_h + \beta_h I_h)I_w \\
-(\mu_v S_v + \mu_w S_w + \mu_u S_u + \mu_v I_v + \mu_w I_w + \mu_u I_u).
\]  

Let us assume that \( p_1 = q_1 \) and that deaths in each of the mosquito classes occur at a uniform constant rate \( \mu_v \).

That is \( \mu_w = \mu_u = \mu_v = \) constant. And assume mass action contact rates to be directly proportional to the population numbers so that

\[
\beta_{vs} = \beta_{vi} = \beta_v(N_h), \beta_{hs} = \beta_{hi} = \beta_h(N_h)
\]

which will be referred to as \( \beta_v \) and \( \beta_h \) respectively.

We choose a specific functional form for the birth rate function \( \lambda_v \). To this effect, we consider the logistic function,

\[
\lambda_v(\theta) = \lambda_0 \left(1 - \frac{\theta}{L}\right)
\]  

Combining Eqs (1 - 13) taking into consideration the above simplifying assumptions, our model becomes:

\[
\dot{S}_h = \mu_h N_h + r_h I_h - \beta_h S_h I_w - \mu_h S_h
\]
\[
\dot{I}_h = \beta_h S_h I_w - (\mu_h + r_h)I_h
\]
\[
\dot{S}_u = p \beta_v S_h S_w - (a_v + \mu_v)S_u
\]
\[
\dot{S}_v = a_v \lambda_v(S_u)S_u + a_v \lambda_v(I_u)I_u + a_v S_u - (\mu_v + a_v(N_h))S_v
\]
\[
\dot{S}_w = a_v (N_h)S_v - (\mu_v + \beta_v N_h)S_w
\]
\[
\dot{I}_u = p_1 \beta_h N_h I_w + q \beta_v I_h S_w - (a_v + \mu_v)I_v
\]
\[
\dot{I}_v = a_v I_u - (\mu_v + a_v(N_h))I_v
\]
\[
\dot{I}_w = a_v (N_h)I_v - (\mu_v + \beta_h N_h)I_w
\]

Together with the following equations for the total populations:

\[
\dot{N}_h = 0
\]
\[ N_{mv} = a_v \lambda_v (S_v) S_u + a_v \lambda_v (I_u) I_u - \mu_v N_{mv} - \alpha \beta_v S_l^0 \]
\[ - (1 - q) \beta_v h S_w - (1 - \alpha) \beta_h N_h I_h \]  
(24)

The simplest type of initial conditions would take the form
\[ (S_h(0), I_h(0), S_v(0), S_w(0), S_u(0), I_v(0), I_w(0), I_u(0)) = (S_h^0, I_h^0, S_v^0, S_w^0, I_u^0, I_v^0, I_w^0, I_u^0) \]

Eqn (24) immediately shows that \( N_h \), the total human population is constant and thus may appear as a parameter in the model.

**EXISTENCE AND LINEAR STABILITY OF STEADY STATES**

The disease free system

In the absence of the malaria disease, \( l = 0, u_i = 0, v_i = 0, w_i = 0 \) and the system reduces to

\[ \dot{u}_s = w_s - u_s \]  
(25)

\[ \dot{v}_s = \alpha \lambda_0 u_s (1 - u_s) + \alpha u_s - \rho v_s \]  
(26)

\[ \dot{w}_s = \gamma (v_s - w_s) \]  
(27)

For completeness, we highlight the following important result, which is stated without proof.

**THEOREM 1:**

In the absence of malaria disease there is a threshold parameter \( R^* \) given by \( \frac{\alpha \lambda_0}{\rho - \alpha} \) with the following properties:

i. If \( R^* \leq 1 \), there exist a unique steady state, the trivial steady state \( E_0 = (u^*_s, v^*_s, w^*_s) = (0, 0, 0) \), which is linearly stable to small perturbations.

ii. If \( R^* > 1 \), there exist the trivial steady state \( E_0 \) and a non-trivial steady state \( E_1 \) given by

\[ E_1 = (u^*_s, v^*_s, w^*_s) = \left( 1 - \frac{1}{R^*}, 1 - \frac{1}{R^*}, 1 - \frac{1}{R^*} \right) \]

More so, for \( R^* > 1 \) we have that

a. The trivial steady state, which always exists, is linearly unstable to small perturbation.

b. The non-trivial steady state \( E_1 \) is linearly stable to small perturbations whenever \( QR - P(R^* - 1) > 0 \) and can be driven to instability via Hopf Bifurcation at the point in parameter space where \( QR - P(R^* - 1) = 0 \)

\[ Q = \gamma + \rho + 1 > 0; R = \gamma + \rho + \gamma \rho > 0; P = \gamma (\rho - \alpha) > 0 \text{ since } \rho > \alpha \]
Where Q and R are as stated. It is then straightforward calculation to show that $E_0$, $u^*_c = 0$ and all solutions will have negative real parts when $QR - P(R^* - 1) > 0$ and that Hopf Bifurcation occurs where $P(R^* - 1) = QR$.

**ANALYSIS IN THE PRESENCE OF THE DISEASE**

A threshold parameter that is of essential importance to infectious disease transmission is the basic reproduction number denoted by $R_0$ which measures the average number of secondary clinical cases of infection generated in an absolutely susceptible population by a single infectious individual throughout the period within which the individual is infectious. Generally it is assumed that the disease will eventually disappear from the community if $R_0 < 1$ and may possibly establish itself within the community if $R_0 > 1$. However, in some situations, there is the possibility of the occurrence of backward bifurcation which then complicate disease control even when $R_0 < 1$. The critical case $R_0 = 1$ represents the situation in which the disease reproduces itself thereby leaving the community with a similar number of infection cases at any time. One way of calculating $R_0$ is to determine a threshold condition for which endemic steady state solutions to the system under study exists or for which the disease free steady state is unstable. Another method is the next generation approach where $R_0$ is the spectral radius of the next generation Matrix. Using the next generation approach, we compute the basic reproduction number, here denoted by $R_0$ as in the spectral radius of the next generation matrix $M = FV^{-1}$ where:

\[
F = \begin{pmatrix}
0 & 0 & 0 & \beta_h N_h \\
q \beta_h N_h & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
\end{pmatrix}
\]

\[
V = \begin{pmatrix}
\mu_h + r_h & 0 & 0 & 0 \\
0 & a_v + \mu_v & 0 & -p_1 \beta_h N_h \\
0 & -a_v & \mu_v + \alpha_v(N_h) & 0 \\
0 & 0 & -\alpha_v(N_h) & \mu_v + \beta_h N_h \\
\end{pmatrix}
\]

From these, we have

\[
\tilde{R}_0 = \frac{\beta_v \beta_h N_h S^*_v}{\mu_v(r_h + \mu_h)} \cdot q \cdot \frac{a_v \alpha_v(N_h)}{a_v \alpha_v(N_h)(1 + \frac{(1 - p_1)(1 - p_2)}{\mu_v} \beta_h N_h) + (\mu_v + \beta_h N_h)(a_v + \alpha_v(N_h) + \mu_v)}
\]

(28)

In dimensionless parameters, $\tilde{R}_0$ takes the form
\[ R_0 = \frac{\beta \sigma \omega^*}{\mu (1-\delta)} = \frac{\beta \sigma (R^*-1)}{\mu (1-\delta) R^*} \] (29)

Which is positive since \( R^* > 1 \) and \( 0 \leq \delta < 1 \). In this case, since \( 0 < R_0 \leq 1 \), implies \( 0 < R_0^2 \leq 1 \) and \( R_0 > 1 \) implies \( R_0^2 > 1 \), we use the value \( R_0 = R_0^2 \) which coincides with the value with the basic reproduction number obtained by seeking conditions for the existence of an endemic steady state or instability of the disease free steady state.

**CHARACTERIZATION OF BACKWARD BIFURCATION**

Huang et al first established the phenomenon of backward bifurcation. The existence of a backward bifurcation shows that reducing \( R_0 \) below unity may not be enough to eradicate certain diseases. Here we apply the approach described in the existence of a backward bifurcation in model for \( R_0 < 1 \)

**THEOREM 2:**
Let \( \lambda_0(y) < (y + \rho + 1)(y + \rho + \gamma \rho) + \gamma (\rho - \alpha)/(\alpha \gamma) = \lambda_0^H \) then the model undergoes a backward bifurcation at \( R_0 = 1 \)

**Proof:**
The matrix of the linearized system about the disease free equilibrium \( E_{deq} \) is

\[
A = \begin{pmatrix}
-\mu & 0 & 0 & 0 & 0 & \beta \\
-\mu^* & -1 & 0 & 1 & 0 & 0 \\
\alpha \lambda_0^* (1 - 2 \mu^*) + \alpha & -\rho & 0 & \alpha \lambda_0^* & 0 & 0 \\
0 & \gamma & -\gamma & 0 & 0 & 0 \\
\sigma \mu^* & 0 & 0 & 0 & -1 & 0 & \delta \\
0 & 0 & 0 & 0 & \rho & -\rho & 0 \\
0 & 0 & 0 & 0 & \epsilon & -\epsilon
\end{pmatrix}
\]

And the characteristic equation of \( A \) is given by

\[
[\lambda^3 + Q \lambda^2 + R \lambda + P(R^* - 1)] [\lambda^4 + (Q_1 + \mu) \lambda^3 + (\mu Q_1 + Q_2) \lambda^2 + (\mu R_1 + P_1) \lambda + P_1 \mu (1 - R_0)] = 0
\] (30)

\( Q_1 = \epsilon + \rho + 1 > 0 \); \( R_1 = \epsilon + \rho + \epsilon \rho > 0 \). Note that when \( R_0 = 1 \), there is a simple zero eigenvalue and \( \lambda_0^* = \frac{\beta \sigma (\rho - \alpha)}{\alpha \sigma - \mu (1 - \delta)} = \frac{\rho - \alpha}{\alpha [1- \frac{\mu (1-\delta)}{\beta \sigma}]} \) since \( R^* > 1 \) when \( R_0 = 1 \) and

\[
(Q_1 + \mu)(\mu Q_1 + Q_2) - (\mu R_1 + P_1) = \mu Q_1 (\mu + Q_1) + (\epsilon + \rho)(1 + R_1) > 0
\] (31)
the ROUTH HURWITZ conditions assure us that all other eigenvalues of $A$ have negative real parts when

$$0 < \lambda_0(y) < (\gamma + \rho + 1)(\gamma + \rho + \gamma\rho) + \gamma(\rho - \alpha)/(\alpha\gamma) = \lambda_0^H \quad (32)$$

The model exhibits a backward bifurcation.

**MATHEMATICAL IMPLICATIONS AND CONCLUSIONS**

We believe that both the oscillations and backward bifurcation are generated due to changes in the mosquito growth rate $\lambda_0$ as well as the feedback mechanisms captured in the requirement that successfully fed and fertilized mosquitoes returned to the breeding site to lay eggs at the rate $\lambda_0$ and then start the process again, while unsuccessful ones are assumed killed. Now, there are several factors that affect $\lambda_0$ at different stages of the mosquitoes breeding cycle. In particular, the cyclic behaviour of mosquitoes reproducing, in which mosquitoes must lay eggs, emerge, quest, feed and return to the breeding sites to lay more eggs affect $\lambda_0$ and the dynamics of the malaria disease which constitutes a basis for oscillations. If there is a healthy blood meal with many mosquitoes returning to the breeding site to breed and lay healthy eggs, $\lambda_0$ gets large and the mosquito population at the breeding site gets large. However, when these mosquitoes and the newly emerged mosquitoes leave the breeding site and go to the human habitat site to quest and feed on blood, the population of mosquitoes at the breeding site reduces and hence the cyclic and oscillatory patterns in the mosquito populations that drives the oscillations into the malaria dynamics is also affected. When $\lambda_0$ gets small, the steady state at the breeding site is sustained by the batch of mosquitoes that are returning to the breeding site. These are probably the mosquitoes that drive the malaria infection in the system until a critical value of $\lambda_0 = \lambda_0^{bb}$ below which the endemic steady state is stable.

In this paper, we have developed a new SIS model for endemic malaria, which explicitly integrates the demography and lifestyle of the vector that transmits the disease together with its interaction with the human population, and incorporates the disease dynamics. Two threshold parameters were identified in the model: one directly linked to the demography and lifestyle of the vector ($R^*$) and the other linked to the disease dynamics($R_0$). Furthermore, our model captured the natural fluctuations known to occur in mosquito populations and malaria dynamics as well as presents a new route to periodic oscillations in the dynamics of malaria transmission. These oscillations provide a plausible framework for mosquito and malaria control.

The difficulty in eradicating malaria may therefore lie in the complicated lifestyle of the vector responsible for the transmission process, the complicated nature of malaria parasite in its ability to share its life cycle so that part of it is in the mosquito and the other in the human. Some common practical measures of controlling the malaria-transmitting vector (the Anopheles sp.) are:

1. Spraying the adult mosquitoes and their larval forms with non-resistant insecticides and other chemicals, as well as the usage of insecticide treated bednets. This form of control though desirable, may pose health problems because of the toxic nature of the chemicals to human beings.
2. The introduction of biologically control predator at the mosquito breeding site so that the predators can feed on the returning and newly emerged vectors as well as their larval forms at breeding sites.

3. The use of preventive and sanitation schemes designed to limit or eliminate stagnant man made water reservoirs such as gutters, empty bottles, cans, old tires, potholes as well as some natural ones around human dwellings.

For an effective and successful control campaign, our results suggest that these control measures should be continuous and sustained over longer periods until a smaller mosquito population is attained with small growth rates, because even a slight increase in the mosquito population might lead to the backward bifurcation situation in which we have a bistable endemic steady state and a disease free state coexisting. Thus, there should be continuous monitoring and evaluation of the control measures and continuous education of the public to ensure that the disease burden is continuously reducing before eradication may be attained.

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COLLABORATIVE AVENUES CREATED BY ELECTRONIC LEARNING (E-LEARNING) IN THE STUDY OF GEOGRAPHY IN NIGERIAN UNIVERSITIES

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Abstract

The study investigated the opinions of geography lecturers and students on the collaborative avenues created by e-learning in the study of geography in Nigerian universities. Two research questions and one null hypothesis guided the study. The population of the study was 1,241 Stratified Random Sampling Techniques was used to draw a sample of 366. A structured questionnaire with 14 items was the instrument used for data collection that was duly validated, and its reliability ascertained using Cronbach Alpha, which yielded an index of 0.83. 350 copies were properly filled that was used for the study. The data collected were analyzed using means and standard deviations to answer the research questions, and 't' test was applied to test the hypothesis at 0.05 level of significance. The findings of the study showed that the respondents believe that the collaborative avenues created by e-learning would enhance the study of geography in Nigerian universities, making it possible for groups to work together on given projects, thereby removing boredom and isolation in the study of geography phenomena globally. It then implies that the study of geography could be enhanced through the collaborative avenues e-learning has created. Based on the findings of the study, recommendations were made.

Key Words: Electronic-Learning; Collaboration; Geography; Digitalization; Universities.

Introduction

The present era of globalization places a demand on Nigerian children to brace up in order to meet up with their colleagues in the developed world. Subsequently, the Nation’s curricula need to be repositioned to meet up with the demand by re-engineering the methods, procedures and contents of all disciplines. With the modern trend of digitalization, various disciplines need to be restructured in a way to fit into the global village. The present study focuses on the discipline-geography and how e-learning can be adopted in its study in universities. Geography is a discipline, which uses scientific methodology in finding answers to problems generated through interaction of man in the physical and social environment. It is derived from a Greek word which literally means ‘to write about the earth’. Presenting a more comprehensive and concise definition, Buchanan (1974) posits that geography is the study of the diverse features on the Earth’s surface, such as relief, climate, vegetation, soils, economic resources, their description, development, distribution and their interaction with man. It is a discipline that seeks to understand the world and its human and physical features through spatial location and distribution. (Routledge, Taylor and Francis,
(1996). As a discipline, geography is important for the development of any society. Its worth stems from
its nature as a tool for the development of the individual, and the entire society.

Geography teachers and authorities in the discipline according to Adinna (1990) are concentrating on the
application of geography concepts in their areas of specialization. They probably do this as a way of
managing the vast nature of the subject. The various segments of geography like weather and climate
(Climatology); rock nature and their distribution (Geomorphology); plant and animal distribution termed
(Biogeography), among other areas of geography are now taught as separate entities. This approach has resulted
to a fragmental pattern of study. Minshull (1972) observes that this approach may lead to the splitting of the
subject into several disciplines. Similarly, with each specialist teacher confining himself to one aspect of
geography, Varma and Vedanayagam (1971) posit that the subject has been fragmented, and students are now
left to fix these fragmented pieces of study in order to see their wholeness.

This approach has in a way pose a challenge for students, and in course of time, they resign to fate. Once this happens, it might result to gradual withdrawal from the subject. Akuma (2002)
conducted a study on the trend of withdrawals on enrolment pattern of secondary school students in
five subjects. The author discovered that out of the five subjects used for the study, geography had
the least enrolment, and that teacher’s ineffectiveness; wide area of coverage and shortage of
qualified teachers are contributing factors to the withdrawal trend. An increasing number of
geographers are now changing rapidly in their line of thought for a new method of studying geography. They are thinking of the best approach to make it attractive and competitive to our teeming youths. As a result, collaborative avenues electronic-learning (e-learning) offers to enhance geography study are being investigated.

Electronic learning (e-learning) connotes learning and knowledge derived from using computer-aided gadgets (Noah, 2002). E-learning is a subset of Information and Communications Technology (ICT) encompassing the application of information technologies, and communicating same through electronic devices. E-learning might likely be a good tool for improving teaching and learning, and an access route to teaching, learning and research materials (Naidoo, 2003). Emphasizing more on the benefits of e-learning, Naidoo explains that it makes delivery of instruction very flexible, interactive, and learning, lasting. Tend in Eya (2006) simply perceives e-learning as the use of computer-aided-gadgets to aid learning. Rees, Mackay, Martins, Conole and Davis (2008) see e-learning as the application of advanced learning technology that is computer based, and that makes delivery of lesson flexible, interactive and long lasting. Eya (2006) reiterates that e-learning is the largest and the most challenging application of ICT in the delivery of education. The author sees e-learning as the process of e-literate teachers communicating with e-literate learners with up-to-date books and information using electronic skills.

E-learning with its web-based facilities provides the learners with exciting opportunities to reach for
more educational information. This leads to the development of inquiry mind, creativity and
good study habits. Professional isolation that many teachers suffer in the traditional classroom
becomes a thing of the past. This is because e-learning connects teachers with other professional
associates and colleagues worldwide (Villanueva, 2000). By so doing, teachers have access to their colleagues’ study
materials, methods and wealth of knowledge, and also, share their teaching experiences and challenges. With
its enriched virtual classroom, e-learning provides direct interaction between teachers and learners of varied
backgrounds. In the process, they share real life experiences or occurrences, and discuss events as it happens immediately. (UNESCO, 2003; Naidoo, 2003 and Nnajiofor, 2007). The above excerpts are a glimpse of the loaded benefits which e-learning provides through its collaborative avenues.

Collaboration simply implies working together as a group, or partners with like minds working together on an activity or project. Rao (2008) upholds that collaboration and team work are characteristics of the modern work environment that affords individuals the opportunity to interact with each other. The author further explains that collaborative learning is relevant for students working on a group project, as they interact and seek advice and information from each other, and from the other groups. Collaborative opportunities offered through e-learning allows teachers and learners to participate in various educational experiences together without regard to their physical locations, thereby improving their task performance and attitude towards learning (Nnajiofor, 2007).Corroborating this, Rao (2008) posits that collaborative avenues of e-learning build up constructive dialogue and debate among teachers and learners, and enhance interests and motivation among colleagues and peers respectively. Rees et al (2008) explains that e-learning helps in the building of “Learning Nugget Concept” which is a forum for developing collaborative work, and to develop the meta-data needed for easy transfer of e-learning materials, from one institution’s virtual learning environment to another. According to the authors, the common element is the ‘nuggets’ which involves identifying common elements on which to base the merger, and that these nuggets contain learning materials, students’ assignments and evaluation of students’ achievement modules.

The world is tending towards becoming a global village through the World Wide Web (WWW) and geography, as the study of the earth as a home of man may likely be re-positioned in this village through e-learning. As earlier stated, the vastness of geography content had been a source of fear to students, and of serious concern for geography teachers. Introduction of collaborative avenues which e-learning provides might make the study of geography in our universities easier, as it will likely reduce its vastness to mere interaction and discussion classes from all sides of the globe. Hence the study sought the opinions of geography lecturers and the students, on the collaborative avenues e-learning has created in the study of geography in universities in Nigeria. Specifically the study sought to examine the opinions of the:

1. University lecturers on the collaborative avenues created by e-learning in the teaching of geography,
2. University students on the collaborative avenues created by e-learning in the learning of geography.

The study was guided by two research questions thus:

1. What are the collaborative avenues created by e-learning in the teaching of geography in Nigerian universities?
2. What are the collaborative avenues created by e-learning in the learning of geography in Nigerian universities?

One null hypothesis was formulated for the study, and was tested at 0.05 level of significance:

There will be no significant difference in the mean opinions of university lecturers and the students, on the collaborative avenues created by e-learning in the study of geography in Nigerian universities.
Theoretical Framework

The study is based on school-centred innovation theory of Blenkin; Gwyn, and Kelly (1975) and Stenhouse (1975), which values the relationship between curriculum innovation and teachers’ development. According to Stenhouse (1975:40) “Teachers are community of researchers engaged in a continuing process of enquiry into their own educational practices, developing their professional understanding as a consequence”. It then means that it is through curriculum development and innovation that significant teacher development take place. School-centred innovation theory is a preferred theory for curricular innovation in teaching and learning, as it is cost-friendly, and has diverse alternatives for its information dissemination and processes, making it easy for the adoption of an innovation. Blenkin et al (1975) reiterate that for any substantial and lasting change to take place in the education system, an active involvement of the practitioners (teachers) should be considered. As a result, the collaborative avenues of e-learning being examined in the paper are an innovation that is school-based; hence, it is an off-shoot of school-centred innovation theory.

Methods and Procedures

The research design used for the study is the descriptive survey type. According to Osuala (2001), a survey research is only interested in describing the status of a given phenomena as it was observed. Also Anikpo (1997) described a survey study as the use of a representative sample to examine peculiar characteristics of a given population.

The area of the study is South-East States of Nigeria popularly called the “Ibo States” with teeming population of youths who are thirsty for knowledge, especially in this era of globalization. The population of the study was 1,241, made up of 61 lecturers and 1,180 students in the Departments of Geography in Government-owned Universities in the South-East States of Nigeria. The sample size for the study was 366; 61 lecturers and 305 students of geography departments. All the 61 lecturers were used for the study because their population was small. On the other hand, YaroYamene Technique for a finite population was used to draw the students’ sample size of 305 for the study.

The instrument used for the data collection was a 14-itemed structured questionnaire designed by the researchers titled “Collaborative Avenues Created by E-Learning in the Study of Geography Questionnaire” (CACELSG). It was based on a 4-point scale thus: Strongly Agree (SA) =4pts; Agree (A) =3pts; Disagree (D) =2pts and Strongly Disagree (SD) =1pt. The instrument was face validated by three expert in Measurement and Evaluation and four experts in Curriculum and Teaching from Ebonyi State University, Abakaliki-Nigeria. Its reliability was also determined by administering the questionnaire to 10 lecturers and 20 students from the Department of Geography, University of Port Harcourt in Rivers State of Nigeria. The data obtained was subjected to the test of reliability using Cronbach Alpha, and it yielded a reliability coefficient of 0.92, which was considered high enough for the instrument to be reliable. 366 copies of the questionnaire were personally administered to the students, and 350 copies were properly filled and returned, (48 copies from the lecturers, and 302 copies from the students). The data collected were analyzed descriptively using means and standard deviations to answer the research questions, while ‘t’- test of independent samples was used to test the only null hypothesis at an alpha level of 0.05.
Results

Table 1 presents the data that answered research questions 1 and 2.

Table 1
Opinion pool of lecturers and students on the collaborative avenues created by e-learning in the study of geography in Nigerian universities.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Collaborative avenues created by e-learning might:</th>
<th>LECTURERS n=48</th>
<th>STUDENTS n=302</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>1.</td>
<td>Make geography teachers and students to reposition themselves in their new roles as e-teachers and e-learners working together</td>
<td>3.27</td>
<td>0.71</td>
</tr>
<tr>
<td>2.</td>
<td>Lead to geography teachers sharing their successful teaching practices with other teachers globally.</td>
<td>3.42</td>
<td>0.65</td>
</tr>
<tr>
<td>3.</td>
<td>Lead to cooperative teaching/learning which has more positive effect on students’ learning and performance</td>
<td>3.02</td>
<td>0.81</td>
</tr>
<tr>
<td>4.</td>
<td>Enhance thoughtful conversation through its asynchronous interaction (one’s own time) between learners and teachers in its world-wide network</td>
<td>3.04</td>
<td>0.82</td>
</tr>
<tr>
<td>5.</td>
<td>Strengthen the bond between geography teachers and students, since it would allow deeper interaction.</td>
<td>2.94</td>
<td>1.00</td>
</tr>
<tr>
<td>6.</td>
<td>Lead to the development of geography teaching teams and circles, that can collaborate on field work projects of interest globally</td>
<td>3.27</td>
<td>0.89</td>
</tr>
<tr>
<td>7.</td>
<td>Lead to the development of deep love for, and connection with people/phenomena of other lands.</td>
<td>3.04</td>
<td>0.87</td>
</tr>
<tr>
<td>8.</td>
<td>Enhance deeper interaction among geography students globally.</td>
<td>3.25</td>
<td>0.73</td>
</tr>
<tr>
<td>9.</td>
<td>Enable geography teachers to be able to determine each other’s relative teaching strength across the globe in terms of teaching/research outputs.</td>
<td>3.02</td>
<td>1.02</td>
</tr>
<tr>
<td>10.</td>
<td>Enhance the creation of geography teaching circles(cooperating team teachers), which now removes isolation from their colleagues globally</td>
<td>3.02</td>
<td>0.81</td>
</tr>
</tbody>
</table>
Create unique opportunities for geography students to share their
discoveries with other students globally.

Table 1 continued

12. Encourage occasional interchange of teaching/learning circles and
materials in the traditional classroom.

13. Initiate the sharing of course work materials posted in the electronic
bulletin boards among the teaching/learning circles in the traditional
geography classroom.

14. Encourage the exchange of research ideas and materials among the
teaching/learning circles, from the e-learning class to the traditional
classroom.

| Grand Means = | 3.17 | 3.33 |

Note: S.A. = Strongly Agree; A. = Agree

Table 1 is the summary of the opinions of geography lecturers and students on the avenues created
by e-learning in the study of geography. All the items had means above 3, except item 5 of the lecturers that
had a mean of 2.94; hence the grand means of 3.17 and 3.33 for the lecturers and students are recorded
respectively. This shows that the respondents believe that all the enlisted are good collaborative avenues
created by e-learning in the study of geography in Nigerian universities. Specifically, the lecturers and their
students believe that they would be re-positioned as e-teachers working together with e-learners, with means
of 3.27 respectively; an avenue created for the sharing of their successful teaching practices with means of
3.42/3.46; that another avenue created by e-learning is the development of cooperative teaching/learning,
which has more positive effect on students’ learning and performance, which recorded means of 3.02/3.35.
Again, the lecturers and the students perceived in items 4-8 respectively, that other collaborative avenues
created in the study of geography include: enhancing thoughtful conversations through its asynchronous
interactions with means of 3.04/3.35; strengthening the bond between geography lecturers and students, with
means of 2.94/3.19; development of geography teaching/learning teams and circles that can collaborate on
field work projects of interest with means of 3.27/3.37; development of deep love for, and connection with
people/phenomena of other lands, having means of 3.04/3.23, and enhancing deeper interaction among
geography students globally, recording means of 3.25/3.44.

Furthermore, the findings revealed that the lecturers and the students in items 9 and 10 are optimistic
that they would be able to determine each other’s teaching strength in terms of teaching and research outputs,
with means of 3.02/3.27, and enhancing the creation of geography teaching/learning circles that could help
to remove isolation from their colleagues/peers globally, with means of 3.02/3.16 is possible, as a result of
the collaborative avenues created by e-learning. The respondents also envisaged the possibility of geography
students sharing their discoveries with the other students globally because of the collaborative avenues of e-
learning, with means of 3.31/3.48. They also saw the possibility of uploading and downloading study
resources from e-learning class to the traditional classroom, and the interchange of teaching/learning circles.
The lecturers and their students in item 12 believe that the interchange of teaching/learning circles and
materials in the traditional classroom is possible with means of 3.17/3.26. In item 13, the finding shows that they perceived that it is possible to share course work materials pasted on the electronic bulletin boards between the teaching/learning circles in the traditional class, with means of 3.25/3.39. Finally in item 14, the lecturers and the students attest to the reality of exchange of research ideas and materials among the teaching/learning circles, from the e-learning class to the traditional class, as seen in the recorded means of 3.40/3.45. Conclusively, the findings confirm that the respondents believe that these collaborative avenues created by e-learning would enhance the study of geography in Nigerian universities.

Table 2
‘t’-test analysis of geography lecturers’ and students’ opinions on the collaborative avenues created by e-learning in the study of geography in Nigerian universities

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>Df</th>
<th>t-cal</th>
<th>Sig.(2-tailed)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative avenues created by e-learning</td>
<td>Lecturers</td>
<td>48</td>
<td>3.17</td>
<td>0.80</td>
<td></td>
<td></td>
<td>1.409</td>
<td>0.299</td>
</tr>
<tr>
<td></td>
<td>Students</td>
<td>302</td>
<td>3.33</td>
<td>0.82</td>
<td>348</td>
<td>1.409</td>
<td>0.299</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 portrays the t-test analysis of geography lecturers’ and students’ opinions on the collaborative avenues created by e-learning in the study of geography in Nigerian universities. The ‘sig’ value as seen in the table above is 0.299 at 0.05 level of significance. The decision rule is: If the 2-tailed ‘sig’ value is less than 0.05 level, reject the null hypothesis, but if it is greater than the 0.05 level, then the null hypothesis is accepted. A look at table 2 above shows that the significant value is 0.299, which is greater than the 0.05 level. So the hypothesis is upheld that there is no significant difference between the mean opinions of the lecturers and the students on the collaborative avenues created by e-learning in the study of geography in Nigerian universities. This finding again confirms that geography lecturers and the students are optimistic that e-learning offers good collaborative avenues for the study of geography in this era of digitalization.

Discussion

A closer observation of table 1 shows that the geography lecturers and students believe that the collaborative avenues created by e-learning would help to re-position the subject better as can be perceived from the high means of 3.17 and 3.33 respectively. They believe that as e-teachers and e-learners working together from all sides of the globe, it would be easier to study geography phenomena. All the items had mean values above 3 except for item 5 on the lecturers’ side. This may likely be their view points that deep interaction that may lead to bonding might not be easily established as a result of the heterogeneous nature of a university setting. On the whole, the 14 items were viewed as good collaborative avenues created by e-learning in the study of geography in Nigerian universities.
In table 1, the geography lecturers and students perceived that the collaborative avenues created by e-learning would make them re-position themselves as e-teachers and e-learners working together. This finding is in line with the views of Eya (2006) and Adimabua, Obukohwo and Okechukwu (2006) when they affirm that e-learning materials are arranged in simplified formats to make them interesting for both teachers and students as they work together. Backing up this finding, Naidoo (2003) confirms that e-learning is a medium that would help teachers and learners as they recreate their minds, as e-literate teachers communicating with e-literate learners with up-to-date books and information using electronic skills. Item 2 in table 1 is on geography teachers sharing their successful teaching practices with their colleagues globally, which the respondents affirm to be true. In line with this finding, Villanueva (2000) posits that relevant educational materials are available online for teachers’ successful teaching practices, which they share with their colleagues globally. Furthermore, Naidoo (2003) reiterates that e-learning is a tool that makes delivery of lesson flexible, interactive and long lasting.

In items 3 and 4 of the table, the respondents agree that the collaborative avenues created by e-learning would lead to the development of cooperative teaching/learning with its beneficial effects on students' learning and performance, and would enhance thoughtful conversations among lecturers and students as a result of its asynchronous interaction pattern. These findings are in line with the observation of Davis (1997); that collaboration in e-learning encourages active learning in students. Again, Villanueva (2000) maintains that the asynchronous interaction in e-learning gives students the chance to present their responses better, and by so doing, they can develop more thoughtful and creative conversations.

A run down of items 5, 6, 7 and 8 shows that they are concerned with strengthening the bond between lecturers and students; developing deep love for and connection with people/phenomena of other lands; development of teaching/learning teams and circles that can collaborate on relevant projects of interest, and enhancement of deeper interaction among geography students globally respectively. These findings of the study are in line with the views of Davis (1997) who states that e-learning creates opportunities for teaching/learning groups to work together. In the same vein, the findings are supported by the opinion of Naidoo (2003) when he explains that e-learning provides direct interaction between teachers and students of varied backgrounds across the globe, as they discuss current events. Furthermore, the findings are supported by the view points of Adimabua et al. (2006), saying that e-learning is a world of community communicating, leading to the exchange of ideas and collection of materials from diverse geographical locations, thereby making the planning and execution of fieldwork a lot easier.

Items 9 and 10 of table 1, present the opinions of the respondents on the collaborative avenues provided by e-learning for geography teachers to determine each other’s teaching strength across the globe, in terms of teaching/research outputs, which they affirmed to. Rees et al (2008) confirm these findings when they made it clear that teachers and other researchers can work together to develop their study materials and contribute their intellectual quota in the teaching/learning arena. According to the authors, this is enhanced through the use of ‘nuggets’ which is the common elements on which mergers are based for the collaborating groups, thereby building up team spirit and cooperation which help to remove isolation and boredom in the study of some geographical phenomena. The lecturers and students in item 11 believe that the collaborative avenues offered by e-learning would allow geography students to share their discoveries with other students globally. This is in line with the observations of Gomez (1994) and Dwyer and Yocam (1996) when they affirm that the e-learning forum allows students to work together, share and comment on each other’s work. Finally, items 12, 13 and 14 were framed to elicit the responses of the geography lecturers and students on the collaborative avenues created by e-learning in the areas of interchange of teaching/learning circles and
materials in the traditional classroom; sharing of course work materials pasted in the bulletin boards among the teaching/learning circles in the traditional geography class, and encouraging the exchange of research ideas and materials among the teaching/learning circles, from the e-learning class to the traditional classroom respectively. The respondents were optimistic that these avenues created by e-learning would effectively aid the study of geography in universities in this era of globalization. In line with these findings, Davis (1997) affirms that e-learning has virtual classroom with multimedia computers for the teachers and students to work together as teaching/learning circles. The author maintains that the synchronous and asynchronous interaction modes involved can be carried further into the traditional classroom. Wiley (2000) explains that the way study and research materials are arranged in e-learning enhances interaction that can be extended beyond the electronic realm. So far from the findings of the study, the geography lecturers and students very much believe that e-learning has created good collaborative avenues for the effective study of geography, thereby making it more interesting to the learners.

Table 2 presents the t-test analysis of the geography lecturers’ and students’ opinions on the collaborative avenues created by e-learning in the study of geography in Nigerian universities. The table shows that the ‘sig.’ value is 0.299, which is greater than 0.05 level. Consequently, the hypothesis is accepted that there is no significant difference between the mean opinions of the geography lecturers and students on the collaborative avenues created by e-learning in the study of geography in Nigerian universities. This implies that the lecturers and the students have perceived that e-learning is a welcomed development in the study of geography in the current technological dispensation. This finding is supported by Mitchell (2007) who observes that e-learning is a veritable tool in the study of geography because, it leads to the development of more collaborative learning than the traditional classroom can offer, and uses many techniques/strategies at the same time in the study of geography phenomena. The author further explains that with the ‘webcam’ effect of e-learning, (erosion of boundaries leading to a trend of borderless world), the various geographical phenomena are brought within a geographical space, thus making their teaching and learning stress free and manageable.

Conclusion

With the collaborative avenues created by e-learning in the study of geography, lecturers and students can connect with colleagues and peers respectively from different sides of the globe, to discuss their teaching/learning strategies, fieldwork projects of interest, and research procedures in geography. The collaborative avenues of e-learning from the findings have positive effects on both lecturers and the students in their task performances, and would help to boost their individual/group achievements. The respondents agree that the collaborative avenues created by e-learning would lead to the development of cooperative teaching/learning, with its beneficial effects on students’ learning and performance, and would enhance thoughtful conversations among lecturers and students as a result of its asynchronous interaction pattern, making their work loads manageable.

Recommendations

Based on the findings of the study, the following recommendations are made:

- Lecturers and students in universities in Nigeria should be properly trained in e-learning applications and its collaborative procedures to enhance university education;
- Government at all levels of education in Nigeria should be committed in the mounting of e-learning facilities to boost the digitalization of the Nigerian classrooms.
Universities in Nigeria should work out the modalities of collaborations within and outside the country, in the study of geography and other courses offered in the institutions, using e-learning procedures.

Some academic staff in Nigerian universities are not interested in electronic applications in teaching and learning. University authorities need to enlighten the staff on the need to brace up in this era of digitalization, in order not to be misfits in the globalization process.

E-learning is power driven; and as such, the Federal Government of Nigeria should ensure that constant power supply and reliable standby generators are available in the universities in the country for effective e-learning application.

References


OPTIMIZING SOIL PH FOR POTENTIAL TEA PLANTATION USING DIFFERENT CHEMICALS

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ABSTRACT

Tea plantation requires an acidic soil with a pH range of 4.5-5.5. These pH values have not been reported for Pakistani soils. Lowering soil pH is important for better tea crop productivity in Hazara Division. Therefore, soils from three different sites of Mansehra area were sampled where tea has already been grown but due to the higher pH value, the desired tea production has not been achieved. This study focused the mitigation of pH of silt loam soil through different chemicals. Treatments were mixed in soil-water (1:1) paste and incubated for three months. Temporal changes in soil pH were also measured. Majority of the acidic chemicals significantly lowered soil pH. Combinations of amendments namely FeSO₄, HNO₃, S, Al₂(SO₄)₃, H₂SO₄, H₂O₂, HCl and citrus fruit material were used at different ratios in the same soil. Irrespective of the type of chemical used, all treatments ratios lowered soil pH favorably. Thus we conclude that soil pH in Mansehra area can be lowered using a suitable amendment or appropriate ratios of chemicals for a sustainable tea plantation.

Keywords: soil pH, Optimization, chemicals, combinations, tea, Mansehra area

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INTRODUCTION

Tea (Camellia sinensis L.) belongs to family Theaceae. It is herbaceous, dicotyledonous and perennial crop. Tea may be propagated either by seed or by vegetative means. The effect on yield etc. may be due to the soil fertility, acidity, elevation and weather conditions [1]. The tea plant (Camellia sinensis L) is an evergreen of Camellia family. It was originated in China and India [2]. Tea is cash crop and one of the most important beverages used worldwide. Tea production contributes greatly to the economy and job opportunities for many countries of Asia and Africa due to its large scale production, trade and marketing. Pakistan is perhaps among the few countries where tea has attained the status of basic food especially among the poor. During 2009-10 Pakistan imported 95219 tons of black tea costing Rs. 21622 million with highest share from Kenya (60.95%) while the green tea import was 913.72 tons with 64.46% from China [3]. In addition to legal import, the arrival of tea through illegal channels is also common to feed the Pakistan tea market. Pakistan has a long tradition of tea drinking that has now become an integral part of the social life. The first tea experiments were initiated in the then West Pakistan (present Pakistan) in village Baffa (district Mansehra, NWFP) under the auspices of Pakistan Tea Board in 1958.

Subsequently, efforts to grow tea were reinitiated in 1964 at Misriot Dam near Rawalpindi but due to unfavorable soil and climatic conditions could not achieve the desired results. After the delinking of East Pakistan the entire requirement of tea is imported by Pakistan (Refer Tea imports by Pakistan, Hanif Janoo, IJTS 1:4, 2002). Pakistan is the 3rd largest importer of tea after England and Russia and the consumption is increasing day by day with the increase in population. Pakistan is importing black tea from nineteen different tea-producing countries of the world. Since self-sufficiency is inevitable in the
local production of tea by proper regional soils management [4]. The genus Camellia includes some 82 species, which are mostly indigenous to highlands of south India (Sealy, 1958). Under normal conditions the tea plant is an evergreen tree and widely grows into medium size tree but under cultivation it is pruned and trained as low spreading bush to ensure that a maximum crop of young shoots can be obtained [5].

Pakistan is an agricultural country. It is bestowed with different agro-climatic conditions combined with soil of suitable physico-chemical properties. Under these diverse climatic conditions with different soils various crops, vegetables and fruits can be grown successfully. Fortunately, some of the areas of NWFP are feasible for tea cultivation due to its climatic and soil characteristics. These areas include the districts Mansehra, Batagram, Shangla and Swat. In these areas 1.5 lakh acres of land has been declared suitable for tea cultivation [6]. Tea has begun as medicine and grew into one of the most important beverage of the world. Tea is taken both by poor and rich in Pakistan. Per capita consumption of tea in Pakistan is about one kilogram per annum. Economics revealed that 100 percent tea consumed in the country is imported, and presently Pakistan is the second largest importer of tea after United Kingdom [7]. Soil samples were collected from reported areas and were analyzed for various Physical and Chemical Parameters using standard methods of USDA. Classification and genesis of soils will provide the scientific basis for the studies in future. The soil series and phases studies were done by the criteria of USDA Soil Survey Manual (U.S.D.A. 1951); some minor adjustments were made, however, to suit the local conditions [8].

Eden (1976) reported the suitable range of soil pH as 4.5-5.6 for tea cultivation, in which the cuttings rooted and grew satisfactory [12]. Green (1964) pointed out that the soil of much low reaction i.e. 4.5 had no ill effect on the growth and rooting of tea cuttings. The cutting did not normally root in soil of high pH. In Pakistan, tea cultivation has been recently started. The prospective tea growing areas of Pakistan are ranging from 1000 to 2000 m with varying soil pH ranging from 5.0 to 7.65, the annual rainfall is more than 1000 mm with average temperature ranging 10.07°C to 22.8° C. The objective of this study was to find suitable acidification combination to mitigate pH of basic soils, to satisfy the optimum range of pH required for the growth and yield of tea in Pakistan [13]. Sampling analysis and incubation of pH is shown in the following diagrams.
Pot experiments were conducted at lab-scale to establish suitable chemical amendments as a new way to mitigate higher pH by combination of two or three chemicals rather than individual application. It was desired to raise acidity and to retain it for longer time against the buffering capacity of soil. This research study was joint work with National Tea Research Institute, Shinkiari (Mansehra) and Directorate of Science and Technology Govt. of KPK, it was conducted at COMSATS IIT Abbottabad during years 2011-2012 on soils of three different areas having good potential for tea plants. The prime objectives as stated earlier was to find suitable Chemical amendments to lower higher pH of soils for the efficient growth and high yield of tea. Soils were subjected to pot experiments followed by post and pretreatment analysis of soil for the physiochemical parameters determination, it was carried out at Soil Survey of the Punjab Lahore and Soil and water testing laboratory for research Lahore. Soil samples were collected from Tarnain, Khan Dairi, and Hathi mera, the well-established climatic and environmental conditions for tea cultivation were already reported in the previous studies by F.S. Hamid et. al., the only problem was high pH than the optimum level of 4.5-5.5 for tea plantation. The details of treatments are given in the Table No.1. Plastic pots were used in this experiment and 500g soil was taken for treatment. There were total four pots one being original treatment and others three being the replicates. Detailed description of the amendments used is given in the table No. 2. Combinations of amendments namely FeSO₄, HNO₃, S, Al₂(SO₄)₃, H₂SO₄, H₂O₂, HCl and citrus fruit material were used at different ratios in the same soil. Irrespective of the type of chemical used, all treatments ratios lowered soil pH favorably. Thus we conclude that soil pH in Mansehra area can be lowered using a suitable amendment or appropriate ratios of chemicals for a sustainable tea plantation. Chemicals effect on lowering of soils pH was recorded on the daily basis, Data was collected for about three months.

**Table 1 Treatments applied to soil**
Experimental Details

Soils samples were collected = Tarnain (Silt Loam S1), Hathi Mera (Silt Loam S2), Khan Dairi (Clay Loam S3)
Total Soil Sample Taken= 500g
Chemical Amendments = 7
Biological Amendments = 1
Total Treatments= 8
Total No of soils under trial = 4
Total No of Replicate= 3
Total No. of experimental Pots = 7x4=28x4= 112
Soil paste with water = (1:1) saturated
C*= Citrus Fruits freshly plucked from university lawns

RESULTS AND DISCUSSIONS

To avoid longevity of the this work only pH response of all the amendments will be discussed for soil No. 1 denoted as silt loam soil (S1). The mean values of the recorded results was taken. Since chemicals amendments used to enhanced the acidity in soil media that helped in the healthy growth of Tea plants. Chemical analysis results showed the soils were having silt loam texture, pH was about 7.7 and EC was turned out 7.8 mS/cm. other parameters responsible for major soil fertility Like NPK and OM% were fairly rich. From these results Soil was categorized in the adequate fertile conditions in general. Since only persisting problem was the high pH than the required for Tea plantation in the region.

Soils Treatment results

Here is the efficiency and suitability order of the all eight treatments applied to the amended soil. T2 sulphur combined with two acids; sulphuric acid and hydrochloric acid> T4 Aluminium sulphate combined with Nitric acid and sulphuric acid > T7 > C* citrus fruit freshly plucked from university trees > T6 > T3, T5 > T1. This was the efficiency order of the all amendments. It was already studied that acidic soil with suitable temperature and adequate rainfalls are considered the critical factors for successful cultivation of tea. As the use of ammonium sulfate increases acidity of the soil therefore the maximum increase in plant height may be due to the acidic characteristics of soil created with the application of ammonium sulfate [14]. The preferable pH range of soil for raising of tea cuttings is 4.5 to 5.5. it was reported that a high pH can be corrected by mixing sulphur @ 151 to 454 gm per 0.76 cubic meters of heaped soil or treatment of aluminum sulphate solution @ 24 gms per 0.91 meter of soil [15]. Tea Research Foundation of Kenya suggested the mixing of 170 gm²of sulphur or 300 gm²of aluminum sulphate for the nursery soil having the pH around 6.1. Elemental sulphur is decomposed in the soil by microorganisms, releasing sulphuric acid. This is a very slow process and roots can be damaged if they come into contact with high concentration of decomposing sulphur. Aluminum sulphate contains 14% sulphur and may be of incidental value as a nutrient. The sulphur content is water soluble and aluminum sulphate even in high concentration does not damage the tea roots [16].

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Chemical Combinations</th>
<th>Soil g</th>
<th>Dose used</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Al₂(SO₄)₃:H₂SO₄:S</td>
<td>500</td>
<td>35g:20ml:35g</td>
</tr>
<tr>
<td>T2</td>
<td>S:HCl:H₂SO₄</td>
<td>500</td>
<td>40g:50ml:10 ml</td>
</tr>
<tr>
<td>T3</td>
<td>H₂O₂: Al₂(SO₄)₃:H₂SO₄</td>
<td>500</td>
<td>15ml:30g:20ml</td>
</tr>
<tr>
<td>T4</td>
<td>HCl:Al₂(SO4)₃:H₂SO₄</td>
<td>500</td>
<td>50ml:40g:10 ml</td>
</tr>
<tr>
<td>T5</td>
<td>H₂SO₄: Al₂(SO₄)₃:HNO₃</td>
<td>500</td>
<td>20ml:30g:10ml</td>
</tr>
<tr>
<td>T6</td>
<td>HNO₃:Al₂(SO₄)₃:HCl</td>
<td>500</td>
<td>50ml:30g:10ml</td>
</tr>
<tr>
<td>T7</td>
<td>FeSO₄: HNO₃: Al₂(SO₄)₃</td>
<td>500</td>
<td>25g:45ml:30g</td>
</tr>
<tr>
<td>T8</td>
<td>Citrus fruit ( C*)</td>
<td>500</td>
<td>415g</td>
</tr>
</tbody>
</table>
Effect of amendments on soil pH

As it was studied earlier that significant reduction in soil pH was observed by the application of farmyard manure, aluminum sulphate and sulphur but the effect was more pronounced in case of aluminum sulphate on the soil. Sulphur is not soluble in water but it acidifies soil relatively quickly. It improves the rate of growth of tea plants considerably. Aluminum sulphate is very soluble in water and acidifies soil without adverse effect on tea. It is quicker and cheaper to use aluminum sulphate to lower the soil pH as also reported by [17] and [18]. In the present study the acidic combinations of the elemental sulphur and aluminum sulphate were very significant in lowering of soil pH.

Table 2 Soil Analysis Results

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Lab. No.</th>
<th>Texture</th>
<th>pH</th>
<th>EC mS/cm</th>
<th>Salinity %</th>
<th>Ca^{2+}+Mg^{2+}</th>
<th>Na^{+}</th>
<th>CO_{3}^{2-}</th>
<th>HCO_{3}^{-}</th>
<th>Cl^{-}</th>
<th>SO_{4}^{2-}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24614</td>
<td>SiL</td>
<td>7.74</td>
<td>7.8</td>
<td>0.3</td>
<td>3.6</td>
<td>2</td>
<td>0</td>
<td>1.8</td>
<td>1</td>
<td>2.8</td>
</tr>
<tr>
<td>2</td>
<td>24615</td>
<td>SiL</td>
<td>7.72</td>
<td>1.1</td>
<td>0.3</td>
<td>4.4</td>
<td>0.44</td>
<td>0</td>
<td>3.2</td>
<td>0.6</td>
<td>1.8</td>
</tr>
<tr>
<td>3</td>
<td>24616</td>
<td>CL</td>
<td>7.73</td>
<td>1.4</td>
<td>0.8</td>
<td>10.4</td>
<td>6</td>
<td>0</td>
<td>2.2</td>
<td>3</td>
<td>11.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Lab. No.</th>
<th>TDS mg/l</th>
<th>SAR</th>
<th>ESP</th>
<th>OM %</th>
<th>CaCO_{3}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24614</td>
<td>270</td>
<td>1.4</td>
<td>0.93</td>
<td>0.79</td>
<td>3.64</td>
</tr>
<tr>
<td>2</td>
<td>24615</td>
<td>273</td>
<td>0.29</td>
<td>-0.82</td>
<td>0.86</td>
<td>11.3</td>
</tr>
<tr>
<td>3</td>
<td>24616</td>
<td>805</td>
<td>2.63</td>
<td>2.55</td>
<td>1.03</td>
<td>11.82</td>
</tr>
</tbody>
</table>
Figure 3 Treatments showing the lowering of soil pH along with no of days

Figure 4 Treatments showing the lowering of soil pH along with no of days

Figure 5 Treatments showing the lowering of soil pH along with no of days
CONCLUSION

On the basis of the findings of this study, it was concluded soils were suitable for tea crop due to climatic and environmental conditions as already studied and reported by the NTRI staff. This may be concluded that treatments T2, T4 and C* citrus fruit gave the encouraging results in amended soil. Since it was the combination of three chemicals that was checked for the amelioration of soil for the first time in the given ratios. Although the amendment ratios were revised many times before the completion of this experiment. It is therefore recommended that these combinations may be used for lowering of high pH soils having suitable climatic conditions for tea cultivation in the Mansehra and its surroundings.

ACKNOWLEDGMENT

I would like to pay my enormous gratitude to the Department of Chemistry, COMSATS IIT Abbottabad, NTRI Shinkiari Mansehra, Soil Survey of Pakistan, Soil and Water Testing Laboratory for Research Lahore are highly acknowledged for nice cooperation and assistance in this work.

REFERENCES


ABSTRACT

Human’s activities on the environment often result in pollution and degradation of water bodies. Water bodies must therefore be jealously guided and protected from being polluted, which will affect water quality and availability for desired usage. Causes of water quality impairment are urban and rural storm water runoff, inadequate waste water treatment, nutrient entrophication, atmospheric deposition and acid rain, pollutant in sediments and fish, and nuisance aquatic weed growth and invasive species. Other factors include unhygienic disposal and inadequate treatment of human and livestock wastes, indecent management and treatment of industrial residues, inappropriate agricultural practices and unsafe solid waste discharge. Suggested strategies to combat water quality problems which should form the basis of policy solution for improving water quality include: (i) prevention of pollution; (ii) treatment of polluted water; (iii) safe use of waste water; and (iv) restoration and protection of ecosystem. It is recommended that our water bodies and the environment in general should be protected through appropriate legislation guidelines and public literacy campaign and mass education to sensitize, educate and make the people a fully environmentally literate society. Taking these steps internationally, nationally and locally will mean better water quality for our present society and future generation.

Key words: Water quality – Environment- Pollution-Prevention-Treatment

INTRODUCTION

Water, though fluid, is the “backbone” of everything alive. This is because clean, safe, and adequate freshwater is vital to the survival of all living organisms, and the smooth functioning ecosystems, communities and economies. Water is utilized in diverse ways among which are: public (domestic) water supply, industrial water supply, agricultural water supply,
fresh and marine water fisheries, recreational and other aesthetic enjoyments, and water transportation. Water bodies must therefore be jealously guided and protected from being polluted, which will affect water quality and availability for desired usage. Without water therefore, life and civilization cannot survive let alone develop and be sustained.

The aim of this study is to X-ray the water quality problems and challenges and their impacts, and suggest strategies of combating such problems.

**WATER QUALITY CHALLENGES AND IMPACTS**

Water quality is a terminology used to depict the physical, chemical and biological characteristics of water in relationship to a set of standards. Water quality is important because its uses covers virtually all corners of life, from personal human consumption to environmental and industrial application and even aquatic matter (Amund et al, 1991). In irrigation, water evaluation emphasis is on the chemical and physical characteristics of the water, and rarely are other factors considered important (Ayers et al, 1994). The quality of irrigation water is generally judged by its total salt concentration or electrical conductivity (EC), relative proportion of cations or sodium absorption ratio (SAR) and bicarbonate and boron content of water (Michael 1999).

Declining water quality has become a global issue of concern as human population grow, industrial and agricultural activities expand and climate change threatens to cause major alterations to the hydrological cycle. Water quality issues are complex and diverse and are deserving urgent global attention and action (UN – Water 2011).

Both natural processes and human activities influence the quality of surface waters and ground water. Some major water pollutants and their possible sources are listed in Table 1. The discharge of these pollutants into water bodies directly or indirectly will contaminate the water system and hence affect water quality and availability for desired usages. The major sources of water pollution are from human settlement and industrial and agricultural activities. Negative factors related to these activities include unhygienic disposal and inadequate treatment of human and livestock wastes, indecent management and treatment of industrial residues, inappropriate agricultural practices and unsafe solid water discharge. For example:

i) Over 80 percent of sewage in developing countries is discharge untreated directly into water bodies (UNICEF and WHO, 2008).

ii) Industries are responsible for dumping an estimated 300 – 400 million tones of heavy metals, solvent, toxic sludge and other wastes into water each year (UN – Water 2011).

iii) Nitrates from agriculture are most common chemical contaminant in the world ground water aquifers (Morris et al, 2003 and Mahvi et al, 2005).

iv) In the united states of America, manures and pesticides from agriculture are the greatest source of water pollution (Revenga and Mock 2000, Faeth 2000). In almost all countries with major land salinization; water salinization is an accompanying problem. Major problems have been reported in Argentina, china, India, Sudan, and many countries in central Asia where more than 10 million hectares of irrigated land are salinized (Ghassemi et al, 1995).
<table>
<thead>
<tr>
<th>Sources of Pollution</th>
<th>Potential/Improve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MUNICIPAL AND RURAL SEWAGE</strong></td>
<td></td>
</tr>
<tr>
<td>Raw sewage</td>
<td>Suspended solids, dissolved solids. High BOD, nutrients.</td>
</tr>
<tr>
<td>Primary effluents</td>
<td>Dissolved Organic, high BO nutrients.</td>
</tr>
<tr>
<td>Secondary Effluents</td>
<td>Nutrients, virus</td>
</tr>
<tr>
<td>Septic tank effluents</td>
<td>Nutrient</td>
</tr>
<tr>
<td><strong>LAND EROSION</strong></td>
<td></td>
</tr>
<tr>
<td>Animal wastes</td>
<td>Suspended soils, high BOD.</td>
</tr>
<tr>
<td>Nutrient, bacteria and virus Mine drainage</td>
<td>Acids, sediment, heavy metals suspended</td>
</tr>
<tr>
<td>Rainfall and other</td>
<td>Solid particles, chemical’s toxic</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Elements, radioactive fallout</td>
</tr>
<tr>
<td><strong>INDUSTRY</strong></td>
<td></td>
</tr>
<tr>
<td>Steel mills and furnaces</td>
<td>Suspended solids, lubricating oils, heat, acid heavy metal dissolved organic solvents</td>
</tr>
<tr>
<td>Paper mills</td>
<td>Suspended solids, high BOD, acid dissolved organic foaming agents, chemical and slimicides</td>
</tr>
<tr>
<td>Motor vehicles and parts</td>
<td>Oil heavy metals, suspended solids, alkali’s acids, cyanide organic solvents</td>
</tr>
<tr>
<td>Textile mill</td>
<td>High BOD, suspended solids</td>
</tr>
<tr>
<td>Products</td>
<td>Grease, bleaches, dyes salt organic solvent, pesticide</td>
</tr>
</tbody>
</table>
Petroleum refining .............................. High BOD, phenols oils
Chemical ................................. Various metals, salts, or Ganic substance.
Fruit and vegetable processing ...... High BOD, suspended solids
Breweries ................................. High BOD, suspended solids
Leather tanning ......................... High BOD, suspended solid’s alkali’s sulphides.
Meat and poultry products .......... High BOD, suspended solids, feathers, bones
Dairy products .............................. High BOD, sanitizing chemicals and soap, cheese whey.
Plastic and resins ......................... Various organic, high
Water craft ............................... COD, Raw sewage, oils, litter wash water suspended solids bacteria and viruses.

STEAM-ELECTRIC AND NUCLEAR
Power plant .............................. Thermal pollution


Pollution and contamination from such sources manifest itself in the form of increased acidity, and higher concentration of nutrients, sediments, salts, trace metals, chemical and other toxins, as well as harmful pathogenic organisms that may thrive in warmer waters. Nutrients enrichments has become most widespread water quality problems, severely degrading freshwater and coastal ecosystem (UNESCO, 2009)

According to millennium ecosystem assessment, 2005; the biodiversity of the freshwater ecosystems has been degraded more than any other ecosystem including tropical rainforest. Most polluted freshwater ends up in the oceans, causing serious damage to many coastal areas and fisheries, thereby constituting a major challenge to ocean and coastal resources management (UN – Water 2011). Apart from upsetting human health, the degradation of ecosystem through polluted water affects humans indirectly as fisheries and biodiversity are destroyed threatening food production and other benefits to mankind. For example, the following are some of the reported consequences of water pollution:

i) In Europe, more than 40% of freshwater fish species and 40% of amphibians are in imminent danger of extinction (UN – Water 2011).
ii) In south Africa, nearly two thirds of freshwater species are considered threatened or endangered (UN – Water 2011).
iii) The rendering of Scandinavian lakes fishless because of gaseous pollutants that originated elsewhere in Europe (Faniran, 1992).

iv) The discharge of waste water containing red phosphorus plant into placenta bay in new found land, Canada, between 1968 and 1969 was reported to have wiped out several herrings from the bay. The episode was called “red – herring disaster” (Faniran, 1992)

v) In 1953, the calamity of mercury poisoning of the fishing community in Minamata bay, Japan was reported. The incident claimed over 80 lives with 900 injured, while several were either crippled or deformed through the consumption of fish containing mercury caught from the bay (Faniran, 1992).

vi) Also in Japan, the Itai – Itai disease (cadmium poisoning) was reported to have plagued Toyoma city region between 1955 and 1973 when industrial effluent containing cadmium (also lead and zinc) from a mining waste water was discharged into river Jintsu. This led to the contamination of the river being used by the community for irrigating rice field. Through the consumption of rice grown therein, the pollution claimed 50 lives with several others at victims (Faniran, 1992)

vii) Every year 1.8 million people die from diarrheal disease attributed to unsafe water or poor sanitation and hygiene (WHO, 2004)

viii) In 2009, over 50 countries still reported cholera to WHO and approximately 200 million people around the world are infected with Schistosomiosis, a depilating water borne parasite diseases (WHO, 2010).

In the Nigerian environment, the following cases have been reported:

i) In 1984, several fishes were found dead and floating in the Lagos lagoon along marina due to the discharge of toxic wastes and in industrial effluent into the river body. (Faniran 1992).

ii) Existence of coastal degradation especially by excessive erosion and flooding. The effects are most pronounced in Lagos, Rivers, Cross Rivers, Ondo and Ogun States. (Anina, 1989)

iii) Coastal and marine pollution caused largely by oil exploration, production and marketing activities, both in the coastal areas and offshore.

iv) Spillage of oil into surface waters and ground waters in the vicinity of petroleum refineries and petroleum products depots in Kaduna, Warri and Port Harcourt. (Aina 1989)

v) Accidental discharge of water containing high ammonia level into Okirika river in 1988 from NAFCON (a fertilizer company), at Onne, near Port Harcourt, caused massive fish kill and socio-economic problems for the artisanal fishery industry in the surrounding village. The villagers then were claiming about N3 Million compensation from the company (Feniran 1992).

vi) Combined industrial effluent from Ikeja industrial estate through WEMABOD treatment plant which had broken down, spilled into Idimangoro area at Agege Lagos in 1970 due to the blockage of one of the man-holes on the effluent channel. Drinking well waters in the area were grossly polluted. The foundation of one the houses affected by the spillage caved in, and the occupants were evacuated (Faniran 1992).

vii) Petroleum product spillage from the Kaduna Refinery into Romi and Rido rivers in 1987. Well waters in Rido village as well as the Rido and Romi rivers were grossly
polluted. Compensation of more than N3 million had been paid to the villagers. (Faniran 1992).

viii) Water hyacinth “outbreaks” in Lagos port and harbor as well as along the coastal creeks and lagoons. These have serious implication on water transport, port operations, recreational amenities, fisheries and tourisms. (Aina 1989).

There are no reliable estimates of the total burden of ill – health resulting from water contaminated by domestic, industrial and agricultural discharges.

Poor water quality also has a direct impact on water quantity in a number of ways. Polluted water that cannot be used for drinking, bathing, industry or agriculture effectively reduces the amount of useable water within a given area.

STRATEGIES TO COMBAT WATER QUALITY PROBLEMS

There are four fundamental strategies to combat water quality problems that can form the basis of policy solution for improving water quality (WHO, 2010).

These are:

i) Prevention of pollution

Pollution prevention strategies focus on the reduction or elimination of waste at the source. Prevention is widely regarded as the cheapest, easiest and most effective way to protect water quality. In industry, solution includes reformulating products so that they produce less pollution and require fewer resources (including water) during their manufacture. In agriculture, reducing the use of toxic materials for pest control, nutrient application and overall water usages through precision farming can reduce pollution (FAO 1996; FAO 2003). In human settlement, the most obvious solutions include increasing improved sanitation coverage, consideration of settlement design (such a type of materials used for construction), the location of storm water, as well as reducing waste water production (UNEP 2010).

ii) Treatment of polluted water

In cases where contaminants result from domestic, industrial or agricultural activities, waste water must be treated before discharging. The appropriate treatment options depend on the circumstance and intended after use. For example, to supply water for larger settlements modern multiple stage water treatment plants are typically required. At the community level, solution may include solar stills, and smaller scale filtration and disinfection plants. At the household level, solution may include boiling, solar pasteurization, simple water filter, solar water infection and chlorine treatment. While several of the option mentioned may also be appropriate for treatment of water for industrial use, agricultural
source water can, in some cases be of much lower quality, especially where harmful contaminants that can accrue in soil and crops are absent (UN – water 2011)

iii) Safe use of waste water

Waste water is usually disposed of into water bodies ideally following treatment to render it environmental safe. However, it can safely be used sometimes even untreated in circumstances where impacts on human health and environment are well understood and all possible action is taken to eliminate risks (WHO/FAO/UNEP, 2006, FAO 2010). If well regulated, safe use of waste water for example, in agriculture, can reduce the pressure exerted by human activities on existing fresh water resources and augment water supply in water scarce and semi-arid zones and in rapidly growing peri-urban setting (Choukr – Allah, 2004).

Furthermore, waste water can be a source of nutrients and when properly managed is potentially valuable for certain agricultural uses, reducing the need for expensive chemical fertilizer (Scott et al 2004). Additionally, agriculture may act as a form of biological treatment, moving nutrients from water that otherwise may pollute water courses.

In peri-urban and rural areas, treated human waste water can be a viable source of water for reuse, after applying ecological sanitation. It involves the separation of urine and faecal matter. Sterile urine may be applied directly to plants while fecal matter is composted until it is safe for land application. This approach has been implemented in several countries and regions including China, India, Burkina Faso, Kenya, Niger, Sweden, and parts of Eastern Europe (UNEP 2010). By re-cycling water and using dry pre-stored human wastes, jobs are created for local populations as well as market opportunities for provision of indigenous fertilizers and soil conditioners for agriculture.

Some industries, such as food and processing industry utilized large volumes of water, and often also discharge considerable quantities of waste water. Such waste water can be reuse in other applications that do not require high quality, or apply appropriate technologies to process waste water for producers requiring water of high quality. Examples can be derived from Namibia and Singapore, where fresh water resources for both industrial and human consumption are supplemented with treated waste water (UN - water 2011).

iv) Restoration and protection of ecosystem.

Healthy ecosystem provide water quality benefits in the form of water purification, often at far lower cost than subsequent engineering efforts to clean contaminated water (Costanza et al 1997). When water systems, including watersheds, are adversely impacted by water quality, strategies to remediate pollution and restore systematic health and function are important (UNEP 2010) Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (Society for Ecological Restoration International, 2004). Strategies for fresh water restoration can be straight forward as removing up stream dams and restoration of rivers and wet lands. One of the well-established approaches that can be used to deal with pollution from both point and non-point sources is eco-hydrology (Costanza et al, 1997). An eco-hydrological approach is based on the understanding of the inter-relationships between the ecological processes and the
water cycles in a given catchment and supports the role of ecosystem processes in water quality improvement. Eco-hydrology can address water related threats such as reducing flood risk by creating wet lands that prevent pollutants from entering water ways. Examples of eco-hydrology approaches can be found worldwide including Iraq, Japan, and Poland (UNEP 2010).

**CONCLUSIONS AND RECOMMENDATIONS**

Water is our richest and most natural resources which should not be polluted. Since water quality problem can be prevented, it is necessary and imperative to protect our water bodies and the environment in general from pollution through appropriate legislation and guidelines.

The industrial waste waters must be properly treated and closely monitored. Limitation guidelines for all industries have been prescribed by various regulatory national and international agencies such as FAO, and FEPA to control water quality and effluents of specific industries. Strict enforcement of these regulations will reduce the present level of pollutions introduced by uncontrolled effluent discharges and waste waters from our industries and protect the water bodies and the environment. These regulations should also be extended to domestic waste discharge for same reasons.

To be effective and achieve meaningful results, those to be policed must be given proper environmental education. The society at large must be sensitized to the need for environmental protection. Public literacy campaign and mass education on environmental problems including water pollution and prevention is a must to make the nations a fully environmentally literate society. The more sound and understanding of the environment the more effective it can be at the service of human beings. Therefore we have a collective responsibility to keep our environment and make it safe to live in.

Taking these bold steps locally, nationally and internationally will mean a better water quality for our society and future generation. The joy of swimming in local rivers and lakes and fishing for recreation and sustenance will then thrive again.

Clean water in life. We already have the know-how and skills to protect our water quality. What is now needed is the will.

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THE STATE OF SCIENCE AND TECHNOLOGY INFRASTRUCTURE
IN SECONDARY SCHOOLS IN NIGERIA

Nwachukwu Uche Emma


Abstract

Science and technology (S&T) education is crucial to the achievement of socio-economic development of any society and also a critical element in the attainment of the Millennium Development Goals (MDGs). Standard laboratories and equipments as well as reagents are S&T infrastructures essential for providing qualitative education for producing national technological manpower. This study evaluates the condition of S&T infrastructures in the Nigerian secondary schools. The study utilises primary data collected from public and private secondary schools across the six geo-political zones in the country. Findings show that there are inadequate teachers, laboratories and necessary equipment for teaching S&T related subjects in most of the secondary schools in Nigeria. Also, electricity supply from the national grid to secondary schools is poor because only 30% of them have light at most 4hours a day. The study therefore recommends the provision of adequate funds and electricity generators for these institutions to enhance the teaching and overall development of S&T education in Nigeria. In addition, adequate and qualified personnel (teachers and laboratory technicians) should be provided while good maintenance culture and improved security of laboratories and equipment in secondary schools should be imbibed by all secondary schools in the country.

Key Words: Science and technology, infrastructure, Nigeria

INTRODUCTION

Science and Technology (S&T) has been globally recognised as major instrument of economic development and social transformation. As a result, every nation has continued to pursue S&T knowledge in order to remain relevant in a globalised world economy. A major source of S&T knowledge and skills are educational institutions at all levels. The purpose of education is to generate and apply knowledge resulting in improvements in science and technology, while the S&T infrastructures required for knowledge generation and the attendant learning processes are the lifeline of the educational system. The state of available S&T infrastructures in educational institutions is a determinant factor of the capacity of the educational system to produce the requisite human capital necessary for achieving competitive economy and social transformation.

The production of adequate and competent technological manpower is a major challenge in Nigerian education industry. The education industry in the country has been battling with various aspects of infrastructure development challenges for improving the quality of education and expanding access. The various government efforts to improve infrastructure in educational institutions include construction of classrooms, lecture halls, laboratories and staff quarters as well as supply of water and electricity to improve quality of education and manpower production.
This study examines the condition of S&T infrastructure in secondary schools in Nigeria. The study aims to contribute to the attainment of Nigeria’s Vision 20:2020 and socio-economic transformation agenda currently pursue by the Federal Government of Nigeria (FGN).

1.1. Problem Statement
It is generally acknowledged that the delivery of education in Nigeria has suffered from many years of neglect. This led to frequent industrial actions by trade unions in educational institutions and students unrests caused by discontent arising from poor state of educational infrastructure.

Again, the various efforts to address the challenges of educational infrastructure include establishment of model schools, creation of specialised colleges, establishment of new public and private secondary schools. Other efforts included the establishment of specialised funding support for infrastructure from donor agencies and local institutions such as the Education Trust Fund (ETF) and the Universal Basic Education Commission (UBEC) among others. The extent to which these mechanisms support or contribute to the development of S&T infrastructure in the educational system has been unclear.

In addition, investment in S&T infrastructure still remain a factor not raised to the forefront when considering issues of educational development in Nigeria, and where it does, such investment is often subsumed under general infrastructure items. Currently, the quality of education provided remains grossly deficient and unable to build the human capital required for a competitive economy.

1.3 Research Questions
The research questions addressed by this study are:
   a) What is the current state of S&T infrastructure in secondary schools in Nigeria?
   b) What are the constraints and opportunities for the development of S&T infrastructure in secondary schools in the country?
   c) What are the necessary policies that will enhance the development of S&T infrastructure in secondary schools in Nigerian?

1.4 Research Objectives
The broad objective of this study is to examine the state of S&T infrastructure in secondary schools in Nigeria. The specific objectives are to:
   a) examine the current state of S&T infrastructure in secondary schools in Nigerian;
   b) identify the constraints and opportunities for the development of S&T infrastructure in secondary schools in Nigerian; and
   c) Make policy recommendations on how the develop S&T infrastructure in Nigerian secondary schools.

1.5 Justification for the Study
Nigeria is technologically poor due to poor investment in human capacity development and necessary infrastructure. Presently, the 60:40 ratio of students’ admission into science and art disciplines in tertiary institutions is yet to be achieved in the country. This study becomes necessary in order to foster national technology capability building. Besides, it is unknown whether any study has examined the state of S&T infrastructure in secondary schools in Nigeria. This study aimed at bridging this knowledge gap and also proffers policies and actions that will enhance availability of S&T infrastructure in Nigerian secondary schools.
2.0 LITERATURE REVIEW

2.1 The Meaning and Role of Science and Technology Infrastructure

Science and Technological Infrastructure can generally be defined as intermediate inputs that provide the basis for the functioning of other technologies or provide essential services to other sectors of the economy. Technology infrastructure thus consists of science, engineering and technical knowledge available to industry. Such knowledge can be embodied in human, institutional, or facility forms. More specifically, technology infrastructure includes generic technologies, technical information, and research and test facilities, as well as less technically explicit areas including information relevant for strategic planning and market development. Science and Technology infrastructures amongst others are some of the minimum requirements that feed into technological and industrial development of any economy. Tassey (1992) describes Science and Technological Infrastructures in much wider terms, as 'science, engineering and technological knowledge available to private industry … embodied in human, institutional or facility forms'. He concludes that at national and firm levels respectively, there is an increasingly dependence on service delivery of Science and Technology Infrastructure.

The role of Science and Technology Infrastructure as an engine of development is an emerging issue that is beginning to feature prominently on the Nigerian scene. This is being demonstrated aptly in the National Education and also National S & T policies and in subsequent economic developments and reform framework of the country. The current economic reform framework is the Vision 20:2020 (NV20:2020), and it features S & T infrastructure as a cross-cutting issue that has to be promoted in order to achieve economic development objectives (NPC, 2007). The state of poverty in the country and the challenge of meeting the Millennium Development Goals, in this respect, in particular have drawn attention to the role of S & T infrastructure for solutions of technological adaptation and diffusion based on local conditions and knowledge. For example those that can boost agricultural productivity and food storage capacity, reduce post-harvest losses, promote renewable energy (including bio-fuels and solar), develop rain water harvesting systems, deliver potable water to rural villages, and improve basic health care.

2.2 The Role and Importance of Science Laboratories

At every level of science education, laboratories are perceived as a vehicle for curriculum enhancement. Studies including Hadley & Rheingold, 1992; McDaniel, Melnerney & Armstrong, 1993; Hannafin & Saverey, 1993) have indicated that a properly equipped and functional science laboratory has the potential for enhancing science learning. Science laboratories have a central and distinctive role in S&T education, and science educators suggest that there are rich benefits in learning from using laboratory activities.

In many African countries, research has revealed shortages in the number of laboratories in schools. A study by Jones (1990) found that 45% of the schools surveyed in selected African countries indicated insufficient laboratories. Alebiosu, 2000 and Onipede, 2003 reported that many schools in Nigeria do not have laboratory with minimum standard facilities. This finding agreed with Barrow’s (1991) findings in Saudi Arabia which also indicated inadequacy in the provision of laboratory facilities in schools. The findings were also consistent with those of Black et al. (1998) who found in Uganda that science education is faced with the problem of lack of resources with half the schools
having no real laboratory. Leister, (1992) observed that shortages of laboratory facilities could have serious implications on the quality of schools’ output.

3.0 METHODOLOGY

3.1 Primary Data Collection and Scope of Study
This study covered both the private and public secondary schools in selected states in the six geopolitical zones of Nigeria. The choice of the secondary schools is anchored on the fact that it is at these levels that education become profound and learning is tailored to breeding future physicians, scientists, engineers, technicians and other professionals. The choice of states for the study is based on investment in S & T infrastructure in the educational sector, and availability of the frame/list of public and private tertiary institutions in 2010.

3.2 Sample Selection
One state was selected in each of the six geo-political zones for the study. Based on perceived performance on investment in education with focus on S & T infrastructure in 2010, one state was selected from each of the geo-political zones as follows:

(i) Edo State - South-South
(ii) Enugu State - South-East
(iii) Katsina State - North-West
(iv) Kwara State - North-Central
(v) Lagos State - South-West
(vi) Bauchi State - North-East

The Ministries of Education in the selected states were contacted for the list and location of secondary schools in their respective states. The lists provides sample frame from which twenty secondary schools that participated in the survey were chosen in each of the states selected. The secondary schools were stratified into public and private secondary schools, and urban and rural secondary schools. Secondary schools located in the state capital and local government headquarters were generally regarded as urban schools while those elsewhere were regarded as rural schools.

There are two types of semi-structured questionnaires employed as instruments for eliciting the primary data/information from respondents. One questionnaire was designed for secondary school principals and one for teachers of S&T related subjects. In each secondary school, five questionnaires were administered. Altogether, 600 questionnaires were administered in secondary schools while 438 questionnaires were retrieved representing 73% retrieval rates.

For the primary data collection, field research assistants were recruited and trained in each state served as enumerators. The questionnaire aimed at collecting data on S&T related issues such as nature of S&T related investments in the educational sector, availability of teachers in S&T related subjects, number and quality of S&T laboratories available in the institutions, capability to use laboratory equipment, availability and adequacy of chemical reagents in the institutions, the availability and adequacy of S&T equipment in the schools, the age and functionality of the available S&T equipment and materials, the adequacy or otherwise of S&T teaching materials and personnel and level of availability of water and electricity. To gain deeper insights into the constraints on S&T
infrastructure development and how to overcome them, interviews of directors of research, planning and statistics in each of the selected state’s ministry of education were carried out.

3.3 Data Analysis
The Statistical Package for Social Science (SPSS) was used to analyze the questionnaires, following which descriptive statistics such as frequency counts, charts and tables were used as appropriate to explain the features of science and technology infrastructure in the sampled secondary schools. Chi-square was calculated to measure the difference in significance between private and public educational institutions.

4.0 FINDINGS

4.1 State of Science and Technology Infrastructure in Nigerian Educational Institutions
4.1.1 Human Capital Outlay
An important determinant of economic growth and development is human capital outlay. The quality and nature of education determine the knowledge and skills available for human capital upgrading. From the findings of the study, three elements of the results provide some insights to the human capital outlay in the Nigeria educational sector. These are qualification of teachers of secondary schools; quantity and level of experience of teachers; and ratio of teachers to students.

4.1.2 Qualification of Teachers
Table 4.1 shows the distribution of the highest qualifications of teachers in the sampled secondary schools. 82% of the teachers have at least a bachelor degree in their subject areas, while the rest have HND or NCE in S&T related subjects. In fact, about 91% of the teachers have at least HND or B.Sc. It thus appears that very high proportion of teachers in S&T related subjects have appreciable requisite qualifications in S&T subjects. It is often advocated that teachers in S&T subjects should also possess training in education. From the results in Table 4.1, only 8.4% of the teachers have a postgraduate diploma in education and only 8.7% have national certificate in education.

<table>
<thead>
<tr>
<th>Highest Qualification</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCE</td>
<td>38</td>
<td>8.7</td>
</tr>
<tr>
<td>HND</td>
<td>41</td>
<td>9.4</td>
</tr>
<tr>
<td>B.Sc.</td>
<td>272</td>
<td>62.1</td>
</tr>
<tr>
<td>M.Sc.</td>
<td>50</td>
<td>11.4</td>
</tr>
<tr>
<td>PGD</td>
<td>37</td>
<td>8.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>438</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Source: Field Survey, 2011

4.1.3 Quantity and Experience of Teachers
Table 4.4 shows the teacher to students’ ratio. The Table shows that, there are 4,793 teachers in S&T related subjects and 90,672 students. This implies a teacher to students’ ratio of 1:19. Except for wood work and metal work, the teacher to students ratios are very poor in all the S&T related subjects the most affected subjects being computer science and introductory technology with teacher to students ratios of 1:251 and 1:201 respectively. This shows that the quantity of teachers for S&T related subjects in the sampled secondary schools is inadequate.

Table 4.4: Teacher to students’ ratio for s&t related subjects in the research sample

<table>
<thead>
<tr>
<th>Subject</th>
<th>No. of</th>
<th>No. of Teacher to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.5: Subject area of teachers’ qualification

<table>
<thead>
<tr>
<th>Subject</th>
<th>Frequency</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>104</td>
<td>24.4</td>
</tr>
<tr>
<td>Physics</td>
<td>110</td>
<td>25.6</td>
</tr>
<tr>
<td>Biology</td>
<td>110</td>
<td>25.6</td>
</tr>
<tr>
<td>Introductory Technology</td>
<td>22</td>
<td>5.1</td>
</tr>
<tr>
<td>Integrated Science</td>
<td>12</td>
<td>2.8</td>
</tr>
<tr>
<td>Computer science/mathematics</td>
<td>22</td>
<td>5.1</td>
</tr>
<tr>
<td>Agriculture/Animal Science/Home Mgt/Food &amp; Nutrition</td>
<td>59</td>
<td>13.8</td>
</tr>
<tr>
<td>Basic Electronics</td>
<td>3</td>
<td>.7</td>
</tr>
<tr>
<td>Metal Work</td>
<td>2</td>
<td>.5</td>
</tr>
<tr>
<td>Wood work/carpentry</td>
<td>3</td>
<td>.7</td>
</tr>
<tr>
<td>Education/Guidance &amp; counselling</td>
<td>2</td>
<td>.5</td>
</tr>
<tr>
<td>Environment/Geography</td>
<td>2</td>
<td>.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>438</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

**Source:** Field Survey, 2011

From Table 4.5 showing the distribution of the subject areas of teachers’ qualification, the vast majority (71%) of the teachers are in the traditional science subject areas of chemistry, physics and biology. The remaining 31% of the teachers are distributed over other S&T related subjects as shown in Table 4.5. These results indicate that secondary school teachers’ experiences are still mainly in basic science subjects comprising of chemistry, physics and biology.

4.2 Science and Technology Hardware

Science and technology hardware in educational institutions is very crucial to the advancement of practical teaching and learning. It includes the science laboratories, equipments, and teaching aids such as ICT facilities (computers, the Internet) as well as the support infrastructure (electricity and water supply) which are expected to aid the best functioning of the science and technology hardware. Science laboratories, in particular have been found to be central to the teaching of science. These laboratories are the workshops where practical activities are conducted to enhance a meaningful learning of science concepts and theories (Seweje, 2000; Olubor and Unyimadu, 2001).
4.2.1 Science Laboratories

The results of our survey showed that 82.5% of schools in our study have between one and five science laboratories, while the remaining 17.5% have over five science laboratories. The minimum age of these laboratories is one year; while the maximum age is 30 years. About 55% of schools have laboratories within the age range 1 and 10 years old, while the remaining 45% are above 10 years old.

For each of the three core science subjects, which are Chemistry, Physics and Biology, over 90% of schools claim to have separate laboratories. Furthermore, while 68.4%, and 50% have laboratories for agricultural science and introductory technology respectively. It was observed that integrated science and introductory science are often taken as the same subjects in many schools, and this may explain why only 39% claim to have a separate laboratory for integrated science. Figure 4.1 shows the responses received on the specific types of laboratories that exist in the schools in our sample. In addition to having specific laboratories, almost 60.0% of the schools attested to the fact that their schools have at least one science laboratory, which may be classified as multipurpose laboratory used for practical sessions for a combination of subjects. The four most common combinations of subjects for which these multipurpose laboratories were used for, are as follows:

a. Chemistry, Physics, Biology Agriculture, Animal Science, Home Management, Food and Nutrition
b. Chemistry, Physics, Biology, Agriculture, Animal Science, Home Management, Food and Nutrition and Basic Electronics
c. Chemistry, Physics, Biology, and Introductory Technology/Integrated Science
d. Chemistry, Physics, Agriculture, Animal Science, Home Management, Food and Nutrition

Figure 4.1: Types of laboratories in Nigerian secondary schools

Source: Field survey, 2011

4.2.3 Quality of Science Equipment
Respondents were asked to rate how they perceived the quality of science equipments in the laboratories on a likert scale reported as poor=1, fair=2, good=3, very good= 4 and excellent=5. The perception of respondents (see Table 4.7) show that about 35% perceive the equipment as good, while 12% perceive the equipments to be excellent, and 17.10% perceive them as poor.

<table>
<thead>
<tr>
<th>Quality of science equipment</th>
<th>Secondary Schools %</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>13.10</td>
<td>17.10</td>
</tr>
<tr>
<td>Fair</td>
<td>25.60</td>
<td>18.05</td>
</tr>
<tr>
<td>Good</td>
<td>34.80</td>
<td>35.80</td>
</tr>
<tr>
<td>Very Good</td>
<td>18.40</td>
<td>17.10</td>
</tr>
<tr>
<td>Excellent</td>
<td>8.10</td>
<td>11.95</td>
</tr>
</tbody>
</table>

**Source:** Field survey 2011

Further analysis was done based on the computation of the level of significance of the perception levels on quality of equipments by teachers in the public and private secondary schools. The results show that there is a significant difference in the perception on quality of equipment at secondary school level (p= 0.0000).

### 4.2.3 Sources of Laboratory Reagents/Consumables in Secondary Schools

The main sources of laboratory reagents and consumables in the secondary school surveyed are the school (68.5%) and the State Government (70.9%). The PTA has not been active in this line of activity with only 7.5% of schools reporting this trend.

### 4.3 Electricity Supply

Electricity supply is one of the factors that are likely to influence the functionality of science laboratories, as it an essential input to many scientific processes. The regularity of electricity supply from PHCN (national grid) to educational institutions is generally very poor. As shown in table 4.11, about 30% of schools have light for not more than 4 hours, and only 21.05% of respondents at secondary education claim to have electricity from PHCN for more than 6 but not more than 8 hours per day.

<table>
<thead>
<tr>
<th>Regularity</th>
<th>Secondary schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not more than 2 hrs</td>
<td>29.9</td>
</tr>
<tr>
<td>More than 2 but not more than 4hrs per day</td>
<td>29.9</td>
</tr>
<tr>
<td>More than 4 but not more than 6hrs per day</td>
<td>21.0</td>
</tr>
<tr>
<td>More than 6 but not more than 8hrs per day</td>
<td>7.6</td>
</tr>
<tr>
<td>More than 8 but not more than 10hrs per day</td>
<td>8.9</td>
</tr>
<tr>
<td>More than 10hrs per day</td>
<td>2.7</td>
</tr>
</tbody>
</table>
With the results obtained on the regularity of electricity, it is therefore also not surprising to report that 74.1% of schools and 85.7% of faculties surveyed attest to the fact that they have alternative sources of electricity power supply to their laboratories. The alternative sources include electric generators, solar panels and inverters, as shown on table 4.1.

<table>
<thead>
<tr>
<th>Sources</th>
<th>Secondary Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Generator</td>
<td>83.7</td>
</tr>
<tr>
<td>Solar Panel</td>
<td>4.8</td>
</tr>
<tr>
<td>Inverter</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2011 (Multiple responses and therefore add more than 100%)

4.4 Constraints To The Development Of S&T Infrastructure In Nigerian Educational Institutions

All impediments to the availability of viable and adequate S&T infrastructure in the educational institutions are referred to as constraints in this study. The general constraints identified to the development of S&T infrastructure in secondary schools include lack of qualified laboratory technicians, inadequate laboratory equipment, poor to high quality reagents, poor electricity supply and poor funding among others.

Analysis of the interviews conducted on selected key officials in the respective State Ministries visited, also highlighted some concerns on the constraints and suggestions for improvement of Science and Technology Infrastructures. These responses are presented in Table 4.14, and it shows that inadequate fund (100%) was considered as the major constraint to the development of S&T infrastructure in the education sector. The inadequate number of qualified teachers (80%) and poor electricity supply (60%) were reported by these officials as second and third constraints respectively. Other constraints were poor maintenance culture, poor management of funds and vandalisation of equipment (16.8% respectively).

Table 4.4: Constraints to s&t infrastructure development identified by government officials
Results of the analysis carried out on the suggestions made by government officials to remove the constraints show that all respondents (100%) suggested improvement in the level of funding of education as a strategic way for improving S&T infrastructure development. This was followed by the suggestion on training and re-training of teachers (80%), procurement of electricity generating sets (60%) improved security, proper management of funds and good maintenance culture (about 20% respectively).

**RECOMMENDATIONS**

- **Improved Funding:** To move Nigeria forward technologically, there is need to provide adequate funds to provide all the necessary S&T infrastructures like laboratories, reagents and equipment for secondary schools.

- **Provision of Necessary Amenities:** There is a need for adequate and regular electricity supply and water supply to run the S&T infrastructure in Nigerian Educational institutions. Electricity generators should be provided for the schools to complement power supply by the Power Holding Company of Nigeria (PHCN). All educational institutions should be provided with regular water supply from a well or borehole.

- **Production of Qualified Personnel:** Adequate and qualified personnel (teachers, laboratory technicians) should be provided in the Educational institutions. In addition, there is need to train and retrain these personnel to perform effectively.

- **Good Maintenance Culture and Proper Management of Funds:** Good maintenance culture and improved security of school properties should be imbibed by all educational institutions. In addition, the provision and proper management of funds to source Science and Technology Infrastructure should be taken as a collective responsibility of the educational institutions, the state government, parents, and private individuals/organizations.
5.0 REFERENCES


15

TOXIC WASTES AND LEAKAGES IN THE NIGERIAN EDUCATIONAL SYSTEM: A CATALYST FOR FURTHER REFORMS

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Abstract

Our educational system is no doubt degenerating. On this premise, the paper looked into the causes via detecting the toxic and other wastes as well as leakages which have cataclysmically contributed to this. Some have injected poison into the system, some have created severe/chronic and acute damages that must be flushed out in order to reduce and subsequently eradicate the loss in quality and quantity of our educational system. The paper therefore addressed these under: the present educational system, toxic waste in the educational system, leakages in the educational system, impact of policy implementation on the educational system, impact of technology on the educational system, human capital development and employment policies, the role of whistle-blowing and transformation in the educational development. A critical review of these confirmed that the system is fraught with the existence of wastes and leakages as a result of which necessary reforms should be occasioned to ensure that the following proffered recommendations are relevant in developmental strides – they include; intensifying exchange programmes in Africa and Nigeria in particular, intensifying portfolio experiences for students and organizing workshops and inaugural lectures for Professors and Chief Lecturers to groom younger lecturers five to ten years (5-10 years) before their retirement; among others.

Keywords: toxicity, leakage, catalyst, waste, values transmission, Total quality assessment, knowledge management, whistle-blowing

Introduction

The concerns expressed over the dwindling educational system in Nigeria and indeed in Africa are not a farce. Efforts have been made by governments and people but it appears our Generation X is only interested in education for a different purpose than hitherto was the case. The sporadic technological changes have only triggered up quest for more games, more films, more music and other time killers rather than creativity. The use of whistle-blowing mechanisms has only yielded negative influence. The mechanisms can however, be utilized positively when tailored by the teacher to create educational portfolios for students. The need for value-added outcomes in education, science, technology and innovation is very essential.
The teachers are poorly groomed as a result of lack of facilities and environment. Fear of failure has paved way for misconducts of different types, thus injecting and ingesting toxins and leakages into the educational system. Because of the interest in certification, the lots of manpower available appear to be clearly unusable as they lower productivity instead of the other way round. To some, the challenges of the numerous changes in technology have occasioned confusion and falling standard. The products of the system then culminate into lowered productivity and poor economy, for which everyone is now suffering. Local contents can only be useful when they have been researched into and their usefulness ascertained so that we do not beat about the bush trying to enforce a law that is not economical to the nation. Investment in human and institutional resources if adequately harnessed would yield much fruits for the nation.

Based on the above concerns and affirmed existing problems in the system, the paper reviewed opinions on the following subheadings: The present educational system; Toxic waste in the educational system; Leakages in the educational system; Impact of policy implementation on the educational system; Impact of technology on the educational system; Human capital development and employment policies; The role of whistle-blowing and transformation in educational development; and Necessary reforms as a way forward.

The present educational system

The strengths in education cannot be fully expressed in one text. In education, the individual is equipped for life; the family is financially, emotionally and materially assured; the nation’s growth is secured. The fact that vision 20:2020 cannot be achieved (for any nation) without real-sense education is but a subtle way of stating the truth (Achilike, 2012). Many have described education in many ways, but summarily, it is the instrument for achieving all life’s desires for all. At designated centers (school environment, conference centers) or on-line, the motive of education does not deviate from grooming individuals and groups for the world of work where the ideas, skills and values would be beneficial to self and society. Education could be in business, science, technology, engineering or arts; but every education is meant for business because the individuals and/groups would have to make their ideas, skills and values available to the consumers (users of their products) and earn a living.

Education has come a very long way. This can be seen in the creation of man, the directive not to eat of some fruits and to eat of others. Not excluded is the need to produce covering for man and preparations for wars, midwifery in Egypt, and so on. The system has not been static, hence it has changed so frequently that researchers have often lost count of the varied technologies employed along the line, as some have not been properly documented. Technology, here will be seen as the procedures of human, equipment and processes evolved and involved in the execution of a project. The role of technology therefore has been that of boosting the process of education towards growth of human and materials.
How far have we thrived?

Our educational system and indeed any system at all are aimed at value creation and service delivery. We have encountered new philosophies, theories, concepts, policies, collaborations, peer reviews for different destinations in order to imbibe creativity and solutions creation through entrepreneurship and leadership changes. These are challenges with which this country has been confronted over the years in the sector called ‘education.’ The contemporary education now metamorphosed into an all area programme, thus enlarging her coast and her problems/challenges.

Are we at the breaking point or are we just basking in the banquet of consequences, after messing up our system for several years? According to Okebukola (2013) and Osundare (2013), Nigeria has always gloried in zooming of her growth without commensurate sectionalization in relevant areas, and thereby encouraging poor policies and implementation. Desperation appears to have forced down our educational backbone, lowering the standard for many to meet up. Prof Osundare, in assessing the educational system, blamed its fallen standard on actions and inactions of the publics that make up the system as unscrupulous tendencies towards wealth by these persons (especially politicians) have made them neglect their role towards the growth of the Nation, thus increasing the wastages and leakages witnessed in the system. As a result, the institutions are seriously lacking universality.

The government transitions have welcomed different and new policies/agenda to handle while abandoning previous ones to make an impact. These have embraced lots of wastages and leakages along the line. Has the sector grown as a result? Incidentally, all these policies and agendas that have been structured, have shown incapability of pacifying the yearnings of the consumers (parents, students, employers, society) – Problem-solving is the KEY.

**Toxic waste in the educational system**

Toxic (waste, debts, lack of results) stands for any of such situations that can cause death, injury, defects, and hazards amongst other negativity in human or systemic life. The educational system has witnessed numerous of such toxic situations. Instances can be seen in unqualified teachers who inject poisonous knowledge into students; examination misconducts of different types being introduced into many educational systems in order to register good results and attract more students as a way of prospering in educational business. They spread their contaminating tentacles very fast and consistently if not checked.

Wikipedia (2010) has described this medically as the degree to which a system or environment has been contaminated. It can also be seen as the degree to which a substance can damage an organization. In the metaphorical sense, toxic effect can fall on larger or more complex situations such as in cases of groups like family unit, education or society. In education, we can identify toxicity as that degree to which the educational system of a city, school, local government, state, nation; has been so affected by the hazards of educational dishonesty of different types injected
into it that its functionality is heavily and negatively affected. Newer paradigms and metrics are still evolving on the issue of toxicity for better understanding and knowledge impact.

Whereas there could be domestic, hospital, industrial, chemical, biological, agricultural and radioactive toxicity; there could also be educational toxicity/waste manifested in brain drain, outdated materials, rustic behaviour, poor implementation policy, moribund equipment as affecting manual dexterity, among others. Factors of influence show that pathway of administration could be applied, ingested, inhaled or injected. Its effect could be acute severe chronic or continuous while some can cause irreversible effects.

**Leakages in the educational system**

Leakage here will be taken to mean lose of strength, energy, and former status. Has education sustained its original strength, added or reduced? From records of poor performances in the West African School Certificate examinations (WASCE) and National Examinations Council examinations (NECO); it is obvious that there have been leakages. The National Youth Service Corps (NYSC) has recorded experiences of graduates who could not defend themselves with regard to their areas of study. Some cannot even write an application letter or prepare a resume, unless someone else does it for them. In leakages, there could be loss in quantity or quality. We have often witnessed quantum leap in number not commensurate with growth. A proper planning could help in ensuring an avoidable nature for leakages.

Insecurity is not only restricted to politics, life and property. It exists in the educational sector. Documentations are no longer secured. Knowledge is no longer secured, hence students are often starved to death of knowledge they desired and paid for. Grades and positions are stolen from students and traded while jobs meant for them are taken away by the old who refuse to retire when tired. Students are short-changed in all ramifications and put in danger of their future. On the other hand, educational pacts funded by governments are now heavily restricted for the domain of Chief Executives who can hardly have time for transfer of such knowledge. Have the intelligentsia failed us? No, they have only misdirected their wisdom or are not given the opportunity at all to perform on the ‘dance stand’. Situations where instruments and equipment are purchased and installed but cannot be used is a clear but critical evidence of colossal wastefulness.

In other to checkmate these attitudes, Eruanga (2006) advocated intensification of values transmission and development through education and the role of teachers. On the other hand, Olafintila (2006) saw a mirage in pursuing national development and survival devoid of strategies (mostly educational which is longer lasting and ensures adaptability competence) that can intensity and radiate the existence of confidence and independence in the citizens and the nation as a whole. These, are veritable tools for bridging wastages and leakages.
Impact of policy implementation on the educational system

Every new government regime (tenure) in Nigeria has come up with new policies, different from the previous policies. Some of these die a natural death as soon as a new Minister of Education is appointed. Such changes are capable of creating serious toxic effects in the system. Achilike (2012) revealed the fact that Nigeria has always scored low in the area of implementation of national policies, especially in the educational sector. Efforts have been made by government to stem the tide to avoid further lowering of the standards of education. These efforts appear not to have yielded fruits yet.

Although the awareness to acquire education has expanded, the standard threshold is yet to be attained. Higher number of people still bask in the euphoria of certification with or without knowledge and skill. Incidentally, Amaewhule (2004) was pungent in the assertion that the educational quality of a nation determines her level of development. Standard is that threshold, parameter or benchmarks which determines acceptability or rejection of a quality as being up to or lower than; given all the variables required to meet the goal(s). While NUC (National Universities Commission), NBTE (National Board for Technical Education) and NCCE (National Commission for Colleges of Education) are trying to assess the performance of institutions in order to ensure standard, there is need for independent assessors for the same purpose in order to avoid the situation where these people will assure too much powers that could lead to gratifications (corruption) which the world is battling with today to stop.

Because change is constant, standard cannot help but be constant be as it must change with trend of change to meet current demands, hence the need for education to step up the strategies for eliminating leakages and closing the waste pipes (gaps). Quality assurance, teaching/learning friendly environment, appropriate recruitment and placement are necessary ingredients for solving the toxic, wastage and leakage problems in education.

Total Quality Management (TQM) and Total Quality Assurance (TQA) are both tools that would be very relevant in the avoidance and eradication of wastages and leakages. According to Okoro and Okoro (2004), TQM was conceptualized to admit a zero tolerance for errors in management or in our case, education and other sectors as it is meant to assume a holistic picture.
When each through Total Quality Management (TQM) and teamwork is properly managed, then our quest to achieve vision 2020 will be achieved.

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Efforts in all the above should be geared towards the marketability of education. Neglect of this will would only render education worthless in its bid to meet the yearnings of the consumers. Thus standardization would help in order to have an all round growth and development.

Innovation in addition to science and technology should be encouraged in order to create knowledge economy worthy of emulation.

The 3 technology information centers set up have bandwidths that are so low that only very few can access information at the same time. When added to hotspots it becomes very difficult for R&D to thrive. Human skills base is being paid lip-service.

It must be realized that science, technology and innovation must be marketed for it to be meaningful to any nation. Perhaps this is why our economy appears to be growing very slowly.

**Impact of technology on the educational system**

Technology, which is the study of or a collection of techniques using different tools and procedures to achieve a goal has played a great role in the development or otherwise of a person, group or nation. This idea, according to Achilike (2006), is evidenced in the sporadic changes in technology being witnessed since the last two (2) decades and which has entailed improvement in equipment and accessories, materials, training, market demands, skills required by employers of labour. Thus, the former sequestered environment that hitherto impacted positively on education has gradually been removed by development and technology. New technologies have emerged yet we are far from acquiring and utilizing them in our educational system. Training and re-training necessitated by these developments are yet to be robustly undertaken for the educational system to take full advantage of global developments.

Technology in recent times appears to signify the spring of hope and the winter of despair (at the same time) to nations and people, especially in the Nigerian educational system. While some nations develop the technology, upgrade and improve upon them at a very fast rate, others like mad people are trying to match them in consumption, thereby discarding at a fast rate too and wasting their God given resources in so doing. This is in consonance with Okwuanaso (2004) view that the “tale of two cities” seem to be addressing our generation.

The litany of reasons advanced for poor standard in education abound; faulty teaching methods, dearth of teachers, un-teachable students, funding, lack of equipment and facilities, changes in technology, among others although contributed significantly, they are mostly there basically due to poor values (value orientation). Nigerians see their occupation as avenues for amassing wealth and not to improve the system or to make significant contributions to her growth. Equipments donated are often stockpiled to decorate institutional stores rather than utilizing them for teaching, learning and research. On the other hand, funding often meant to close gaps in the disadvantaged in different zones of the nation have often been misappropriated (spending them on the wrong group through diversions), thus expanding the gap rather than closing them.
Politicized recruitment is gradually being entrenched in our governance as the norm. Can we call this educational meltdown?

**Human capital development and employment policies**

The need for well developed and deployed human capital is very crucial to a nation, more so in the bid for the race towards the vision 2020. Many nations are at it, hence the need to put all machineries in action. Employment policies need to be reviewed by seeking the best hands in critical areas while others can then take the Federal Character policy. Here knowledge management is in dire need to ensure innovation, creativity and problem-solving in our Human Relation (HR) environment.

Zubairu (2006) in differentiating between knowledge and information/data described it as information or ideas to which meaning, use or intent has been attached; while she viewed data as structured/arranged information without interpretation. Information, on its own was seen as any message which has sender and receiver. Whether knowledge, information or data, they are capable of being stored or captured but only knowledge exists in the heads of humans and often times it directs their actions and reactions to events around them. The need to manage knowledge is obvious since it shapes the values of a people and generates attitudes capable of creating more knowledge and sharing ideas for organizational and national growth via intranet and internet metadata transfers for global use.

The knowledge-based giants of United States of America and Europe and Asian Tigers are still clamoring for better action plans for possible improvements. Nigeria cannot afford to be left behind else she will be out of the vision 20:2020 race. In all, education should aim at improved and prompt service delivery to the consumers.

**The role of whistle-blowing and Transformation in educational development**

Education can be fertilized in order to make it more active and proactive by all the individuals and governments involved. The use of whistle-blowing techniques has been intensified by nations worldwide. Such media as Linked-In, face-book, 2go, what-sap, Skill-pages, among others have been employed for the purpose of whistle-blowing. Sometimes, however, these have generated negative outcomes, although their usefulness cannot be ignored. It can be made more useful and meaningful if our youths are groomed on how to use them so that they do not see such media as a place to settle scores with government or other people. Many researchers have accessed literature and ideas through them and these have been very useful benchmark in adding critically to knowledge.

Transformation here means change for improvement in outlook or character (Wikipedia, 2012). We have proposed many transformational moves and yet are scared of changing outlooks, forms or character. The inertia is killing and so must be killed. A starting point is a group (control) and another retaining the status quo ante. That way, decision-making on the degree to which
transformation would be taken will be ascertained/determined and implemented. The situation whereby NASS (National Assembly) tried to quash JAMB (Joint Admissions and Matriculations Board) Pilot study (2012) aimed at using e-examinations in some designated centers across Nigeria is discouraging. These are situations that have revealed the extent of toxicity experienced in the educational system.

**Necessary reforms as way forward**

- Researches should be encouraged to identify ways of reducing and subsequently eradicating the toxins already injected into the educational system.

- Exchange programmes with West African countries and subsequently developed countries for Nigerian students of universities and polytechnics should be commenced; thus intensifying globalization.

- There should be greater intensity for portfolio demands from students of higher institutions. These should also be showcased in Exhibitions from time to time to encourage innovations and initiatives.

- Outstanding portfolios should attract reward or award to Institutions and students, from government funding. Case studies in addition to portfolio would help in education for purposes of retention.

- The educational sector should be deregulated with intensive monitoring, especially in structural facilities and human capital development with emphasis on teaching staff.

- Multi-national companies, which appear to be more and properly automated, should be used for industrial training ground for tertiary undergraduates.

- Professors and Chief Lecturers should be made to host inaugural lectures and workshops for more junior lecturers five to ten (5-10) years before their retirement. That way they would be transferring some unique knowledge they have gathered during their years of experience.

- A lot of journals exist and these should be registered and information from them should be gathered and data-banked for STI Information Management purposes (acquisition, storage and dissemination). The info can be authenticated and used for research purposes and information sharing.

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GAME-BASED LEARNING: A PANACEA FOR BETTER ATTITUDE AND ACADEMIC ACHIEVEMENT IN BASIC SCIENCE

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Abstract

Science is a very potent tool for the development of every nation. Consequently, poor attitude and performance of science students over the years have been a major concern to science educators in Nigeria. This paper reviews the potency of Game-based learning as a tool in enhancing attitude and performance of science students. Research studies reporting poor performance of students and efficacy of game-Based learning are reported. The paper discusses vital aspects of Game-Based learning; such as its rules, importance and guidelines. Some examples of useful games in science are given as well as the website for details. Recommendations are made among which is the need to encourage science teachers to use games in science teaching.

Key Words: Game, Panacea, Science, Attitude, Achievement

INTRODUCTION

Science is concerned with making discoveries and understanding the environment. It is an intellectual and practical activity, a systematic study of the structure and behaviour of the physical and natural environment, through observation and experimentation. Science presumes that the things and events in the universe occur in consistent patterns that are comprehensible through careful, systematic study. Scientists believe that through the use of the intellect, and with the aid of instruments that extend the senses, people can discover patterns in all of nature.

The reason for inclusion of Science in the school curricula is quite enormous because of the diverse vantage points it places learners as individuals and as members of the society. Among the reasons that can be provided to explain why science is included as a component of Basic Education Curriculum are the following:

- Science helps students to explain events in nature enabling them to identify those beliefs that are superstitious
- Science teaches children how to think and reason in a logical manner
- Science teaches students how to solve simple problems they encounter on a day to day basis.
- Science helps students to develop their physical skills e.g. through the proper handling of objects and equipment e.g. microscope.
• Science enables students to develop their physical skills e.g. establishing friendship while working co-operatively in groups.
• Science helps students to satisfy their natural curiosity through opportunities to carry out scientific investigations.
• Science helps to prepare students for future careers in medicine, pharmacy engineering etc.
• Science helps students to understand, use and control their environment.
• Science helps build a solid foundation for production and employment.
• Science brings about improvement in our economy.
• Living is more meaningful with the application of scientific knowledge (National Teachers’ Institute, 2012)

STUDENTS’ ATTITUDE AND ACHIEVEMENT IN BASIC SCIENCE

The importance of science and technology in the area of economic and political development of any nation in the world made its teaching to be accorded a lot of importance (Kyle, 1997). On a similar note Okpala (1995) noted that it is necessary for Nigeria, a developing nation, to gear more efforts towards authentic development of science and technology by promoting science teaching and learning in schools.

Various science educationists have shown that students perform poorly in science subjects in Nigeria (Aghadiuno, 1995; Uwadiae, 1997; Farombi, 1998 and Agwagah, 2001). Also, some other researchers (Adeyegbe, 2004; Nwosu, 2000 and Oloruntegbe and Omoifo, 2000) reported not only the downward trend in the achievement in science but also the results getting worse and the recipients getting progressively unscientific in their thought pattern and approach to solving problems.

The poor performance of students in science subjects has been attributed to:

i. Poor quality of science teachers whose methods of teaching-excessive teacher talk, copying of note, note learning of text-books materials tend to inhibit interest
ii. The prevalent expository method of instruction rather than inquiry with very little involvement of students in experimentation
iii. Lack of laboratory facilities and equipment necessary for practical work

Some researchers such as Akinmade (1992), Nwosu and Nzewi, (1998) reported poor professional training, poor academic background of teachers as the main factors for the low performance of students in science subjects. Hillac (2002) said that academic achievement depended most heavily on students’ personal conviction of being in charge of their own fate in the learning situation. Kuppuswamy (2002) also noted that an important factor resulting in lower levels of achievement is the fear of failure. He explained that this will haunt some students to the point of where they will not be able to take part in any problem solving test. He further argues that achievement has certain symbolic meanings for the individual, which arouses anxiety and inhibition following it, leading the student/individual to shy away from achievement itself.

In general, the various studies which attempt to explain academic achievement and failure do so beginning with the three elements that intervene in education: parents (family causal factor) teachers (academic casual factors) and students (personal causal factors). Among personal variables...
most studied are motivation and self-concept. Motivation is considered to be the element that initiates the subjects own involvement in learning; when a student is strongly motivated, all his efforts and personality are directed toward the achievement of specific goals, thus bringing to bear all his or her resources.

According to Gonzalez (1997), a consensus exists among the diverse motivational theories and approaches in as much as they conceptualize motivation in terms of conscious beliefs and values. Other authors have found that students themselves attribute low performance to low ability and to luck (Valle, 1999) and an improvement in performance to motivation (task goal orientation), to self-regulating behaviours and to competence as a function of task characteristics (Slater, 2002).

Of recent Yore, Anderson and Shymansky (2002) aimed to model the relationships of classroom characteristics and students’ attributes to students’ science achievement. The researchers used hierarchical linear modelling on TIMSS and Science Co-op Local Systemic Change Project data. As results, classroom factors influenced the weightings of significant student attributes, such as, awareness of nature of science, attitude towards science etc Papanastasiou (2002) aimed to investigate the school, teaching and family influence on students’ attitudes toward science in Cyprus using TIMSS 1995 data and structural equation modelling with LISREL. In the resulting path model, the highest correlation among the latent variables of family, reinforcement, teaching, and climate was the correlation between attitudes and teaching.

Halladyna and Shangnessy (1982) have concluded that a number of factors have been identified as related to students’ attitude to science. Such factors include; teaching methods, teacher’s attitude, influence of parents, gender, age, cognitive styles of pupils, career interest, societal view of science and scientists, social implications of science and achievement. Studies have revealed the influence of methods of instruction on students’ attitude towards science.

**GAME-BASED LEARNING**

One of the biggest problems in all formal learning is keeping students motivated enough to stick with the learning process to the end of e.g. a lesson, course, term/semester, Playing Is an important part of children’s cognitive and social development A child learns through playing with others, creating, and improving his or her stage of development offers cognitive support needed to develop higher order mental processes, initiates the symbolic use of objects and first form of symbolisation (first step towards abstract thinking)

In a bulletin published by Bern University of Applied Sciences, several elements were highlighted which defines an activity as a game as follows:

- **Competition**: the score-keeping element and/or winning conditions which motivates the players and provide an assessment of their performances. Note that players are not necessarily competing against each other. In fact a lot of games have players working as a team to overcome some obstacle or opponent built into the game.

- **Engagement**: Once the learner starts, he or she does not want to stop before the game is overlapped and Cordova (1992) refer to this phenomenon as ‘Intrinsic Motivation’ and ascribe it to four sources: challenge, curiosity, control and fantasy.
• **Immediate Rewards**: Players receive victory or points, sometimes even descriptive feedback, as soon as goals are accomplished.

Learning requires efforts, and students rarely do it without motives such as Intrinsic goals, extrinsic rewards, psychological factors; like fear and need to please (Adesoji, 2008). Play and learning are related. When playing games, students actively see and do, rather than read and listen, as they complete increasingly difficult levels of learning. They are personally involved in what they are doing, and therefore, more motivated to retain what they have learned. The process of learning is often experienced as painful. The process of game-playing is generally engaging. If school activity would be treated in terms of learning, playing, and helping, then children could be more thoroughly engaged in the learning process.

Today's children grow up with computer technology (“Game Generation”). They are capable of processing large amounts of visual, textual, auditory data and demand to be taught in ways that they are comfortable with and not satisfied with traditional learning methods. It is not out of place therefore to conceive and utilise various forms of games especially digital games to impact learning in science classrooms. Computer games offer a programmed environment by which the student can play, experiment, and learn from mistakes and get feedback. Active learning, learning by experience, discovery learning which vital components of learning science are are all achieved through games.

**OBJECTIVES Of GAME-BASED LEARNING**

The objectives of Game-based learning include the following:

- To make learning meaningful to students
- To create a learning culture that is more in correspondence to student’s interests and learning styles
- To create learning environments that actively involve students in the problem and enable them to understand the complex situation
- From “learning by listening” to more active “learning by doing”
- To provide a rewarding experience to many people with the application of computer games

**CATEGORIES OF COMPUTER GAMES**

- Action games
- Platform-jumping games, falling things that must be shot
- Adventure games
- Find the way around the unknown world, solve puzzles
- Simulation games
- Building worlds or companies, flying, driving,
- Fighting games
- Two characters battle each other
- Puzzler games
- Problem solving, presented graphically
- Role-playing games
IMPORTANCE OF GAMES IN LEARNING SCIENCE

So many positive effects accrue from using games to learn. Some of the benefits of Game-Based learning in science include:

- Games are useful in presenting repetitive learning in normal ways
- Games help in creating awareness, reinforcing facts and knowledge, teaching skills and building values.
- They provide a participatory effect in learning especially in sciences
- Games increase motivation, attention and concentration
- Immerse them in the material so they learn more effectively
- Encourages them to learn from their mistakes
- Enhances tutoring, exploring/practising skills, entertainment and attitude change.
- Computer gaming skills serve as precursor for computer skills.
- Improves problem-solving ability and creativity which are vital components in science learning.
- Support cognitive processing, strategic skills and critical thinking
- Increases learning and memory capabilities
- Accommodates different learning styles

In a study carried out by Papastergiou(2009) to assess the learning effectiveness and motivational appeal of a computer game for learning computer memory concepts, which was designed according to the curricular objectives and the subject matter of the Greek high school Computer Science (CS) curriculum, as compared to a similar application, encompassing identical learning objectives and content but lacking the gaming aspect. The study also investigated potential gender differences in the game’s learning effectiveness and motivational appeal. The sample was 88 students, who were randomly assigned to two groups, one of which used the gaming application (Group A, N = 47) and the other one the non-gaming one (Group B, N = 41). A Computer Memory Knowledge Test (CMKT) was used as the pretest and posttest. Students were also observed during the interventions.

Furthermore, after the interventions, students’ views on the application they had used were elicited through a feedback questionnaire. Data analyses showed that the gaming approach was both more effective in promoting students’ knowledge of computer memory concepts and more motivational than the non-gaming approach. Despite boys’ greater involvement with, liking of and experience in computer gaming, and their greater initial computer memory knowledge, the learning gains that boys and girls achieved through the use of the game did not differ significantly, and the game was found to be equally motivational for boys and girls. The results suggest that within high school CS, educational computer games can be exploited as effective and motivational learning environments, regardless of students’ gender.

Similarly, a research published by University of Rochester neuroscientists, Shawn Green and Daphne Bavelier suggested that playing "action" video and computer games has the positive effect of enhancing student's visual selective attention.
GUIDELINES IN USING GAMES TO TEACH

The National Teachers Institute (NTI, 2012) in Nigeria stipulated the following guidelines in using games to teach:

- Games should be simple to play
- They should have simple rules
- Competition should not be emphasised
- Skills should be demonstrated
- Related concepts should be clearly illustrated by the game
- Teacher should discuss the main concepts of the game conveyed after the game
- The game should be adapted for the needs of a particular level of pupils
- Assess the value of the game before using it to teach pupils

EXAMPLES OF SOME GAMES USED IN SCIENCE TEACHING

There are diverse kinds of games, which a science teacher can use to make science teaching and learning interesting and appealing to science students. Details of these games are available at http://mint.ua.edu/games. Some examples include:

- Simple Machines
- School of elements – Back to school
- Rocks Rock
- Discovering the Periodic Table
- Chemical Connection
- Assay – Mania
- Chemical Mix up etc.

CONCLUSION

When games are used in teaching science, students become lively and actively involved in learning. The challenge of the science teacher is thus to meaningfully incorporate them as vital aspects of the lessons in order to make learning fun and to make the games more useful. This paper is just one small part of a very important message that all parents and science educators need to hear which is that Video games, computer games and other games are not to be avoided, but are part of the best opportunities available to engage the present generation students in real and interesting learning, especially in sciences. Game-Based learning could prove useful in addition to traditional teaching, learning methods especially for students, who lack motivation to adopt new attitudes towards learning of science.

RECOMMENDATIONS

The following recommendations are made for use of games in learning science:

- Science teachers should be encouraged to incorporate relevant games in science lessons
• Specialists in digital games should be made to create more and easy-to-access websites with details of interesting games on science concepts for use by science teachers and students
• School administrators should invite game professionals to train science teachers on game-based learning
• Relevant scientific games should be incorporated in the Basic science curriculum and some aspects of continuous assessment based on them
• Adequate number of computers configured with scientific games should be supplied by the federal Government to secondary schools and Basic science students allowed access to them especially at break times.

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DOMESTIC ENERGY NEEDS AND NATURAL RESOURCES CONSERVATION:
THE CASE OF FUELWOOD CONSUMPTION IN NIGERIA

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Abstract

Apart from air, water and food, energy is the most important item for human survival. It is essential for meeting various domestic, industrial and commercial obligations. Kerosene, electricity, gas and fuelwood are however, the major sources of domestic energy in Nigeria. The paper examines the role and challenges associated with the use of fuelwood in Nigeria. Desk research on energy utilisation, rate of deforestation and alternative sources of energy provided data for the paper. Content analysis of available data was used in the preparation of the paper. The paper revealed that domestic energy accounts for more than 50 per cent of the total energy consumed in Nigeria. The paper further shows that fuelwood provides energy for more than 60 per cent Nigerians and also responsible for meeting 80 per cent of domestic energy needs. Again, majority of Nigerians adopted fuelwood for meeting domestic energy needs due to the high level of poverty, inadequate infrastructure and lack of political-will to address the country’s energy challenges. The paper therefore recommends the use of gas, kerosene and electricity for domestic energy needs in order to conserve the nation’s forest resources, prevent loss of biodiversity and conserve the ground water.

Key word: domestic energy, fuelwood, Nigeria

INTRODUCTION

Energy is a basic necessity of life for meeting domestic, social and industrial needs. Adequate and regular energy supply for industrial and domestic purposes are prerequisites for keeping socio-economic life moving. Energy is required at all times for meeting various purposes especially at the household levels. Life becomes difficult and meaningless without the availability of adequate and regular energy supply for domestic needs.

Energy for domestic purposes is determined by two major factors: availability and affordability. This implies that energy must be readily available and the price must be within the reach of the people especially the poor. Making energy available to all and sundry in a particular society is a measure of level of economic development of that particular society. For example, in advanced economies like UK, USA and France, majority of their population have access to cheap and affordable energy supply because they are technologically advanced. The necessary energy infrastructures are available while the costs of energy are affordable by the majority of the people. The reverse is however the case with people living in low income country like Nigeria, where the purchasing power of large proportion of the populace is low while necessary energy infrastructure are not in place. Thus, majority of the people do not have access to energy sources of their choice. In addition, there is lack of adequate energy infrastructure and adequate energy supply.
compounds the problems of energy availability. Overall, most of the developing nations do not have access to cheap, reliable and environmentally friendly energy sources.

This paper aims at discouraging the use of fuelwood for domestic energy needs in order to protect the nation’s forest resources with a view to reduce global warming. This paper was prepared through content analysis of data obtained from various published materials.

1 SOURCES OF DOMESTIC ENERGY IN NIGERIA

Nigeria is a developing economy with human population of about 144 million and total land area of 923.8 square kilometers (World Development Indicators, 2006). The population of urban dwellers is about 67 million (48 per cent) while that of rural dwellers is 73 million (52 per cent). The implication of this demographic structure is that large amount of energy will be required for meeting obligations at both the urban and rural areas in the country.

The rural dwellers, whose needs are often basic, depend to a large extent on the traditional sources of energy for their domestic energy requirements while the majority of the urban dwellers depend on traditional energy sources and fossil fuels. However, the high level of poverty and other socio-economic problems inhibit both the rural and urban dwellers from having access to adequate and reliable sources of energy for domestic purposes.

In terms of energy availability, there are various ample energy sources in Nigeria such as wind, solar, hydro, coal, oil and gas etc, which if properly managed will alleviate energy problems of the people most especially for domestic consumption. Obviously, Nigeria is naturally endowed with oil and gas and depends on it for her economic development. For example, oil accounts for 80.5 per cent of national revenue (CBN, 2007). These two energy sources are the major export commodities that provide foreign exchange for the country. Oil and gas also play major role in meeting energy needs of the various sectors of the nation’s economy. For example, gas, petrol, diesel and kerosene provide energy for wide industrial and domestic application.

Apart from oil and gas, other energy sources such as electricity, wood and coal also play significant roles in meeting energy demands in the country. However, among all these energy sources, only fuelwood is mostly available and utilized almost everywhere in the country for meeting domestic energy needs. Other energy sources are scarce most especially in the rural areas where fuelwood is their major energy carrier.

Adetunji (2007) opined that energy option of any country is influenced by national economic condition, individual level of income, technological advancement, the state of energy infrastructure as well as the rate of population growth. The Nigerian energy sector is not well developed based on the fact that despite abundance various energy sources in the country, majority of the people are yet to have access to affordable and reliable energy. Iwayemi (2008) opined that Nigerian energy sector is probably one of the most inefficient in meeting the energy needs of its people. This is most evident in persistent disequilibrium in the market for electricity and petroleum products, especially kerosene and premium motor spirit (PMS).

The energy dependent sectors of Nigerian economy are domestic, transport, industry, agriculture and commerce. Apart from their energy intensiveness, the periodic total energy demand of each of these sectors varies. In addition, the source(s) of energy for the various sectors also differs. For example, the transport sector depends on the premium motor spirit (PMS) for light vehicles such as cars and buses, automotive gas oil (AGO) for heavy-duty vehicles (lorries and trucks) and rail engines. It is estimated that 74 per cent of local petroleum products supply is consumed by the transport sector in the country (Sambo, 2005). The industrial sector depends on electricity, diesel and gas for meeting their energy needs while the agricultural sector depends on AGO and gas for propelling machine in fertilizer production. The household sector which requires large amount of
energy for cooking, boiling, heating and lighting however depends mostly on fuelwood and partially on electricity and kerosene in many countries across the globe.

2 THE SIGNIFICANCE OF DOMESTIC ENERGY

The significance of domestic energy in the overall well-being of the people cannot be over-emphasized. The various household energy requirements account for the largest quantity of energy consumed among all the other sectors of the economy. This is based on the fact that energy is required for cooking, lighting, heating, boiling, and operation of various domestic appliances among other needs. More so, energy is required almost throughout the day for running these appliances and for lighting. In addition, various categories of people (adult and children) spend most of their time at home and hence depend on energy to make their lives at home comfortable. The level of consumption of domestic energy varies across the globe. In most of the Organization for Economic Cooperation and Development (OECD) countries for example, domestic energy consumption accounts for 40 per cent of total energy use (Kerby, 2008). This figure will increase due to rapid rate of construction in both developing and developed countries. However, heating, lighting, domestic appliance use and cooling equipment gulped 11 per cent of global energy figure (Kerby, 2008).

In developing countries like Nigeria, the level of domestic energy consumption is also the highest among all the other sectors of the economy. The domestic sector consumed more than half of the total energy consumption in Nigeria (Ikuponisi, 2006). Earth Trends also estimates the Nigerian domestic energy consumption figure in 1999 to be 79.5 per cent of total national energy consumption. The energy commission of Nigeria (ECN, 2003) stated that domestic sector accounts for over 50 per cent of the grid electricity consumed and more than 50 per cent of the total energy produced in the country. The sector is therefore the highest energy consumer in the country because it gulps more than half of the total energy supply in the country.

3 THE ROLE OF FUEL WOOD IN ENERGY SUPPLY IN NIGERIA

Fuel wood has been a major source of energy for many countries across the globe for several years back. It is the oldest energy source in most of the developing countries worldwide. The high level of poverty, inadequate knowledge about other energy sources as well as other social diseases are responsible for the adoption of fuelwood as a major energy source in many countries of the world. This scenario has continued to exist in poor countries that lack the required technology and resources to adopt and utilize other energy sources. Developed nations rely on electricity, gas and solar energy for meeting their domestic energy needs. Serious intensification of technological advancement effort has led to the identification, exploitation and utilization of other energy sources in most of the technologically advanced countries. As a result, various energy sources such as nuclear, wind, solar among others are developed and utilized for the generation of energy. Globally, more than 2 billion people depend on fuel wood for meeting their energy needs (Adetunji, et al, 2007). Almost all African countries rely on fuelwood for meeting their domestic energy needs (Sambo, 2005). In addition, fuel wood had a share of between 60 and 86 per cent of African energy consumption, except South Africa. In most of the countries in Sub Sahara Africa, fuel wood accounts for 80 to 90 per cent of residential energy consumption.

One major energy problem confronting the developing countries like Nigeria is that majority of their people lack access to energy sources and therefore mostly depended on fuelwood for most of their energy needs. Most of the rural dwellers in Nigeria depend on fuelwood for their energy. Fuelwood is used by more than 60 per cent Nigerians living the rural areas (Sambo, 2005). Apart from domestic energy purposes, fuelwood is also used in other sector of the economy such as cottage industries. For example, in most of the bakery industry, fuelwood is used for providing heat
for baking bread. More importantly, fuelwood is used mostly in cooking large quantity of several food items used in social occasions in the country. Nigerians consume over 50 million metric tons of fuelwood annually, a rate, which exceeds the replenishment rate through various afforestation programmes (Sambo, 2006).

Table 1 shows the level of consumption of fuelwood for meeting energy needs in Nigeria. The table shows an increase in the level of production and utilization of fuelwood for domestic and industrial purposes. A critical analysis of the table shows that between 1997 and 2006 (a ten year period), about 23,787 thousand cubic meter of fuelwood was the marginal increase in the level of fuelwood consumption for meeting domestic energy needs in the country. In addition, the table shows a steady percentage increase of 72.3 per cent in the yearly fuelwood consumption for domestic energy purpose. Fuelwood is therefore playing a very significant role in domestic energy needs in the country.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Production</th>
<th>Household Consumption</th>
<th>Percentage of Total Production</th>
<th>Industrial Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>152433</td>
<td>110194</td>
<td>72.3</td>
<td>31069</td>
</tr>
<tr>
<td>1998</td>
<td>156500</td>
<td>113134</td>
<td>72.3</td>
<td>31897</td>
</tr>
<tr>
<td>1999</td>
<td>156516</td>
<td>113145</td>
<td>72.3</td>
<td>31901</td>
</tr>
<tr>
<td>2000</td>
<td>160272</td>
<td>115861</td>
<td>72.3</td>
<td>32666</td>
</tr>
<tr>
<td>2001</td>
<td>163959</td>
<td>118526</td>
<td>72.3</td>
<td>33418</td>
</tr>
<tr>
<td>2002</td>
<td>167973</td>
<td>121428</td>
<td>72.3</td>
<td>34236</td>
</tr>
<tr>
<td>2003</td>
<td>172098</td>
<td>124410</td>
<td>72.3</td>
<td>35077</td>
</tr>
<tr>
<td>2004</td>
<td>175884</td>
<td>127147</td>
<td>72.3</td>
<td>35848</td>
</tr>
<tr>
<td>2005</td>
<td>179754</td>
<td>129944</td>
<td>72.3</td>
<td>36667</td>
</tr>
<tr>
<td>2006</td>
<td>185357</td>
<td>133981</td>
<td>72.3</td>
<td>37789</td>
</tr>
</tbody>
</table>


Fuelwood has assumed a major role as domestic energy source in Nigeria as a result of several factors such as poor state of the economy, inadequate infrastructure and lack of good political will. Among all these problems, the poor state of Nigerian economy is the most significant problem confronting majority of the people (Sambo, 2005). The poor condition of Nigerian economy which manifests in form of widespread poverty has several implications on the people.

In the first instance, poverty is a social disease that affects large section of the Nigerian populace with numerous impacts on the socioeconomic well being of the people. Secondly, poverty is a multi-dimensional social malady that cut across the several ways of life of the people such as feeding habits, style of dressing and overall living standards including their choice of energy. About 70.8 per cent Nigerians are poor, living below US$1.00/day (World Development Report, 2007/2008). This condition forces majority of the poor to depend on fuelwood for energy since they could not afford other energy sources like kerosene, gas and coal regularly. The rural poor for example, only need to travel for a short distance from their home, to collect fuelwood. The rural poor, for example, only need to travel for a short distance from their home, to collect fuelwood for meeting their domestic energy needs without any financial implication. More importantly, many people have resulted into cutting, collection and gathering of fuelwood as employment opportunity and means of livelihood. This situation is very common in most of the rural areas in Nigeria where jobless youths and adult (male and female) have adopted gathering of fuelwood as a major employment to complement their farming and other petty trading activities.
In addition, poor state of social infrastructure has become a clog in the distribution of energy to all parts of the country. The infrastructural problems such as poor distribution of petroleum products, lack of good road network, inadequate generation and distribution of electricity among other things inhibits several millions of Nigerians from having access to social services. This situation forced majority of Nigerians to adopt fuelwood for meeting their domestic energy needs and so adversely affects their living condition. Poor infrastructural facility has contributed largely to increase in the level of poverty in this country. As a result, large proportion of the rural dwellers, do not have access to electricity, pipe-borne water and energy goods. They depend on streams and wells for water supply and fuelwood for their energy needs.

The prevailing poor road network of the country inhibits many people from having access to energy goods. Lack of good roads contributed to increase in the prices of goods in the country. This makes prices of kerosene and other energy goods to rise beyond the reach of the poor. The only alternative left for the poor is to adopt fuelwood for their energy needs.

The inadequate state of electric power generation and poor distribution system in the country also limits majority of Nigerian citizens to the use of fuelwood for meeting their domestic needs. More importantly, the supply and distribution of petroleum products in the country is not encouraging. Many people cannot afford to buy kerosene for their domestic purpose. Where the product is available, it is sold at prices more than 50 per cent above what the urban dwellers are paying.

Inadequate and poor condition of infrastructure, especially, the energy infrastructure prevents people from getting regular supply of energy in Nigeria. For example, the four public refineries and private ones in the country cannot guaranteed adequate production of petroleum products for local consumption. In addition, there are inadequate number of petroleum products depots and vehicular transportation to handle the products storage and distribution to all parts of the country. This situation also contributes to increase in the prices of petroleum products and therefore forces the poor to adopt fuelwood for their energy needs.

Absence of good political-will to deliver essential goods to the people is another reason why many Nigerians adopt fuelwood as their major energy source. On many occasions, there is inadequate supply of petroleum products in the country. Also, under the aegis of deregulation, the prices of energy sources often go up beyond the reach of the poor. The federal government of Nigeria (FGN) has carried out upward deregulation of the petroleum products prices in order to raise its revenue and reduce level of subsidization. This condition has forced the prices to go up thereby forcing so many people to adopt fuelwood as their energy source.

Absence of good governance can also translate to social unrests and criminalities. A lot of social infra-structures were vandalized in Nigeria due to government’s insensitivity to the plights of the people. For instance, on many occasions, electricity, gas and oil infrastructure such as cables, transformers pipelines and installations were vandalized thereby leading to artificial scarcity of energy thus forcing people to adopt fuelwood to meet their energy needs.

### 4 THE ECOLOGICAL, HEALTH AND ECONOMIC IMPLICATIONS OF USING FUELWOOD FOR DOMESTIC ENERGY

The use of fuelwood for meeting domestic energy needs has several ecological, health and economic implications. All these have significant impact on man’s social life because human live greatly depends on them. It is obvious to note that good health promotes economic development activities while environmental resources have several implications on human health and economy.

The environmental effects of fuelwood consumption include: desertification, soil erosion and high rate of soil fertility loss. The rate of fuelwood consumption far exceeds reforestation rate. The current economic condition of the country greatly favours continuous utilization of fuelwood for domestic and other energy purposes. Sambo (2006) estimates that about 350,000 hectares of forest
and natural vegetation are lost annually due to various factors, with a much lower afforestation rate of 50,000 hectares/year. Fuelwood consumption is one of the major factors accounting for deforestation in Nigeria. The adverse effects of deforestation are many and demand urgent intervention. Deforestation leads to soil erosion, affects groundwater level and negatively affects soil fertility. Forests are habitat for wild animals. Once the forest is removed, the animals become homeless and flee to another place for their survival. Forests also act as sink for carbon dioxide, a greenhouse gas that causes climate change and global warming. The impacts of climate change are numerous and its consequences are beyond what a poor nation like Nigeria can afford. In addition, most of the trees and shrubs used as fuelwood are part of the biological diversity that provides food, medicine and aesthetic value to the nation. A lot of trees and shrubs of various species have disappeared. Continuous dependence on fuelwood for domestic energy will increasingly have negative effects on the economy and social life of the people. Women and children are involved in the collection and transportation of fuelwood from the bush to the home. On many occasions depending on the situation, they have to travel far and wasted their time in the process. At times, women have to carry heavy loads to reduce the number of trips required to provide fuelwood for their households. They may head-load fuelwood as heavy as 35 kilogram or more over a long distance of up to 10 km in often difficult terrain. Carrying such heavy loads over long distance has adverse health implications on the women especially those within the child-bearing age. This may damage spice and cause difficulties during pregnancies and childbirth because substantial amount of energy is involved coupled with poor access to good medical facilities in most of the rural areas in Nigeria. Fuelwood scarcity may cause changes in the nutritional intake of the people. It may lead to fewer meals being cooked as well as meals being cooked less well. Fuelwood shortage may lead to shift to food items that require less energy to cook, which may be nutritionally poor. Most of the protein food of plant origin such as cowpeas, soybeans, lima beans, groundnut and so on, required large amount of heat and often take longer time to cook unlike starchy foods that require small amount of heat and short time to cook.

5 THE NEED FOR ALTERNATIVE ENERGY SOURCE FOR DOMESTIC USE

Nigeria is expected to experience shortfall in fuelwood supply. This is because the nation forest area is depleting. Nigerian forest has experienced an annual average forest change of -2.4 between 1990 and 2005 (Human Development Report, 2007/2008). This shows that between 2005 and 2009, the nation’s forest is expected to have diminished further due to increase in population and harsh economic condition. As a result, many trees and shrubs will be harvested for energy purpose. The country is therefore expected to witness an imbalance between demand and supply of fuelwood. Population growth translates into increase in the demand for energy. Nigeria is a country that is currently experiencing increase in human population. This will lead to increase in the demand for fuelwood both in the rural and urban areas unless there is a reversal of attitude. The increase in the rate of urbanization in the country may not alter the dependence on fuelwood for domestic energy. This is because most of the urban dwellers that are economically poor would still rely on fuelwood for their various domestic energy needs, most especially for cooking. The above scenarios show that the nation forests are in danger. Nigeria cannot afford to allow its forests to continue to experience an increasing rate of deforestation due to the various economic and social impacts. Therefore appropriate measures must be taken to reverse the ugly situation.

6 THE WAY FORWARD

The need to provide adequate domestic energy supply through other energy sources apart from fuelwood is a necessity in the process of achieving efficient energy utilization and protection of
forest resources in Nigeria. The various available natural energy options in the country should be utilized for meeting domestic energy needs in Nigeria. There is a strong need to develop the various energy resources in the country.

The issue of climate change must be taken into consideration by ensuring a great reduction the volume of carbon dioxide being emitted into the atmosphere through energy generation and utilization. Clean energy sources that emit very low to zero quantity of carbon dioxide into the atmosphere should be given a very priority in energy development agenda of the country.

However fossil fuel has to be depended upon as a major energy source in the country due to its large deposit in the country. The need to depend on fossil fuel is also based on the fact that Nigeria has the capability to develop and install the necessary infrastructure like refineries, depots and means of transportation that will ensure adequate energy supply in the country.

Pending the time when clean energy sources are available for domestic use in Nigeria, kerosene and gas should be provided for the Nigerian populace. In the first instance, Nigeria has the potential of making kerosene available to both the rural and urban dwellers in the country because there is abundant crude oil and we have the capability to refine it. This will ensure adequate production of petroleum products locally.

REFERENCES


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EFFECT OF GENDER ON STUDENTS’ ACHIEVEMENT IN CHEMISTRY USING INQUIRY ROLE INSTRUCTIONAL MODEL

H.C. O. Aniodoh and Joy Johnbest Egbo

Abstract

This study was designed to investigate the effect of inquiry role instructional model on students’ achievement in chemistry. Two research questions and two null hypotheses were formulated to guide the study. It was conducted in public single sex secondary school in Enugu Education zone of Enugu state, Nigeria. Purposive sampling technique was used to select the four schools from the population of twenty-three schools. A sample of 141 SS2 chemistry students was used. Researchers developed instrument, Chemistry Achievement Test (CAT) was used to collect data for both pretest and posttest. Mean and standard deviation scores were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at alpha level of 0.05. The findings showed that students taught with inquiry role instructional model achieved higher than those taught with expository method. It was also found that the female students performed better than their male counterparts when taught using inquiry role instructional model.

Keywords: Inquiry-role, Chemistry Achievement Test, Team members, assigning roles

INTRODUCTION

Science plays a very important role in the development of any nation. Science is a way of thinking in pursuit of understanding nature, a way of investigating and a body of established knowledge (Aniodoh, 2012). Science therefore is very crucial in shaping the way we think, explore, generate and apply knowledge about our environment. The importance of science in national development can hardly be over emphasized, for according to Ivowi, (2003) The development of a nation depends largely on the level of scientific and technological literacy possessed by the citizenry.

Chemistry is a branch of science which deals with the studies of the structure, composition, properties and reactions of matter in different forms. Chemistry is very important in the technological development of the nation. According to Asiyai (2005),

Chemistry has helped in the development of modern technology through the application of its principles in modern invention. The problem of students’ persistent underachievement in chemistry is undoubtedly worrisome and has been a major concern to the researcher. Several studies have revealed unimpressive academic achievement in chemistry at the secondary school level in Nigeria. This problem, if not nipped in the bud, will have adverse consequences on the students and the society at large, given the importance of chemistry in Nigeria’s scientific and technological development.

The West African Examination Council (WAEC), Chief examiners report(2006-2010) and a study by Eze and Egbo (2007) have attributed the observed student’ poor achievement in chemistry to use of inappropriate and ineffective teaching method by chemistry teachers. Ebenebe and Unachukwu(1995)
opined that the principle function of pedagogy is ensure that ideas and information are meaningfully presented, clear and retained over a long period of time. There is therefore, the need to explore innovative methods for effective teaching of chemistry so as to enhance students’ achievement in the subject.

One of such innovative methods is the inquiry role instructional model which is a teaching method that is designed for small groups of students. Inquiry role instructional model has been found to enhance full participation of by team members, with each member being assigned a specific role. Each role has a set of related tasks assigned as the role responsibilities of the person who is performing the role. The roles are: Team coordinator, Technical advisor, Data recorder, Process advisor (Martin, 2004). Team coordinator: coordinates team discussions and decision, clarifies team direction. Technical advisor: assists team coordinator in analyses, leads team in technical aspect of laboratory. Data recorder: records and directs recording of data and notes of team discussion; checks for consistency in records and between records. Process advisor: leads team in analysis of team interaction, identification of strengths and weaknesses, planning actions to improve team work.

Inquiry role instructional model has been found to be beneficial to students by giving them the opportunities to develop and use social and inquiry skills which enables them to participate as responsible members of the team (Bingman, 1994).

The inquiry role has been found to be efficacious in fostering students’ achievement in some school subjects, but there is paucity of research evidence on its use in chemistry teaching in Nigerian secondary school system.

Gender as a factor in science achievement has generated a lot of concern for science educators. Ocho a science educator (1997) observed that female students achieve better than male students in science. Mama (1995) found out that boys perform significantly higher than girls in science. Ezeudu (1995) observed that sex has significant effect in favour of females in cognitive achievement. This shows that there is controversy on science achievement by gender. This underscore the need to investigate the effect of gender on students’ achievement in chemistry using inquiry role instructional model.

The main purpose of the study is to determine the effect of inquiry role instructional model in teaching chemistry when compared with the expository method of instruction. The study specifically intended to:

(1) determine the effect of inquiry role instructional model on students’ achievement in chemistry

(2) ascertain the effect of inquiry role instructional model and expository method on male and female students’ achievement in chemistry.

Research questions: The following research questions were posed to guide the study (1) what are the mean achievement scores of students taught chemistry using inquiry role instructional model and those taught by expository method of instruction

(2) what are the mean achievement scores of male and female students taught using inquiry role instructional model and expository method of instruction respectively as measured by Chemistry Achievement Test (CAT)

Hypotheses: Two null hypotheses tested at 0.05 level of significance guided the study
There is no significant difference in the mean achievement scores of SS2 chemistry students taught with inquiry role instructional model and those taught with expository method.

There is no significant difference in the mean achievement scores in chemistry between male and female students taught with inquiry role instructional model as measured by Chemistry Achievement Test.

**METHOD**

The design of the study is quasi experimental; Research design. Specifically it is pre-test, non-equivalent control group design. The design was used because of non-randomization of subjects. The research subjects were not randomized because of problems of re-arrangement or re-grouping of intact classes. The population for the study consisted of all senior secondary class two (SS2) chemistry students who were offering chemistry in public single sex schools in Enugu Education Zone in the 2010 / 2011 session, numbering seven hundred and ninety-seven (797) (Statistics Units Post Primary Schools Management Board Enugu.) Single Sex schools were used to avoid gender interaction since gender is a factor in the study. The sample consisted of one hundred and forty one chemistry students. Simple random sampling technique was used to select two males and two females schools. In each of the sampled schools, all the SS2 chemistry students were used as research subjects. Chemistry Achievement Test (CAT) was used as instrument for the study. The instrument consisted of 40 multiple choice objective test developed by the researchers. The measuring instrument was based on chemistry content of qualitative analysis subdivided into preliminary tests, for cations and tests for anions.

**PROCEDURES**

The regular chemistry teachers were used. The pre-test was administered to the experimental and control subjects before the teaching started. One hour was allowed for pretest, thereafter, the questions papers and the answer were collected from each student in both the experimental and control group. The reason for retrieving questions papers was that the same question will be used for the posttest. The posttest was administered to both the experimental and control subjects immediately after the three week of teaching. The pretest was reshuffled and printed on a coloured paper to give it a different look, before it was used for the posttest. The subject teachers did the supervision and invigilation.

**RESULTS**

The results are presented according to the research questions and the hypotheses.

**Research question 1:**

What are the mean achievement scores of student’s taught inquiry Role instructional model (RIM) and those taught using Expository method of instruction (EMI)?

**Table 1 mean chemistry achievement score of students taught using RIM and EMI**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>12.94</td>
<td>21.55</td>
<td>4.02</td>
<td>4.54</td>
<td>71</td>
</tr>
<tr>
<td>Control</td>
<td>12.59</td>
<td>11.31</td>
<td>3.91</td>
<td>3.38</td>
<td>70</td>
</tr>
</tbody>
</table>
Table 1: indicates the means score of the experimental RIM group 12.94 and the standard deviation 4.02 are comparable to the mean score of the control EMI group 12.59 and standard deviation 3.91 during the pretesting whereas during the post-test, there seem to be an appreciable difference in the mean score of the experimental group is 21.55 and standard deviation 4.54 while that of the control group is 11.31 and standard deviation 3.38. This means that the treatments have a positive influence in the experimental group.

Research question 2:

What are the mean achievement scores of male and female students taught chemistry using inquiry Role instructional model Expository method of instruction respectivel

Table 2: mean achievement scores of male and female students taught chemistry using IRM and EMI respectively.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Preset</th>
<th>Post-test</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Experiment</td>
<td>12.10</td>
<td>21.40</td>
<td>4.49</td>
<td>4.78</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>12.35</td>
<td>11.67</td>
<td>4.09</td>
<td>3.44</td>
<td>34</td>
</tr>
<tr>
<td>Female</td>
<td>Experiment</td>
<td>13.56</td>
<td>21.66</td>
<td>3.56</td>
<td>4.40</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>12.81</td>
<td>10.97</td>
<td>3.77</td>
<td>3.33</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 2 shows that male student obtained a mean of 21.40 and female student has 21.66. The result in table 2 indicates that female group differed with male group in the mean achievement score in chemistry by 0.26. The slight difference is in favour of the female subjects. Ho2 where tested at 0.05 level of significance difference using two way analysis of covariance (ANCOVA) Ho1:There is no significance difference in the mean achievement scores of SS2 chemistry students taught With IRIM and those taught with expository method of instruction.

Ho1: There is no significant difference in the mean achievement scores in chemistry between male and female student taught chemistry with IRA as measured by chemistry Test (CAT)

Table 3: ANCOVA for student’ mean achievement scores by instructional package types and gender.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Significant</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>23.292</td>
<td>1</td>
<td>23.292</td>
<td>2.305</td>
<td>.131</td>
<td>NS</td>
</tr>
</tbody>
</table>
For hypothesis 1, table 3 showed that method was found significant at 0.000 which is less than 0.05 set for the study. Since the computed level of significant is less than the 0.05 set for the study.

The researchers therefore conclude that there is a significant difference in the mean achievement scores of chemistry student taught with IRIM and those taught with EMI.

For hypothesis 2, table 3 showed that gender was significant at 0.31 which is greater than 0.05 set for the study. Since the computed level of Significance is greater than the 0.05 set for the study and in agreement With the decision rule. The researcher upholds the null hypothesis and concludes that there is no significant difference in the achievement scores of male and female students taught Chemistry with IRIM as measured by Chemistry Achievement Test (CAT)

**CONCLUSION**

Inquiry role instructional model was found more effective than expository method on Student’s achievement in chemistry. Female chemistry students achieved higher than their male Counterparts. Chemistry teachers should be encouraged to employ the use of inquiry role instructional model more in the teaching of chemistry; by so doing, the achievement of the subject could be increased.

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Mid Continent Regional Education laboratory Kansas City


QUALITY OF SCIENCE TEACHERS PRODUCED FROM COLLEGES OF EDUCATION IN PLATEAU STATE: IMPLICATION FOR SCIENCE EDUCATION

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Federal College of Education, Pankshin-Nigeria

Abstract

The onus of laying the foundation for scientific literacy lies on the NCE science teachers according to the national policy on education. The paper set out to determine the quality of N.C.E science teachers produced from colleges of education in Plateau state. Student’s results were used as well as a peer reviewed questionnaire. 120 respondents participated in the research. Analysis of the data using mean and percentages revealed that not less than 30% of the students carry over courses every year. 62.5% of the respondents stated that it is becoming difficult to teach the N.C.E students. Poor background of students from secondary school and poor communication skill are some of the problems faced by the teacher trainers. It was recommended that only high quality students should be admitted into the programme.

INTRODUCTION

The importance of science and technology to any nation is no longer in doubt hence nations the world over are emphasizing the study of science and technology in schools. In Nigeria, science is taught from primary school level to the higher education level. The importance attached to science education is so much that non-science students in tertiary institutions Nigeria are made to learn some science in their general studies courses.

Other efforts made by the nation can also be seen in the admission policy which states that 60% of the candidates admitted into higher institutions should be for science and technology courses. In addition, there are schools and even universities established mainly for science and technology courses with the aim of taking the nation higher in science and technology.

In Nigeria today, there are many schools, universities and colleges of education. Some are owned by individuals and organizations. They offer admission to students to study various courses including science courses. Thus there are many students graduating from these institutions. Education has thus grown quantitatively but the quality of our education has some question marks. Some researchers have expressed doubts about the products from our schools. Akpan (2001) stated that products from our school system have been found wanting in all the parameters used to assess them. Ajewole (2005) observed that students’ achievement scores often fall below international standard; implying that their knowledge and understanding of
science do not meet the standard for competence in the global market. There has also been a persistent cry about the performance of students in science and technology over the years (Oyedokun 2002 and Chukwu 2010). This is manifested in the low percentage of students who make the required credits at the school certificate examination. Some research findings also show that pre-service as well as practicing teachers lack proper understanding of some science concepts (Ngoka1989; Jimo 2002 and Chukwu 2010).

The poor performance of the students has been attributed to unavailability of human and material resources such as qualified teachers, well equipped laboratories as well as the conceptual demands of science and the students background knowledge among other causes (Gyuse, 1990; Akano and Akpokiere, 2006 & Chukwu 2010).

The search light should also beam on the teachers especially teacher preparation. This is because no educational system can rise above the level of its teachers. To ensure effective science and technology education in our schools, highly qualified and competent teachers are required. Agreeing to this, Ameh (1987) states that for effective science teaching in our schools, science teachers with knowledge of the subject matter and confidence to teach the concepts effectively are required. Akale (1992) on his part points out that one of the problems of science curriculum development efforts is the non recognition that the teacher is the key factor in determining the quality and success of its implementation. The implication of these statements is that for the nation to develop in science and technology, competent and effective science teachers are required.

In Nigeria, science teachers are produced in colleges of education and faculties of education in the universities. Students from colleges of education obtain the Nigerian Certificate in Education which qualifies them to teach science in primary and junior secondary schools according to the national policy on education. In practice however, the N.C.E science teachers are also teaching at the senior secondary school level (Chukwu & Chukwu 2013). Thus they are involved in preparing students for senior secondary school certificate examination. The question one should ask is: What is the quality of science teachers being produced in the colleges of education? What calibre of students are admitted to be trained as science teachers. Chukwu and Chukwu (2008) stated that the problem of teacher education is the caliber of students admitted into the N.C.E programme. For Dike and Ndokwu(2007:20)

---the increase in the nations population led to a corresponding increase on the quest for education. The interplay of economics and politics as they affect education and teacher education and training in particular led to some degree of compromise of admission requirement. Consequently, a large proportion of what we have today as ‘trained teachers’ are academically and professionally incompetent.

This is a very ugly trend because the onus of inculcating the scientific skills lies on the science teachers. Where the teacher lacks the competence, the nation will not advance scientifically. Though there is improvement on the admission requirement; that is all candidates seeking admission into higher institutions are required to have five credits including English and Mathematics. The problem has not been solved.

The N.C.E programme is very important because the products are not only to teach at the primary and junior secondary schools but also act as feed stock for the faculty of education in the
universities. They also lay the foundation for science teaching in the secondary schools. This makes their position more important because even those who may not pursue science courses in future need the basic science knowledge. The world today needs individuals who are scientifically literate so that they can participate effectively in science based societal issues and understand their environment. Olorukooba (2007) observed that this can only be achieved with better programme oriented towards teacher preparation and professional development.

What is observed in our colleges of education now in fact leaves much to be desired. Chukwu, Gambo and Ibejekwe (2013) showed that N.C.E science students are not performing well as expected of them. If the students are not doing well in schools, what will be their output when they go into the field for one cannot give what he/she does not have? The hands of the teacher trainers seem to be full because of the crowded class making it difficult for them to give individualized instructions or carry out practicals effectively.

Many students are being admitted into colleges of education to study science but little attention is paid on the quality of the products. There are certain qualities expected of a good teacher and invariably a good science teacher. A good teacher is expected to be firm, humorous, loving, kind, patient, have good knowledge of the subject matter, have effective discipline skills, have good communication skills etc. All these qualities are of importance but this paper is concerned mainly with the knowledge of the subject matter. This is because everything that happens in a classroom centres on the subject matter. All the teacher is doing in the class is to make his/her students to understand the subject matter. If Nigeria is to advance in science and technology, more attention should be paid on the quality of science teachers from our colleges of education and not the quantity. The efforts made to better the educational system should be in the right direction which is teacher preparation. Since the N.C.E science teachers are the ones to lay the foundations for science education and knowledge generally, their preparation is of utmost importance. This paper therefore tried to determine the quality of science teachers produced from colleges of education in Plateau State.

RESEARCH QUESTIONS

The following questions were raised to guide the research.

1. What is the performance of the science students in colleges of education in Plateau State?

2. What is the perception of the teacher trainers about the quality of the science teachers graduating from their departments?

3. What are the challenges faced by the teacher trainers in producing high quality NCE science teachers?

METHODOLOGY

The population for the study is 160 science teachers in the two colleges of education in Plateau State i.e College of Education Gindiri and Federal College of Education Pankshin. Out of this only 120 participated in the study. Effort was made to reach all but it was not possible. The instruments for the data collection were the students’ results and a questionnaire. The result used was that of NCE 111 students from both colleges for four years. These calibre of students have
gone through the programmes of the colleges including teaching practice. The questionnaire was divided into two sections. Section A sought information about the perceived quality of the science teachers in training while section B is a five point Likert Scale on the factors militating against effective teaching on the part of the teacher trainers. Data collected was analyzed using means and percentages. The colleges are represented with A and B.

**ANAYSIS OF DATA**

Research question one: What is the performance of the science students in colleges of education in Plateau State?

Table 1: Performance of students in first semester in 2007/08 – 2009/10 and 2011/2012

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>141</td>
<td>255</td>
<td>323</td>
<td>212</td>
</tr>
<tr>
<td>B</td>
<td>195</td>
<td>270</td>
<td>320</td>
<td>400</td>
</tr>
<tr>
<td>Total number of students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. without carry over</td>
<td>65</td>
<td>150</td>
<td>93</td>
<td>77</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>46</td>
<td>58.8</td>
<td>28.8</td>
<td>36.3</td>
</tr>
<tr>
<td>No. with carry over</td>
<td>76</td>
<td>105</td>
<td>230</td>
<td>135</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>53.9</td>
<td>41.2</td>
<td>71.2</td>
<td>63.7</td>
</tr>
</tbody>
</table>

Table 2: Performance of students in second semester in 2007/08 – 2009/10 and 2011/2012

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>146</td>
<td>240</td>
<td>325</td>
<td>215</td>
</tr>
<tr>
<td>B</td>
<td>199</td>
<td>261</td>
<td>297</td>
<td>382</td>
</tr>
<tr>
<td>Total number of students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. without carry over</td>
<td>68</td>
<td>160</td>
<td>200</td>
<td>209</td>
</tr>
<tr>
<td>Percentage (%)</td>
<td>46.6</td>
<td>66.7</td>
<td>67.3</td>
<td>54.7</td>
</tr>
<tr>
<td>No. with carry over</td>
<td>78</td>
<td>80</td>
<td>97</td>
<td>128</td>
</tr>
</tbody>
</table>
Tables 1 and 2 show that not less than 30% of the students carry over courses. The percentage is even as high as 68.2%. This is not an encouraging observation.

**Research question two:** What is the perception of the teacher trainers about the quality of the science teachers graduating from their departments?

Table 3: Perception of teachers about students graduating from their departments.

<table>
<thead>
<tr>
<th>Quality</th>
<th>No. of Respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Very good</td>
<td>27</td>
<td>22.5</td>
</tr>
<tr>
<td>Average</td>
<td>63</td>
<td>52.5</td>
</tr>
<tr>
<td>Poor</td>
<td>30</td>
<td>25.0</td>
</tr>
<tr>
<td>Very poor</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3 shows that 52.5% of the respondents graded the students graduating from their departments as just average while 25.5% graded them as poor. None graded them as excellent or very poor.

Table 4: Trend of the quality of the students over the years in terms of academic performance.

<table>
<thead>
<tr>
<th>Item</th>
<th>No. of Respondents</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance has been impressive</td>
<td>20</td>
<td>16.7</td>
</tr>
<tr>
<td>There has been no change</td>
<td>10</td>
<td>08.3</td>
</tr>
<tr>
<td>The students are good; they learn fast</td>
<td>15</td>
<td>12.5</td>
</tr>
<tr>
<td>It is becoming increasingly difficult to teach the students</td>
<td>75</td>
<td>62.5</td>
</tr>
</tbody>
</table>

Table 4 shows that 62.5% of the respondents find it difficult to teach the students while 16.7% feel that the students are doing very well.

Table 5: Response to assignment by students
Table 5 shows that 67.5% of the respondents observe that the students copy answers to assignment from one another instead of making efforts to do the assignment themselves. Copying defeats the aim of the assignments.

Table 6. Students response to examination or test questions.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>NO. OF RESPONDENTS</th>
<th>PERCENTAGE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students do independent work</td>
<td>6</td>
<td>05</td>
</tr>
<tr>
<td>The students copy from one another.</td>
<td>81</td>
<td>67.5</td>
</tr>
<tr>
<td>The students submit assignment promptly</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>The students do not do the assignment as required.</td>
<td>21</td>
<td>17.5</td>
</tr>
</tbody>
</table>

Table 6 shows that 68.3 % of the respondents observe that students’ response to questions only shows faint understanding of the subject matter. Tables 3, 4, 5 and 6 show that the teacher trainers perception of the students is not encouraging. To them, they are of low quality.

**Research question 3:** What are the challenges faced by the teacher trainers in producing high quality NCE science teachers?
Table 7. Shows that the teachers see poor background of the students from the secondary school as the greatest challenge they face in the course of training the students followed by lack of commitment on the part of the students then poor communication skill while incessant strike had the least mean of 3.1. All the nine items were seen as factors militating against the production of high quality science teacher.

**DISCUSSION**

It has been stated that the teacher is the bedrock of every educational system and that no teacher can give what he does not have. This being the case, the quality of the teachers produced to teach science in Nigerian schools leaves much to be desired. Tables 1 and 2 show that not less than 30% of the students carry over courses. The implication is that the students are not performing well. It is important to note that these students made credits at the senior school certificate examination (SSCE) before admissions were offered to them and the examinations written are teacher made tests. Chukwu, Gambo and Ibejekwe (2013) from their study showed that the NCE Science students are not performing well in their examinations. This carrying over of courses has cost implication as well as work load for the teachers. The students too will end up spending more years in the colleges before graduation or end up not graduating at all.

Table 3 shows that 52.5% and 25% of the teachers perceive the academic performance of the students as average and poor respectively. In the same vain, 62.5% say that it is becoming increasingly difficult to teach the students. One can only imagine what kind of science teachers this calibre of students will be when they go into the field. No wonder Dike and Ndokwo (2007) states that “What we have as trained teachers are academically and professionally incompetent”.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor communication skill</td>
<td>4.30</td>
</tr>
<tr>
<td>Poor background from secondary school</td>
<td>4.68</td>
</tr>
<tr>
<td>Inability to understand the subject</td>
<td>4.12</td>
</tr>
<tr>
<td>Lack of commitment to their studies</td>
<td>4.48</td>
</tr>
<tr>
<td>Crowded programme on the part of the teachers</td>
<td>3.87</td>
</tr>
<tr>
<td>Incessant strike actions</td>
<td>3.1</td>
</tr>
<tr>
<td>Inadequate teaching materials/equipment</td>
<td>3.7</td>
</tr>
<tr>
<td>Inadequate facilities/classroom</td>
<td>3.8</td>
</tr>
<tr>
<td>High population of students in class</td>
<td>3.6</td>
</tr>
</tbody>
</table>
In Table 4, 67.5% the respondents stated that the students copy from one another when assignments are given to them. This is disheartening it means that the students do not know what they are doing. If a student teacher cannot seek for information, read it and reproduce it at his own time in order to do an assignment how will he/she be able to prepare his/her lessons when he/she is in the field more so when he/she may have to teach topics that he was not taught while in school. Copying is examination malpractice it appears that the students do not know this. Chukwu, Gambo and Ibejekwe (2013) found that some students in our higher institutions no longer know activities that constitute examination malpractice. If the student teachers do not know that copying is wrong how will they inculcate the right examination ethics in their students?

In Table 6, 68.3% indicated that students’ response to questions show only faint understanding of the subject matter. This is a clear indication that the students being trained as science teachers find it difficult to understanding the subject matter. This result is expected since they cannot task themselves to do assignments when it is given to them; how will they learn or improve themselves? Table 7 shows that the lectures are having hard time producing high quality science teachers. Poor background from secondary school, poor communication skills had very high means (over 4). Relating this to all the tables, it is like a case of garbage in garbage out. But should this be in education? Chukwu and Chukwu (2008), had stated that the problem of teacher education is the admission policy. Though the new admission policy is that all candidates seeking admission into higher institutions must have five credits including English and Mathematics, discrepancy still exists. Those who score high marks go to the universities while those with low scores are sent to colleges of education for the teacher trainers to perform miracles and turn them into wonderful teachers. The government seems to be paying lip service to their desire to become technologically advanced. Imagine that the cut off point for colleges of education for this year 2013 was reduced to 150 and the reason advanced is to give more people opportunity to gain admission into higher institutions. Is the government interested in people just going through science programme and still remain scientifically illiterate (Ajewole 2005) or to build a scientifically literate nation. The poor back ground of the students could be because the teachers preparing them are not competent too. Thus it is a case of a viscous circle. This must stop. It is high time the nation calls a spade a spade. NCE teachers must be properly selected and trained because they lay the foundation of our educational system.

CONCLUSION

The N.C.E science teachers according to the national policy on education are to teach at the primary school and junior secondary school. So the onus of laying the foundation for scientific literacy lies on them. The paper has revealed that the quality of N.C.E science teachers being produced from the colleges in Plateau State is nothing to write home about. Teacher education should not be taking for granted or looked at as a dumping ground where those who could not gain admission into other courses should be admitted. It is important to note that a ‘small mistake’ made by a teacher can destroy the dreams of a whole generation.
**RECOMMENDATION**

1. Attention should be paid to the secondary education where the education foundation is laid
2. Tertiary educations are not a basic education d/4 only those who can benefit from it should be given the opportunity to go through it.
3. High quality students should be admitted into the programme if any desired change is to be made.
4. The government should make a conscious effort to attract good and highly qualified students into the programme.
5. Serious efforts should be made to teach the students the language of instruction at the primary and secondary school for effective communication.

**REFERENCES**


STUDENTS’ PERCEPTION OF THEIR SELF-EFFICACY AS A MECHANISM TO SUSTAINED POSITIVE ATTITUDE IN PRACTICAL AGRICULTURE

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College Of Education, Zing,
Taraba State, Nigeria

Abstract
This research examines the interest and self-efficacy of students of Colleges of Agriculture and Education both in Jalingo, Taraba state of Nigeria. A sample size of 186 agricultural students was drawn from the two institutions. The sample was drawn using proportionate stratified random sampling technique from agricultural students who had offered practical agriculture in their previous levels of study. The instrument used to elicit data for the study was a questionnaire termed students’ interest and self-efficacy questionnaire (SISEQ). A reliability coefficient of the instrument, Cronbach alpha, of 0.91 was obtained. Descriptive statistics of mean and standard deviation were obtained and used. The result of the study revealed that students of agriculture showed strong positive interest in agricultural practical. Furthermore, the result added that students of agriculture were efficacious to agricultural practical. The study recommends that agricultural teachers should develop students’ awareness of their self-efficacy to enable them exclaim “I can do it”.

Key words: Self-efficacy, Students’ attitude, Practical agriculture, Interest, Anxiety.

Introduction
Preparing students for challenging careers in the crop production, animal production, irrigation, agricultural engineering, etc and technical skills are critical to adequately prepare agricultural students to be effective employees for the work force in a knowledge economy (Zarafshani, Knobloch & Aghahi, 2008). The need for information, knowledge and skills needed by agricultural students, in Nigerian Colleges, to be effective in career and life planning decision cannot be over emphasized. Agriculture students need to have wide range of information to succeed in their career goals as well as feeling capable enough to manage and cope with everyday tasks.
For agriculture students to be successful in preparing themselves for challenging professional careers in agriculture, they need to have a high sense of self-efficacy. Self-efficacy is “the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations” (Bandura, 1994). It is the person’s belief in his or her ability to succeed in a particular situation (Roberts & Dyer, 2005; Wolf, 2008; Kurbanoglu & Akim, 2010; Edziwa & Chivheya, 2012; Hashemi, Hosseini & Rezvanfar, 2012; & Tenaw 2013). Other researchers refer to self-efficacy belief as the judgments about one’s ability to organize and execute the courses of action required to produce given outcome (Zimmerman & Cleary, 2006; Niemivirta & Tapola, 2007; Zarafshani, Knobloch & Aghahi 2008; du Preez, 2010). Self-efficacy is an “I can do it” belief that reflects one’s accurate self-assessment in his or her ability to effectively adapt and perform necessary tasks in the face of challenging environment. It is an important motivation for people to be successful in their careers. Self-efficacy plays a role in a student’s academic motivation in terms of choice of activity, amount of effort expended on the academic task and the persistence shown in completing academic task. On a general view, self-efficacy can enhance human accomplishments and influence the choices people make and the courses of action they pursue, how long they will endure when confronting obstacles and how resilient they will be on the face of adverse situation. In the structure of conceptual model, perceived academic self-efficacy would contribute to a sense of personal efficacy for careers in scientific-technical, educational, medical, artistic-literary and commercial-managerial careers because they all call for advance knowledge and high level cognitive skills. A strong sense of academic efficacy would enhance perceived efficacy for the latter types of careers both directly and through the mediation of academic aspirations and scholastic achievements. That is it influences learning and performance (Bandura 1986, 1997, Niemivirta & Tapola 2007; du Preez, 2010; Bandura, Barbaranelli, Caprara & Pastorelli, 2001 and Ajegbomogun, 2011). Some researchers have also revealed that self-efficacy affect students’ achievement and attitudes (Roberts & Dyer, 2005).

Self-efficacy and self-concept beliefs at a glance seem to have minimal distinction between them. The two constructs represent different phenomena (Bandura, 1986). Self concept refers to a generalized self-assessment incorporating a variety of self-reactions and beliefs such as feelings of self-worth and general beliefs of competence. In contrast, self-efficacy beliefs are context-specific judgments of personal capability to organize and execute a course of action to attain a set goal. Self-efficacy focuses more specifically on the tasks or activities that an individual feels capable of performing rather than a more global assessment of “how good you are at something” as provided in assessment of self-concept (Zimmerman & Cleary, 2006 & Wolf, 2008). Self-esteem is another construct that is a type of belief involving judgments of self-worth. It is an affective reaction indicating how a person feels about him or herself. This is quite distinct from self-efficacy perceptions, which involves cognitive judgments on a personal capacity and capability (Pintrich & Schunk, 2002).

Perceived self-efficacy is people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses (Wolf, 2008 & Hartfield, 2011). Self-efficacy beliefs are one of the strongest, if not the strongest, predictor of human motivation and behaviour. A strong sense of self-efficacy enhances accomplishment and personal well-being in part because of an individual’s beliefs in their own potentials to influence the outcome. Individuals with a high sense of self-efficacy often exhibit
an intrinsic interest and tend to be deeply engrossed in their activities; they set challenging goals and maintained a strong commitment to achieving these goals. Individuals with high sense of self-efficacy approach threatening situations with greater confidence, feeling they have at least some ability to exert an influence and/or a degree of control over the situation. That is, they recover quickly from setbacks and disappointments. Individuals with low self-efficacy tend to doubt their ability or potential to influence an outcome, generally avoid difficult or threatening situations, dwell on personal deficiencies when faced with difficult tasks, slacken efforts and give up in the face of adversity and are slow to recover from failure (Bandura, 1994).

Efficacy beliefs involve different types of capabilities, such as management of thought, affect, action and motivation. Beliefs related to self-efficacy allow individuals with a similar set of skills or attribute to perform the same function differently. Nonetheless, efficacy beliefs can only show true excellent performance if a skill set is available (Hartfield, 2011). Self-efficacy beliefs affect how people approach new challenges and will contribute to performance since these beliefs influence thought processes, motivation and behaviour. Self-efficacy is not static and can change over time resulting from periodic reassessments of how adequate one’s performance has been (Bandura, 1986). Self-efficacy provides a mechanism to explain individual behaviour and is associated with a positive self-concept and self-appraisal of personal control which arises from experiences of mastery and the anticipation of competent performance. A person with a positive (high) self-efficacy expects to succeed and will persevere in his commitment to accomplish the task at hand. On the other hand, an individual with negative (low) self-efficacy anticipates failing and is not likely to persevere in the challenging task.

Individual self-efficacy is derived from four main sources namely (i) mastery experiences, (ii) vicarious experiences (iii) social persuasion and (iv) physiological and emotional (affective) states (Bandura 1977 & 1982; Zimmerman & Cleary, 2006; Wolf, 2008; & Hartfield, 2011). Mastery experience is the most effective way to master a strong sense of self-efficacy. An individual’s (student’s) successful experiences boost self-efficacy, while failures erode it. Successes build a robust belief in one’s efficacy. After individuals are convinced they have the ability to succeed at a task, they are much more resilient in the face of failure. The resilience allows them to manage failure and learn from their mistakes, rather than become demoralized.

Vicarious experiences is observing a peer succeed at a task strengthen beliefs in one’s own abilities. Modeling is a form of vicarious experience; an individual modeling behaviour must ensure that the level of performance is reachable by the observer, social persuasion occurs when people could be persuaded to believe that they have the skills and capabilities to succeed. Consider a time when someone said something positive and encouraging that helped you achieve a goal. Getting verbal encouragement from others helps people overcome self-doubt and instead focus on giving their best to the task at hand thereby raising the individual’s self-efficacy. Physiological and emotion (affective) states affect self-efficacy. A positive mood can boost one’s beliefs in self-efficacy, while anxiety can undermine it. A certain level of emotional stimulation can create an energizing feeling that can contribute to strong performances. Teachers, for instance, can help by reducing stressful situations and lowering anxiety surrounding events like examinations or presentations.

Anxiety which is an emotion that is experienced in anticipation of some usual ill-defined misfortune influences students’ performance. It has been observed that students fear practical
agriculture activities and such fear is characterized by practical involvement required by the students in agriculture. This anxiety makes students lose interest in practical agriculture. Moreover, the causes of practical agriculture anxiety include past bad experience in practical science classes, exposure to science anxious teachers who are teaching science and lack of role model. Though some degree of anxiety may be helpful in the learning process, a high level of anxiety impedes optimum performance on science learning (Kurbanoglu & Akim, 2010; Simsek, 2011). Practical agriculture anxiety could be said to be the feeling of anxiety encountered when taking practical course in agriculture. Avoidance of stressful (practical) activities impedes development of coping skills and the resulting lack of competency provides a realistic basis for anxiety. Acquiring behavioural means for controlling potential threats in practical agriculture eliminates anxiety arousal. Behavioural control in practical agriculture not only allows students to manage the aversive aspects of an environment (farm), it also affects how the farm is likely perceived by the students. Practical stressful situations that can be controlled are observed to be less threatening and such cognitive appraisals further reduce expected anxiety arousal (Bandura, 1977).

**Purpose and Objectives**

Practical is a very important aspect of agricultural courses in tertiary institutions in Nigeria. For this reason, all agricultural courses have one aspect or the other. It is in view of the relevance and the importance of practical agriculture in studying agriculture as a future career that this study has been carried out to investigate the perception of students’ self-efficacy as a mechanism in sustaining self interest in practical agriculture. Based on the foregoing the purpose of the study was to investigate the students’ perception of their self-efficacy as a tool to sustain their interest in agricultural practical. The objectives of the study were to:

i. describe students’ interest in practical agriculture;
ii. describe students’ anxiety in practical agriculture;
iii. describe students’ self-efficacy in practical agriculture;
iv. describe the relationship between students’ self-efficacy and their attitude (interest and anxiety).

**Research Questions**

To guide this study, the following research questions were passed:

i. What is the students’ interest in practical agriculture?
ii. What is the students’ anxiety in practical agriculture?
iii. What is the students’ self-efficacy in practical agriculture?
iv. What is the relationship between students’ self-efficacy and their attitude (interest and anxiety)?

**Hypothesis**

$H_{o1}$: There is no significant relationship between students’ self-efficacy and their attitude (interest and anxiety) to agricultural practical.
Methodology

Population and Sample of the study

The population (1100) for this study consists of all students in NCE two and three hundred level in the department of agricultural education in College of Education and all the ND II students in the College of Agriculture, both in Taraba state. The choice of these categories of students is on the basis that they must have done practical in agriculture in their previous levels of study.

The population (1100) of the study area was stratified based on the departments in the two tertiary institutions in Taraba state. The strata are the six departments in College of Agriculture and one department in the College of Education. The sample size consisted of 186 agricultural students drawn from the two tertiary institutions in Taraba state for the study. The sample for the study was drawn using proportionate stratified random sampling technique. This technique divides the population into strata (departments) in which samples were selected randomly but independently from each stratum and an estimate of each parameter was computed over all strata (Yalams & Ndomi, 2000; Jen. 2002; Emaikwu, 2011). Using the sample size table presented by Emaikwu (2011), agricultural students’ population of 1100 gave a sample size of 186. The samples from the two Colleges were drawn by proportionate stratified random sampling technique on the ratio of 3:1 from College of Agriculture (876) and College of Education (224) respectively.

Instrumentation

The study was a descriptive survey design. The study was grounded in the need to describe and interpret the students’ self-efficacy in sustaining their interest in agricultural practical in Colleges of Agriculture and Education in Taraba state. A survey design was chosen because descriptive data can be utilized to produce information about various aspects of education (Yalams & Ndomi, 2000, Gall, Gall, & Borg, 2003; Emaikwu, 2011). This will in turn lead to empirically based decision making to improve education.

The instrument used to elicit data from sampled respondents was a questionnaire tagged “students’ interest and self-efficacy questionnaire” (SISEQ). The instrument was developed by the authors based on relevant literature reviewed in the course of this study. The instrument was a structured questionnaire based on a 5-point rating scale. The instrument was validated by experts in agricultural education for both face and content validity (Yalams & Ndomi, 2000 & Emaikwu, 2011). A reliability coefficient, Cronbach alpha, of 0.91 was obtained using statistical packaging for social sciences (SPSS) version 16.0. The alpha value was high enough indicating that the instrument was reliable for the study.

Results and Discussion

The data obtained from the instrument were analyzed using SPSS version 16.0. Descriptive statistics of mean and standard deviation were obtained. A cut-off point of 3.00 and above of mean responses were considered agree or confident while mean responses of below 3.00 were considered disagree or not confident.
A total of 186 agricultural students responded to the questionnaire (SISEQ). About 74.2% of the respondents were males and 25.8% were females. The percentage respondents for College of Education were 26.9% while that of College of Agriculture was 73.1%. These two colleges are the tertiary institutions that offer agricultural courses in Taraba state.

Table 1: Students’ mean responses on their interest in practical agriculture

<table>
<thead>
<tr>
<th>S/N</th>
<th>Statement of interest</th>
<th>Mean</th>
<th>S. d.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Practical agriculture lesson has influenced my interest.</td>
<td>4.56</td>
<td>0.63</td>
<td>Agree</td>
</tr>
<tr>
<td>2.</td>
<td>Practical agriculture books are easy to read.</td>
<td>4.43</td>
<td>0.66</td>
<td>Agree</td>
</tr>
<tr>
<td>3.</td>
<td>I am happy attending practical agriculture class.</td>
<td>4.34</td>
<td>0.72</td>
<td>Agree</td>
</tr>
<tr>
<td>4.</td>
<td>Practical agriculture lessons are not generally boring.</td>
<td>3.82</td>
<td>1.14</td>
<td>Agree</td>
</tr>
<tr>
<td>5.</td>
<td>I would like to learn more about practical agriculture.</td>
<td>4.41</td>
<td>0.89</td>
<td>Agree</td>
</tr>
<tr>
<td>6.</td>
<td>I do not hate practical agriculture lessons.</td>
<td>4.12</td>
<td>1.03</td>
<td>Agree</td>
</tr>
<tr>
<td>7.</td>
<td>I never regret the time I spend in practical agriculture lessons.</td>
<td>4.25</td>
<td>0.85</td>
<td>Agree</td>
</tr>
<tr>
<td>8.</td>
<td>I do not feel afraid when practical agriculture is mentioned.</td>
<td>4.28</td>
<td>0.94</td>
<td>Agree</td>
</tr>
<tr>
<td>9.</td>
<td>I enjoy doing experiments in agriculture laboratory.</td>
<td>4.23</td>
<td>0.93</td>
<td>Agree</td>
</tr>
<tr>
<td>10.</td>
<td>I prefer doing practical agriculture to other things in agriculture laboratory.</td>
<td>3.90</td>
<td>1.08</td>
<td>Agree</td>
</tr>
<tr>
<td>11.</td>
<td>I enjoy talking to other people about practical agriculture.</td>
<td>4.28</td>
<td>0.87</td>
<td>Agree</td>
</tr>
<tr>
<td>12.</td>
<td>I often read ahead in practical agriculture.</td>
<td>3.96</td>
<td>1.08</td>
<td>Agree</td>
</tr>
</tbody>
</table>

Table 1 shows the interest of agriculture students on practical in agricultural courses as required by the first objective. Results indicated that student were interested in practical in agricultural courses taught in their institutions. All the twelve items responded to by the respondents were rated agree with mean rating ranging from 3.82 to 4.56 above 3.00. This agrees with the findings of Ehiemere, Tsojon and Gidado (2011) who established in their study that agriculture students like practical agriculture and lessons in practical agriculture. They added that this has developed in them strong evaluative beliefs about agriculture and also develop strong behavioural tendency to learn practical agriculture.

Table 2: Students’ mean responses on their anxiety to agricultural practical

<table>
<thead>
<tr>
<th>S/N</th>
<th>Statement of anxiety</th>
<th>Mean</th>
<th>S. d.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I find it difficult to understand practical agric</td>
<td>2.04</td>
<td>1.16</td>
<td>Disagree</td>
</tr>
<tr>
<td>2.</td>
<td>I do not do very well in practical agric</td>
<td>2.31</td>
<td>1.15</td>
<td>Disagree</td>
</tr>
<tr>
<td>3.</td>
<td>I do not remember most of the things I learn in practical agric</td>
<td>4.19</td>
<td>0.88</td>
<td>Agree</td>
</tr>
<tr>
<td>4.</td>
<td>It makes me nervous to think about practical agric</td>
<td>3.56</td>
<td>1.24</td>
<td>Agree</td>
</tr>
<tr>
<td>5.</td>
<td>Class activities in practical agric. upset me</td>
<td>3.23</td>
<td>1.26</td>
<td>Agree</td>
</tr>
<tr>
<td>6.</td>
<td>I often think I cannot do it when a practical agric assignment seems hard</td>
<td>2.71</td>
<td>1.28</td>
<td>Disagree</td>
</tr>
<tr>
<td>7.</td>
<td>It scares me to attend agric practical class</td>
<td>2.73</td>
<td>1.35</td>
<td>Disagree</td>
</tr>
<tr>
<td>8.</td>
<td>If I do not see how to do a practical agric assignment</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
right away, I never get it. 3.05 1.29 Agree

The second objective was to determine the anxiety of the respondents to agricultural practical. Table 2 shows the anxiety of the respondents to agricultural practical. The results revealed that four of the eight anxiety items were responded to as agree with mean rating ranging from 3.05 to 4.19 above 3.00 while the remaining four items were rated disagree with mean rating between 2.04 to 2.73 below 3.00 cut off point. These results revealed that students experienced some level of anxiety when taking agricultural practical. The degree of anxiety to some extent challenges (helpful) the learner in the learning process, but a high level of anxiety impedes optimum student’s academic performance (Kurbanoglu & Akim, 2010, & Simsek, 2011). The degree of anxiety required by the respondents may be responsible for the 50-50 percent responses to the eight items presented in table 2.

Table 3: Students mean responses on their self-efficacy to practical agriculture

<table>
<thead>
<tr>
<th>S/N</th>
<th>How confident are you:</th>
<th>Mean</th>
<th>S. d.</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>That after reading an article about practical agric experiment; you could write a summary of its main point?</td>
<td>4.20</td>
<td>0.83</td>
<td>Confident</td>
</tr>
<tr>
<td>2.</td>
<td>That you could explain something you learn in practical agric to another person?</td>
<td>4.16</td>
<td>0.89</td>
<td>Confident</td>
</tr>
<tr>
<td>3.</td>
<td>That after being given homework, you will find materials to answer the questions?</td>
<td>4.11</td>
<td>0.96</td>
<td>Confident</td>
</tr>
<tr>
<td>4.</td>
<td>That after being given a specimen in practical agric you will identify it?</td>
<td>4.36</td>
<td>0.92</td>
<td>Confident</td>
</tr>
<tr>
<td>5.</td>
<td>That after reading a procedure in practical agric experiment you will explain the main ideas to another person?</td>
<td>4.20</td>
<td>0.88</td>
<td>Confident</td>
</tr>
<tr>
<td>6.</td>
<td>That after watching a television documentary dealing with some aspects of practical agric you could writes a summary of it main points?</td>
<td>3.88</td>
<td>0.96</td>
<td>Confident</td>
</tr>
<tr>
<td>7.</td>
<td>That you could teach another student practical agric?</td>
<td>4.38</td>
<td>0.79</td>
<td>Confident</td>
</tr>
<tr>
<td>8.</td>
<td>That you could ask a meaningful question that could be answered experimentally?</td>
<td>4.00</td>
<td>1.01</td>
<td>Confident</td>
</tr>
<tr>
<td>9.</td>
<td>That you will be successful (pass) in practical agric courses?</td>
<td>4.27</td>
<td>0.88</td>
<td>Confident</td>
</tr>
<tr>
<td>10.</td>
<td>In your ability to understand the subject area of practical agric?</td>
<td>3.93</td>
<td>1.05</td>
<td>Confident</td>
</tr>
<tr>
<td>11.</td>
<td>In your ability to understand and use mathematics to solve practical agric problem?</td>
<td>3.59</td>
<td>1.16</td>
<td>Confident</td>
</tr>
<tr>
<td>12.</td>
<td>In your ability to organize your time and use it effectively?</td>
<td>3.79</td>
<td>1.12</td>
<td>Confident</td>
</tr>
<tr>
<td>13.</td>
<td>In your ability to plan what you need to be done?</td>
<td>4.12</td>
<td>1.00</td>
<td>Confident</td>
</tr>
<tr>
<td>14.</td>
<td>In your ability to find time to complete your assignment in practical agric?</td>
<td>4.22</td>
<td>0.94</td>
<td>Confident</td>
</tr>
<tr>
<td>15.</td>
<td>In your ability to use appropriate skills to report on</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
practical agric? 4.05 0.91 Confident
16. In your ability to obtain resources, e.g. practical books from the library? 3.92 1.08 Confident
17. In your ability to enjoy writing examination in practical agric course? 4.21 0.92 Confident
18. To keep calm while writing practical agric course examination? 4.04 1.05 Confident
19. In your ability to understand the subject matter of practical agric course? 4.19 0.95 Confident

The third objective was to determine the students’ self-efficacy to practical in agricultural activities in their institutions of learning. Table 3 shows the self-efficacy of the respondents. The result revealed that all the nineteen items on students’ self-efficacy were rated confident with mean rating ranging from 3.59 to 4.38 above the cut-off point of 3.00. The result revealed that the respondents were efficacious to practical in agricultural courses which is likely attributed to the sources of self-efficacy. Self-efficacy is shaped by how students perform course assignments and pre-career experiences, by observing their peers and instructors perform expected tasks, from mentoring and positive feedback, and how they handle their anxieties in challenging situations (Zarafshani, Knobloch & Aghahi, 2008).

**Hypothesis** (H₀₁): There is no significant relationship between students’ self-efficacy and their attitude (interest and anxiety) towards practical agriculture.

Table 4: Relationship between students’ self-efficacy and their attitude to practical agriculture

<table>
<thead>
<tr>
<th>Attitude</th>
<th>N</th>
<th>Mean</th>
<th>s. d.</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>186</td>
<td>4.22</td>
<td>0.45</td>
<td>0.450**</td>
</tr>
<tr>
<td>Anxiety</td>
<td>186</td>
<td>2.98</td>
<td>0.70</td>
<td>0.009</td>
</tr>
<tr>
<td>P&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The hypothesis was tested using Pearson correlation statistics. In the correlation, the students’ self-efficacy responses were pooled together and correlated with their pooled responses on interest and anxiety. Table 4 revealed that students’ self-efficacy has a positive and significance relationship (r = 0.460**) with their interest towards practical agriculture while the relationship (r = -0.009) with anxiety is minimally negative and not significant. This means that students who are efficacious have interest in practical agriculture. The implication is that students’ interest in practical agriculture can be sustained by their self-efficacy. This finding is in consonant with Bandura, 1986 & 1997; Niemivirta & Tapola, 2007; du Preez, 2010; Bandura, Barbaranelli, Caprara & Pastorelli, 2001 & Ajegbomogun, 2011 who maintained that self-efficacy plays a role in a students’ academic motivation in terms of choice of activity, amount of effort on the academic task and the persistence shown in completing academic task.

**Conclusion and Recommendations**

The findings and discussion of the study indicated that the respondents (students) in the study area (Colleges of Agriculture and Education both in Jalingo, Taraba state, Nigeria)
indicated strong positive interest to agricultural practical. The interest of the respondents must have been motivated by their agricultural teachers (lecturers), peers, careers in agriculture and environment (Ehiemere, Tsojon & Gidado, 2011). The level of anxiety indicated by the respondents revealed that it was minimal which was within the acceptable range which is said to be helpful to learning (Kurbanoglu & Akim, 2010 & Simsek, 2011). Agricultural students in the study area are efficacious (confident) in general terms such as performing difficult tasks, confronting obstacles and coping in the face of adverse situations.

Based on the findings of the study, the following recommendations are presented:

i. Teachers of agriculture should continue to raise the interest of students on practical agriculture through various pedagogical methods to enable the students learn and excel in agriculture to bring about the desired national development.

ii. Seminars, workshops, training and re-training should be organized on regular basis for teachers (lecturers) of agriculture on how to minimize and manage anxiety in practical agriculture for effective learning by the students.

iii. Curriculum developers should consider self-efficacy when developing essential employability skills as this can help students adapt and succeed in many different situations.

iv. Agricultural teachers should develop students’ awareness of their self-efficacy through modeling to enable them exclaim, “I can do it”.

v. General self-efficacy should be considered when preparing students for national and international experiences in science and in agriculture particularly.

vi. Students should be encouraged to be having group study.

vii. Students should be motivated to develop appropriate skills in writing reports in practical agriculture.

References


MENSTRUAL HYGIENE PRACTICES AMONG JUNIOR SECONDARY SCHOOL STUDENTS IN BENIN CITY

Lucy Ameze Gharoro

ABSTRACT

The study assessed the menstrual hygiene practices and challenges of junior school students during menstrual periods, with its implication for Home economics education. The multistage method of sampling was used to select a sample of 500 post menarche junior secondary school students. A structured questionnaire was used for data collection. Frequency tables were generated. Percentages and mean values with standard deviation were calculated. 70.9% of the respondents reported some challenges during their menstrual periods. Abdominal pains and cramps were the major challenges. 11.7% feel depressed. 63.9% do nothing to relieve the discomfort, while 17.5% visit a doctor for treatment. 83.4% use sanitary pads. About half of the respondents have challenges with getting good sanitary facilities and sanitary pads. 13.8% have absented themselves from school/examinations during menstruation as a result of severe menstrual pain [dysmenorrhoea].52.1% of the students change their sanitary pads twice daily; and a majority of 83.9% bathe two or more times a day. Many of the students burn their sanitary material. A minority flush their sanitary pads in the toilets. Increase in public enlightenment in the society and increase in the toilet facility in the schools were suggested as ways of improving menstrual hygiene practice.

Key words: Menstrual hygiene, Menstruation, Menarche, Sanitary pads, menstrual cycle.

INTRODUCTION

Menstruation and menstrual hygiene are issues which every girl and woman will have to contend with in her lifetime. Coping with menstruation can be an enormous task. Menstruation is defined as the cyclical shedding of the inner lining of the uterus, the endometrium, under the control of hormones of the hypothalamo-pituitary axis. (Aniebue U., Aniebue P., Nwankwo 2009). The period between the first day of a menstrual period to the onset of the next menstrual period is called a menstrual cycle. An average menstrual cycle is twenty-eight days. Menstruation last for a period of three to five days. This is called a menstrual period. The first menstrual period, which a girl
experiences, is called menarche. Menarche occurs between nine and fifteen years. Menarche signals reproductive maturity. Menarche often comes with anxiety, fear, confusion and depression. (Marianne, Pherson and Korline 2004 as in Aniebue et al 2009) on the other hand, menarche is celebrated in some cultures and gifts are given to the young girl.

Keeping clean and tidy (hygiene) during menstrual period is a problem to many young girls, especially where information on menstruation and reproductive health are poorly discussed. Issues relating to the practical management of menstrual hygiene are very important because it has health implications in terms of vulnerability to infections. (Anuradha 2011) The absorbent materials used as well as their mode of usage contribute to the health status of the users. On menstrual hygiene practices, Johnson (2010) opined that “there are no ‘correct’ practices and many of these issues surrounding menstrual hygiene are dependent on finances and cultures. According to her, it is important to maintain a high standard of hygiene during menstruation as any bacteria on the hand before changing pads can be transferred into the vagina and cause infection and any bacteria from the vagina following changing of pads can be transferred to other items. Furthermore, she reported that a lot of women feel uncomfortable during menses and they wish to bathe often. She is of the view that there is no need to wash inside the vagina during menses as washing disturbs the natural flora of the body and increase the risk of infection. On sexual intercourse during menses, Johnson (2010) advocates that if both parties agree, they can have it. There is a general consensus on changing sanitary towels regularly (as often as three to four times a day), as well as bathing (Bhomia 2010, Pouresiami, Mohammad, Osati-Ashtiani, Farzaneh 2002, Oyegbeda 2000, Anyakohia 2010).

Different cultures and religions view menses in different ways. Traditionally, in Africa, a menstruating woman is not expected to associate closely with her husband, his room, his food, and his shrine. This has psycho-social effect on the women. Also, the major world religions share the view that a menstruating woman should be secluded or excluded from certain places and activities. Banes and Philpps (1980), in Guterman, Mehta and Gibbs (2008) reported that there are some Christian denominations who exclude women from some activities, such as receiving communion during menses. Guterman et al (2008), quoting Whela (1975) writes “in Muslim religion, ‘impure’ (menstruating) women are to be avoided by men. They should be left alone until they are cleansed and have purified themselves”. Hinduism also views the menstruating woman as impure and polluted. (Fischer, 1978. Whela, 1975 in Gutermal et al, 2008).

Menstruation is an important part of the physiology and life experience of women. It affects the reproductive health and productivity of women to a large extent. Menstrual hygiene is scantily taught under puberty in the schools. The issue is not given sufficient attention at the junior secondary school level. A lot of girls and women do not have sufficient knowledge about this issue. Facilities to promote healthy menstrual hygiene are lacking in many schools. The obvious implication here is that the individual of this age group may be faced with the risk of having short and long term health implications. The irony is that in spite of the importance of this subject matter, there is scarcity of information in literature and it has also not attracted serious attention by the citizenry. The study was embarked on to find out if junior secondary school students practice good menstrual hygiene and whether they face challenges during menstrual periods, with its implication for Home economics education.
METHODOLOGY

The researcher adopted the survey method of research, collected and analysed data from a representative sample of the population of post-menarche girls of junior secondary schools.

The population of the study was made up of the post-menarche girls in all the Junior Secondary Schools in Benin City. They need adequate information on menstrual hygiene. A representative sample of 500 post menarche junior secondary school students were used for the study. The multistage method of sampling was used. The schools in Oredo Local Government Area were zoned into five groups by location. Two schools were randomly selected from each zone. Fifty questionnaires were administered in each of the schools to get the representative sample of 500 students.

A structured questionnaire titled Menstrual Hygiene Practices (MHP) was used as instrument of data collection. The questionnaire was made up of two sections. Section A. contained three items for biodata while section B. had eighteen (18) items where respondents were required to tick selected options.

The data were fed into a computer and analysed, using the Microsoft Excel electronic spread sheet, Office 2007 version. Frequency tables were generated. In addition, percentages and mean values with standard deviation were calculated.

RESULTS

Five hundred (500) questionnaires were distributed and collected. 494 were sufficiently filled for analysis. The mean age of the respondents was 14.3 ±1.3, range 12 to 17 years. Figure 1, shows the age in years, the age group 14-15 was the most common (43.7%), next 12-13 years (34.2%). The average age at first menstruation was 12.88 ± 1.1 years, range 10-15 years. Figure 2 shows that 65.8 percent of the respondents have their first menstruation (menarche) between 12 and 13 years of age, while 24.3 percent of the student experience menarche at 14-15 years. Christian’s respondents were the majority (92.3%), while traditional African religion made up 5.1%. Table 1 is a summary of the respondents’ religion. 451 (91.5%) of the respondents had knowledge about menstruation before their menarche, while 42 (8.5%) had no information. Mothers were the major source of information 238 (52.2%), next is teacher 156 (34.2%), and sisters 52 (11.4%). Table 2 shows the respondents’ information source about menses before menarche.

The majority of respondents 480 (97.4%) think that menstruation is a normal body function, while 13 (2.6%) think it is a disease condition. Majority of the respondents, 395 (84.5%) could explain the function of the menstrual cycle. Figure 3 depict the responses of the students to the question can you explain what the menstrual cycle is about?

A total number of 349 (70.9%) of the respondents reported some form of disturbance and or inconveniences during their menstrual periods. 143 (29.1%) have none. Abdominal pains and cramps were the major complaints 264 (75.6%), next is feeling depressed, 41 (11.7%) of the respondents. Table 3 is a summary of the disturbance/inconveniences reported felt by the students. A large majority 63.9% do nothing to relieve the discomfort, while 61 (17.5%) visit a doctor for treatment as shown in table 4. Table 5 shows the distribution of the sanitary materials used to collect
menstrual blood by respondents in the study. Eighty three (83.4%) use sanitary pads, while none (0.0%) use the Tampons. Sixty eight 68 (13.8%) students have absented themselves from school during menstruation (Table 6). The major reason from absenteeism from school/examinations was severe menstrual pain [dysmenorrhea] 49 (72.1%) students (Table7), while no student absented because of religious ground. More than half (52.1%) of the student change their sanitary pads twice daily (Table 8); and a majority of 83.9% (Table 9) bathe two or more times a day. Most of the students burn their sanitary material (39.6%) as shown in table 10, but a small minority (16.5%) flush their sanitary pads in the toilets.

A large majority, 93.9% of the students felt that enough of information is being taught on menstrual hygiene in the school curriculum (table 11). To improve awareness of menstrual hygiene practice among teenage girls, a large majority (47.3%) advocated for an increase in public enlightenment and discussion to be organised in the society, 15.8% suggested an increase in the toilet facility by government in the public schools. Table 12 shows the different suggestions made by the students to improve menstrual hygiene practices.

**DISCUSSION**

It is evident from the result of the study that most of the students have some information about menstrual hygiene before their first menstrual period. This agrees with the result of study conducted by Wateraid in Nepal. (Wateraid, 2009) The major source of the information to the students is their mothers, closely followed by their teachers. This shows that adequate knowledge about menstrual hygiene is imparted to the students during school work. This is further confirmed by the result of the study where many of the students saw no need to teach menstrual hygiene more extensively in schools. Most of the students are aware that menstruation is a normal body function and can explain what the menstrual cycle is about. Majority of the students use disposable sanitary pads as absorbent materials to collect their menstrual blood. This is unlike Wateraid’s study of adolescent school girls where more of them make use of new pieces of cloth. (Wateraid, 2009) More than half of the students change their sanitary towels, and take their bath two or more times daily. Majority of the students dispose of their used absorbent materials by burning or putting them in refuse dumps. The study show that they are not secluded or excluded by any cultural or religious taboo as reported by Banes et al in1980 in Guterman et al (2008). Many of the students experience abdominal pains during their menstrual period, but do nothing to relieve it while few of them visit a doctor. A few of them absent themselves from school as a result of abdominal pains. A few of them also feel depressed during their menstrual period. A large majority of the students advocate for an increase in public enlightenment and discussion to be organised in the society as a measure to increase awareness about menstrual hygiene.

**CONCLUSION**:

The standard of menstrual hygiene practice amongst Junior Secondary school girls in Benin City is lofty (high). There is need to increase and sustain the present level of awareness as a significant minority flush their sanitary pads in the toilet. The objective of helping students to develop good menstrual hygiene practices, in teaching menstrual hygiene, as a sub-topic under puberty, in JSS 2 Home economics is achieved among Junior Secondary School students in Benin City.
RECOMMENDATIONS

From the study, it is recommended that the government should improve and increase toilet and other sanitary facilities in the schools. House owners, parents and guardians should improve toilet and other sanitary facilities at home. Parents and guardians should provide adequate sanitary towels for their children during menstrual periods.

Figure 1: Age in years

Figure 2: Age at Menarche
Table 1 – Respondents’ religion

<table>
<thead>
<tr>
<th>Religion</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christianity</td>
<td>456</td>
<td>92.3</td>
</tr>
<tr>
<td>Traditional African religion</td>
<td>25</td>
<td>5.1</td>
</tr>
<tr>
<td>Islam</td>
<td>13</td>
<td>2.6</td>
</tr>
<tr>
<td>Judaism</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Hindu</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>494</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 2 Source of Information

<table>
<thead>
<tr>
<th>Sources</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
<td>238</td>
<td>52.2</td>
</tr>
<tr>
<td>Teacher</td>
<td>156</td>
<td>34.2</td>
</tr>
<tr>
<td>Sister</td>
<td>52</td>
<td>11.4</td>
</tr>
<tr>
<td>TV/Electronic Media</td>
<td>10</td>
<td>2.2</td>
</tr>
<tr>
<td>Other Relative</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>456</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3: Disturbances experienced during menses

<table>
<thead>
<tr>
<th>Disturbance</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal Pains and Cramps</td>
<td>264</td>
<td>75.6</td>
</tr>
<tr>
<td>Depression</td>
<td>41</td>
<td>11.7</td>
</tr>
<tr>
<td>Feeling Sick</td>
<td>22</td>
<td>6.3</td>
</tr>
<tr>
<td>Weakness &amp; unable to walk</td>
<td>13</td>
<td>3.7</td>
</tr>
<tr>
<td>Vomiting</td>
<td>9</td>
<td>2.6</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>349</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 4: Remedy sort for disturbance relief

<table>
<thead>
<tr>
<th>Relief</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing</td>
<td>223</td>
<td>63.9</td>
</tr>
<tr>
<td>Visit a Doctor</td>
<td>61</td>
<td>17.5</td>
</tr>
<tr>
<td>Buy medicine from chemist</td>
<td>46</td>
<td>13.2</td>
</tr>
<tr>
<td>Given drugs by parents</td>
<td>19</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>349</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 5 – Absorbent material used by respondents

<table>
<thead>
<tr>
<th>Absorbent</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary pad</td>
<td>412</td>
<td>83.4</td>
</tr>
<tr>
<td>Pieces of clothe</td>
<td>34</td>
<td>6.9</td>
</tr>
<tr>
<td>Toilet Tissue paper</td>
<td>27</td>
<td>5.5</td>
</tr>
<tr>
<td>Menstrual cup</td>
<td>14</td>
<td>2.8</td>
</tr>
<tr>
<td>Reusable sanitary materials</td>
<td>7</td>
<td>1.4</td>
</tr>
<tr>
<td>Tampons</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>494</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 6- Number of respondents absent from school

<table>
<thead>
<tr>
<th>Absent</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>68</td>
<td>13.8</td>
</tr>
<tr>
<td>No</td>
<td>423</td>
<td>86.2</td>
</tr>
<tr>
<td>Total</td>
<td>491</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 7- Reasons for being absent from school

<table>
<thead>
<tr>
<th>Reason</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe pains (Dysmenorrhea)</td>
<td>49</td>
<td>72.1</td>
</tr>
<tr>
<td>Nothing</td>
<td>11</td>
<td>16.2</td>
</tr>
<tr>
<td>Inadequate toilet facility at school to change</td>
<td>8</td>
<td>11.8</td>
</tr>
<tr>
<td>My Religion forbids me doing anything</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8- How often do you change your absorbent (Sanitary) material

<table>
<thead>
<tr>
<th>Change</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once daily</td>
<td>38</td>
<td>7.8</td>
</tr>
<tr>
<td>Twice Daily</td>
<td>253</td>
<td>52.1</td>
</tr>
<tr>
<td>Three or more times daily</td>
<td>181</td>
<td>37.2</td>
</tr>
<tr>
<td>At the end of my menses</td>
<td>14</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td>486</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 9- How often do you bathe during your menstrual periods

<table>
<thead>
<tr>
<th>Bathe</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>7</td>
<td>1.5</td>
</tr>
<tr>
<td>Once a day</td>
<td>54</td>
<td>11.3</td>
</tr>
<tr>
<td>Two or more times daily</td>
<td>398</td>
<td>83.3</td>
</tr>
<tr>
<td>At the end of my menses</td>
<td>19</td>
<td>4.0</td>
</tr>
<tr>
<td>Total</td>
<td>478</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 10- Method of disposal of used sanitary material

<table>
<thead>
<tr>
<th>Disposal Method</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>By burning</td>
<td>182</td>
<td>39.6</td>
</tr>
<tr>
<td>Put away in a refuse dump</td>
<td>96</td>
<td>20.9</td>
</tr>
<tr>
<td>In a pit latrines</td>
<td>106</td>
<td>23.0</td>
</tr>
<tr>
<td>Flushing in the toilet</td>
<td>76</td>
<td>16.5</td>
</tr>
<tr>
<td>Total</td>
<td>460</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 11- Do you think enough is thought In school

<table>
<thead>
<tr>
<th>Information</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>462</td>
<td>93.9</td>
</tr>
<tr>
<td>No</td>
<td>30</td>
<td>6.1</td>
</tr>
<tr>
<td>Total</td>
<td>492</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 12- Suggestions to improve awareness Among teenage girls

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Include subject in family life education curriculum</td>
<td>153</td>
<td>31.9</td>
</tr>
<tr>
<td>Public enlightenment and discussion</td>
<td>227</td>
<td>47.3</td>
</tr>
<tr>
<td>Remove taboos about discussion</td>
<td>24</td>
<td>5.0</td>
</tr>
<tr>
<td>Religious bodies to encourage discussion</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Government to provide adequate toilet / Sanitary facilities in schools</td>
<td>76</td>
<td>15.8</td>
</tr>
<tr>
<td>Total</td>
<td>480</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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UNIVERSAL SERVICE: PROVIDING ACCESS TO TERTIARY EDUCATION THROUGH E-LEARNING

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National Open University of Nigeria, Lagos-Nigeria

Abstract
This paper is on the place of e-learning in facilitating access to tertiary education and the extent to which the achievement of universal service in the communications sector will affect the actualisation of e-learning objectives for tertiary education. The paper considers the problem of lack of capacity as a barrier to entry into the tertiary education sector, e-learning as a practical solution and universal communications service as a necessary ingredient for e-learning. The paper also looks at practical challenges posed by poor telecommunication service and experiences in the National Open University of Nigeria, the only single mode Open and Distance Learning institution in Nigeria.

1. INTRODUCTION
Education has long been recognised as a social service with direct effects on development levels in every nation. Education is even more important in Nigeria, where unemployment is rife resulting in intense competition for the few available jobs. Owing to onerous job requirements and competition for such jobs, tertiary education has become a necessity. Unfortunately, access to tertiary education is severely restricted by lack of carrying capacity in most conventional universities.

This paper is on the place of e-learning in facilitating access to tertiary education and the extent to which the achievement of universal service obligations in the communications sector will affect the actualisation of e-learning objectives for tertiary education. The paper considers the problem of lack of capacity as a barrier to entry into the tertiary education sector, e-learning as a practical solution and universal communications service as a necessary ingredient for e-learning. The paper also looks at practical challenges posed by poor telecommunication service and experiences in the National Open University of Nigeria, the only single mode Open and Distance Learning institution in Nigeria.

2. DEMAND-SUPPLY INEQUALITIES IN TERTIARY EDUCATION
Where tertiary education in Nigeria is concerned, demand far outweighs supply. This inequality is clear from the perennial problem of over-registration of candidates for tertiary education. Each year, millions of candidates register for the Unified Tertiary Matriculation Examinations (UTME) administered by the Joint Admissions and Matriculations Board (JAMB). Of the successful candidates, a substantial percentage is denied admission each year.

Aluede, Idogho and Imonikhe (2012) opined that only 5.2% to 15.3% of the thousands of candidates applying for admission into tertiary institutions are given admission each year. Despite the falling standards of education in Nigeria, this inequality in demand and supply is not attributable to mass failure but to lack of carrying capacity in the sense that there is insufficient infrastructure to train these students. The Nigerian Tribune in its July 15th 2010 carried a story titled ‘2010 JAMB, Survival of the Fittest’. The statement which was attributed to the Registrar of JAMB noted that of
867,000 candidates who made the cut-off points for admission under the UTME in 2010, only about 527,000 candidates would be admitted due to lack of sufficient spaces. The 360,000 students who could not be admitted would be required to write the examination the next year as part of the 1,493,604 other candidate who will sit for the examination in 2011. In 2012, a total of 1,503,931 students sat for the UTME while 1,644,100 sat for the 2013 UTME.

Open Distance and E-learning (ODEL) provides a solution to this problem. Owing to its emphasis in self learning and reduced need for face-to-face lectures, capacity issues related with lack of physical infrastructure do not arise. With ODEL the possibility of universal tertiary education becomes a reality. This mode of learning has been used effectively as an alternative means of delivering qualitative tertiary education in more developed nations like the United Kingdom where the Open University remains the largest academic institution with over 240,000 students. In 2006, the OU was ranked highest in students satisfaction and assessment /feedback. It was also ranked among the top six universities in the United Kingdom for quality of teaching, academic support and organisation/management. Through the Open University, Open and Distance learning has been used to increase capacity and train the workforce.

The concept of distance learning in tertiary education is not entirely new in Nigeria. Before the establishment of universities, many Nigerians took correspondence courses. Presently, several tertiary institutions have embraced distance learning as a flexible means of providing tertiary education without limitations as to time or location. Initially, this was achieved through the establishment of satellite campuses and outreach centres. In some institutions like University of Lagos and University of Ilorin, this has metamorphosed into distance learning centres for dual mode tertiary education. In addition, with the revival of the National Open University of Nigeria, single mode ODEL is now available for tertiary education in Nigeria thereby increasing capacity and reducing the need for physical connections between students and their teachers. For Nigeria, e-learning holds great potentials for increased access to qualitative tertiary education with added advantages of flexibility and cost effectiveness. It is however, largely dependent on information and communications technology (ICT), access to which is still a struggle in many parts of the nation. Owing to its importance for e-learning, communications service is an essential facility.

Limiting factors such as poverty and insufficient knowledge are the first barriers to effective use of ICT. Where these factors are absent, technical factors such as lack of or poor quality service become the next culprits. By its very nature, the communications sector is characterised by high barriers to entry and huge sunk costs. As a result, investments in the sector are few. Though the profit margin increases on the long run, the cost of entry is very high and not easily recouped. Where an investor invests in the sector and is forced out due to competitive disadvantage, initial investments are usually lost.

Considering the issues associated with the communications sector vis-a-vis its relevance for the development of other sectors, government involvement is necessary, at least, until the sector is fully competitive. Furthermore, the regulator must be active in ensuring that the service is freely available and not restricted by competition.

3. WHAT IS UNIVERSAL SERVICE?

Article 1(2) of the EU Universal Service Directive defines ‘universal service as the provision of a defined minimum set of services of specified quality to which all end users have access, at an affordable price in the light of national conditions without distorting competition’. Going by current
technological advances - particularly in the convergence of telecommunications and ICT media, many countries have set universal service standards with obligations on service providers and/or other regulatory bodies to attain such standards. Universal service standards vary from country to country depending largely on levels of development. Universal service standards in all countries include voice telephony with some countries stretching their standards to include data, number portability and/or disability access to telecommunications services.

Whatever the standards adopted in a particular country, the requisite services must have three common features namely availability, accessibility and affordability.

a. Availability does not necessarily mean that there must be one communications terminal per user. Instead, depending on the unique economic realities of the country in question, it refers to reasonable coverage with public or private access to a communications terminal.

b. Accessibility entails qualitative service which is available at a convenient location within walking distance of users. Where this is a public communications terminal, it should be open within convenient hours with an all inclusive design accessible to handicapped or physically challenged users. Users should also be able to get assistance where needed, in their use of the facility.

c. Affordability refers to ability of the consumers to pay for the service. Charges must be a small percentage of per capita income with various payment options and the ability to pay per use of small units of service e.g. single calls or hourly internet rates.

Current universal service standards for Nigeria include voice services, internet services and other network facilities.

In Nigeria, universal service means that 100% of a designated population are reasonably able to privately subscribe to and use a particular service at a specified quality on an individual, household or institutional basis.

It is instructive to note that the Nigerian definition differentiates between universal access, universal coverage and universal service. Sections 43(a) and 84(1) of the Universal Access and Universal Service Regulations 2007 define universal access to mean where 100% of a designated population can obtain, at a minimum, public access to a particular service at a specified quality whilst Sections 43(b) and 84(1) define universal service to mean where 100% of a designated population are reasonably able to privately subscribe to and use a particular service at a specified quality on an individual, household or institutional basis (emphases mine). Accordingly, whilst universal access relates to the use of public facilities, universal service relates to the use of private facilities. In Nigeria, telecommunications and internet services are available either privately (through personal telephones and computers) or publicly (through payphones or cybercafés). Due to the cost of personal computers and connection charges, majority of Nigerians patronize cybercafés.

In view of the foregoing and considering the economic realities in Nigeria, reference to the term ‘universal service’ shall be taken to include both universal access and universal service as defined in the Universal Access and Universal Service Regulations 2007 i.e. the ability of a designated population to obtain communications services through public or private means.
4. THE LEGAL AND REGULATORY FRAMEWORK FOR UNIVERSAL SERVICE IN NIGERIA

The Nigerian communications sector is regulated by the Nigerian Communications Commission (NCC) under the Nigerian Communications Act 2003 (NCA). The NCC is charged with responsibility to devise, manage and implement the universal access strategy and program in line with the policy and objectives of the Federal Government of Nigeria. In the exercise of its powers, the NCC promulgated the Universal Access and Universal Service Regulations 2007 (‘the Regulations’) to provide the framework for the design and implementation of universal access and universal service in Nigeria.

One of the objectives of the NCA is the promotion of universal communications services throughout Nigeria. In furtherance of this universal service objective, the NCA also created the Universal Services Provision Fund (hereinafter referred to as ‘the Fund’) to facilitate the rapid achievement of national policy goals for universal access to telecommunications and information and communication technologies (ICT) services. Some of the objectives for creating the Fund are as follows:

- To contribute to national economic and social development through enhancing the universal accessibility and availability of telecommunications and ICT infrastructure and services.
- To facilitate the provision of access to ICT services within a reasonable distance to all persons in Nigeria.
- To facilitate the provision of infrastructural development to rural and underserved areas in a non-discriminatory manner.
- To ensure effective utilization of funds to leverage investments in rural communications.

The Fund is managed by a Board known as the USP Board. The USP Board is charged with the responsibility of supervising and providing broad directions for the management of the Fund and the Fund Managers. The Fund contains monies pooled from several sources, including monies appropriated to it by the National Assembly, contributions to NCC based on levies paid by licensees, gifts, loans and aid.

In line with the universal service objectives of the Fund, the main beneficiaries are unserved areas, underserved areas and underserved groups in Nigeria. Whilst the goal of regulation is to achieve universal service for all Nigerians, the focus of the Fund is on unserved and underserved areas and/or groups because, it is expected that liberalization and competition in service provision will stimulate the achievement of universal service goals in other areas and groups. This is the case, for instance, in urban areas like Lagos, where all the service providers have a strong presence with necessary infrastructure and a viable market for communications services in place.

One of the key points for universal service under the NCA is the availability of relevant services to educational institutions. S113(4) of the NCA provides that the NCC shall, in determining the definition of institutions have regard to the educational, health and other socio-infrastructural needs of Nigerians (emphasis mine). Regulation 44(a)(v) and Regulation 44(b)(v) of the NCA also includes educational institutions in definitions ascribed to universal access and universal service.
The Fund also pays particular attention to the provision of universal access to telecommunications and ICT services in Nigerian institutions of learning, with projects such as the School Access Programme (SAP) - to provide internet access to schools with each beneficiary school receiving 100 computers with full internet access. Other programmes directed at the provision of access to communications services to educational institutions are the Tertiary Institution Access Programme (TIAP) and Creation of E-Libraries.

The Fund also has other projects which though not directly focused on e-learning will facilitate access to communications services for the purpose of e-learning. They include the Connectivity for Development (C4D) Programme - to encourage and facilitate the building of an e-society in Nigeria and promote a digital lifestyle, and the Community Communications Centre (CCC) Project under which the Fund aims to deliver one Community Communications Centre per senatorial district.

Progress made in the provision of communications services in Nigeria has received acclaim in various quarters. In 2010, the International Telecommunications Union (ITU) hailed the Nigerian communications sector as ‘one of Africa’s biggest success stories in its expansion of telecommunications and ICT’. This is largely due to the liberalisation of telecommunications services and the grant of unified licenses for the provision of voice and data services which has stimulated competition, resulting in the availability of an array of communications and network services with multiple service providers offering diverse services and plans to suit different strata of the society. From 866,782 lines in 2001 when the sector was liberalised, telecommunications connections have risen steadily to 164,892,379 in April 2013. Teledensity has also risen steadily from 0.73% in 2001 to 82.25% in April 2013. The same is true for internet usage. NCC statistics (2013) show that internet usage as at April 2013 was 34,928,770. According to Internet World Stats (2012), internet penetration in Nigeria was estimated at 200,000 in December 2000. Today, Nigeria accounts for 28.9% of all internet users in Africa. This marked increase in communications connections and usage in Nigeria can be attributed to the liberalisation of the communications sector and the deployment of new technologies such as Code Division Multiple Access (CDMA), Broadband and submarine cabling. The result of liberalisation is clear with improved pricing and availability of communications services.

The USP Secretariat and Board having been formally constituted, the Fund has commenced activities in fulfilment of its universal service mandate. Requests have been made for proposals to facilitate the SAP and TIAP programmes. The Zaria Community Communications Centre has also been completed. Furthermore, ICT and internet tools and facilities have been delivered to several educational institutions in Nigeria. As of 2009, a total of 474 schools have been provided with fully functional internet and ICT Facilities supplied by the Fund.

5. COMMUNICATIONS SERVICES AND E-LEARNING: PRACTICAL ISSUES

5.1 Telecommunications Service in Nigeria

The above statistics indicate a positive drive towards the attainment of universal service in telecommunications and ICT provision in Nigeria. However, they point more to the general as against the specific. For instance, teledensity refers to the number of telephone lines (including wired residential and business lines) per 100 people. A rough estimate of telephone penetration in a particular location, measurement of teledensity is usually done on a country wide basis. Whilst teledensity may show the extent of telecommunications penetration on a general scale, it does not
show the quality of service available. Furthermore, it may not clearly indicate the extent of access to communications services in specific regions, especially when considered in connection with universal service which focuses more on availability, affordability and qualitative service to specific regions and groups. While there may be multiple connections and services available to consumers in cosmopolitan/urban areas where competition drives access and availability of service, it may not be the case for unserved and underserved areas where the subscriber base is usually insufficient to support viable competitive communications projects because of huge sunk costs and high barriers to entry associated with communications service provision. As a result, such unserved or underserved communities will be largely dependent on the achievement of universal service obligations as mandated by the regulator, if they are to benefit from e-learning.

On a related note, achievement of e-learning will, to some extent, depend on quality and affordability of relevant communications services. The USPF Board is charged with the responsibility of enforcing quality standards in unserved and underserved areas. Also, the NCC as the regulator of the communications sector has been working actively in the discharge of its responsibility to protect consumers’ interests. The NCC, has taken on this task with significant results. In the past, incidences of poor service quality and network congestion were rife in Nigeria. Though such challenges still arise from time to time, the NCC has made appreciable progress in quality control for telecommunications services.

Unfortunately, the same level of progress is yet to be achieved with regard to internet services. Ituen (2010) opined that slow internet speed is a major impediment to Nigeria’s technological growth. It must be noted, however, that consumers in urban areas enjoy better internet service quality with competitive pricing made possible through the deployment of technology and infrastructure by profit driven service providers. Competition and market forces usually drive improvement in service quality and pricing of commodities. The same is true for telecommunications services. With the passage of time, it is expected that technological deployment occasioned by NCC’s liberalisation of communications services (particularly the recent deployment of submarine cables and licensing of additional service providers) coupled with soft touch regulation will help to drive down pricing and improve service quality for telecommunications services in Nigeria.

Figures 1 and 2 show a pictorial representation of telecommunications coverage in Nigeria, as provided by two of the major GSM telecommunications service providers – Airtel and MTN respectively. The information depicted in the attached pictures is representative and comparable to coverage for other telecommunications service providers in Nigeria.
As shown in the Figures 1 and 2, urban regions like Lagos, Port Harcourt and Abuja are saturated with telecommunications services whilst rural areas enjoy less coverage. In Nigerian urban areas, it is commonplace to find base stations in every locality inclusive of uninhabited areas. As a result, users
travelling along urban expressways enjoy telecommunications services because base stations are located even in such uninhabited areas. The same is not the case for unserved and underserved areas where telecommunications infrastructure is usually scanty, with poor quality service.

In a survey conducted by Mishra (2009) at the University of Maiduguri, 71.54% of respondents identified slow internet connection as the major problem encountered in their use of the internet. This is a common complaint in unserved and underserved regions, for the reasons stated above. In view of the sharp dichotomy in the level of access and quality of communications services available to consumers in different locations, the achievement of universal service benchmarks set from time to time will make a marked difference in the provision of services and infrastructure to facilitate e-learning in the unserved and underserved areas of Nigeria.

5.1 Universal Service and E-learning: Experiences in National Open University of Nigeria

The National Open University of Nigeria (NOUN) is the only specialist provider of open and distance education in Nigeria. It is also the largest tertiary institution in terms of student population. The main focus of the institution being to educate the Nigerian workforce, NOUN offers over 750 courses of study from certificate to post graduate level. At present, there are over 50 study centres situated at various locations in Nigeria. The Study centre is designed to be the hub of activity with study materials available for pick up-and interactions made possible between students and facilitators, tutors and student counsellors who offer support as required by students.

In line with recent advances in distance education, the emphasis in NOUN is on e-learning. Owing to the continued use of the iLMS platform, admission and course registration are initiated online. Upon completion of registration, students are entitled to hard copy study materials, available for collection from their respective study centres. These course materials are also available online for free download.

Continuous assessment in NOUN is in form of tutor marked assignments (e-TMAs) which students are required to complete online through their personal student portals. E-exams have also been introduced with students writing pre-formatted computer based examinations at designated examination centres.

Most NOUN study centres are located in state capitals or regions where internet service is readily available. Exceptions are Special Prison Study Centers located in certain prisons for access to prison inmates. Internet service is not available to prison inmates so, students in those centers are assessed through hard copy examination questions which are marked manually. Though some of these areas in which NOUN study centres are located would qualify as underserved areas because of the level of internet penetration, students can access the internet through commercial cybercafés – on a pay per view basis or through broadband internet access provided by major telecommunications service providers. There are plans to deploy wireless internet services to facilitate e-learning in all study centres but some study centres do not have ready internet access at present.

The NOUN headquarters where all academic departments and academic staff are located has internet facilities of satisfactory quality. This facilitates study and research as well as preparation and uploading of relevant study materials, e-TMAs and e-Exams. There is a physical library situated at the headquarters for use by staff and students and the NOUN e-library contains a large collection of electronic resources. From our research, there is no conclusive indication whether NOUN has
benefitted from the Fund. All academic staff and most administrative staff have access to computer systems with internet access. There are also a number of computer laboratories in the Headquarters.

Whilst it is commendable that the above facilities are in place for e-learning in NOUN, we must not lose sight of the fact that proper service delivery is dependent on quality of service and affordability. It can be argued that anyone who can afford tertiary education should be able to afford commercial internet access. However, service quality is another matter. Though not dependent on users’ economic abilities, service quality has a direct effect on the quality of education received by students. Moreover, issues of affordability will arise where students have to purchase internet connection repeatedly to complete assignments which would ordinarily be completed in a single browsing session but become impossible to complete because of service failures.

Complaints regarding internet service quality are recurrent in Nigeria, regardless of location. In NOUN, for instance, students regularly complain of their inability to complete their registration, access relevant information and/or log onto their portals to complete their e-TMAs. Such complaints have resulted in deadline extensions to enable students meet their continuous assessment obligations.

6. A WAY FORWARD

The e-learning project is commendable and holds positive prospects for increased access to tertiary education in Nigeria. However, e-learning objectives stand the risk of under-achievement in the face of current challenges associated with access and quality of communications service in Nigeria.

The requisite legal and regulatory framework is in place to ensure the success of e-learning in Nigeria. Accordingly, implementation should be carried out with utmost seriousness and urgency if the teeming applicants for tertiary education are going to have a chance at achieving their dreams.

E-learning institutions occupy a unique position as specialist providers of open and distance education in Nigeria. Considering current literacy rates, such institutions are veritable avenues for ensuring the achievement of social justice and qualitative education for all. They must therefore be encouraged to leverage on this unique status to obtain the requisite facilities for the achievement of their e-learning objectives.

Additional physical infrastructure can be put in place but infrastructure will always be limited by time and space. Considering the numbers of students denied admission yearly because of lack of capacity, there is a lot of building to do. This is however not a sustainable solution because demand for tertiary education increases on a yearly basis but continuous construction is impracticable. Conventional universities should therefore borrow a leaf from NOUN and put alternative modes of learning in place as obtains in developed climes. For those who are already exploring the distance learning option, e-learning needs to be seen not as a change in the status quo but an improvement thereon.

As demonstrated in NOUN, single mode ODEL institutions are not restricted with respect to available slots or infrastructure. Communications service being an essential component of qualitative e-learning, the successes of ODEL can be further strengthened through universal access to the service.

The following recommendations are therefore in order:
a. The Fund must expedite action on the completion of on-going rural connectivity projects especially those with educational objectives.

b. Service quality must be monitored on a continuous basis to guarantee the attainment of requisite objectives of the Fund.

c. It is suggested that the Ministries of Education and Communication should jointly generate and monitor a practical road map for the attainment of universal service in educationally disadvantaged communities who will benefit from e-learning.

d. Study centres of e-learning institutions should be equipped with ICT facilities and internet connectivity which will be freely available for student use especially during busy periods such as registration and assessment periods.

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RELEVANCE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND REMOTE SENSING (RS) TO ENVIRONMENTAL EDUCATION: A PANACEA FOR SUSTAINABLE DEVELOPMENT IN NIGERIA.

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Abstract

Human have demonstrated interaction with the environment through the quest for industrial development, increase in agricultural products, construction of roads, houses and social amenities, fishing for food, mining, excavation and other human activities, all of these have indeed led to a serious environmental problems, however on daily basis, environmental degradation resulting from environmental abuse is rapidly and constantly experienced, hence the need for educating the population on the environment. It should be noted however that, the development in the knowledge of Geoinformatics such as Remote Sensing, Geographic Information Systems, Global Positioning System has help greatly in the understanding of the space technology as well as applying it in every sector of human endeavour. In this paper an attempt is made to explain the relevance of GIS and RS to Environmental Education towards Sustainable Nation Development.

Keywords: Geographic Information Systems, Remote Sensing, Environmental Education, Sustainable Development, Nigeria.

INTRODUCTION

The goal of sustainable planning, policies, and governance is to design processes that return our planet to a more balanced level of use. To do so we must realign our values and earth’s ability to support them. The success of this effort is dependent upon a foundation of science and technology knowledge particularly geoinformatics technology, Environmental Education, as a means of collaboration, and the implementation of sustainable policies and administration. Geographic Information System and Remote Sensing as components of geoinformatics technology are essential tools for designing and implementing sustainable processes at a scale ranging from local to global.

The earth environment has provided mankind with the most valuable and greatest asset; he depended on it for his agricultural practices to produce his food and raw materials for his industries. The Rivers, Seas, and Oceans compliments the agricultural produce of man with water resources, the vegetation also provide forest product for man consumption etc.

The importance of science and technology in the development of any nation of the world is no longer a doubt; in fact countries of the world are classified as developed, developing or
underdeveloped mainly on the basis of their scientific and technological developments, Itamah (2007).

Further more for any development to be meaningful in any nation there is need for effective knowledge in science and technology particularly space technology which can provide efficient data and information on the environment which will brings effective sustainable development in the world and the Nigeria in particular.

The National Policy of Education made it clear on the critical issues of science and technology where it stated that, science and technology have been the critical instruments used to uplift the economy of any country but their absorption and application depend very much on the environment Federal Republic of Nigeria (2004).

It should be noted however, all over the world today we depend on the environment for all our needs such as health, food safety and survival, though through our activities consciously or unconsciously we continuously destroying the environment more especially through the advancement in human activities such as industrial, agriculture etc hence the need for environmental education to educate environmental users on the danger of tempering with the environment and without proper maintenance of environment if at all we want have a sustainable national development in Nigeria.

However, in Nigeria today to attain sustainable development there is the need for modern and vibrant environmental education strategy that provides every Nigerian to facilitate and provides the nation with adequate manpower to exploit the natural environmental potential for growth and development. Therefore it advocates for transparency and involvement of the broadest representation of stakeholders, groups and socio-political perspectives, Report of the Federal Republic of Nigeria (2004).

In this paper an attempt is made to explain how relevance is geoinformatics technology particularly Geographic Information Systems (GIS) and Remote Sensing (RS) to environmental education and how this can enhance sustainable development in Nigeria.

What is Geographic Information Systems (GIS)?

The use of Geographic Information Systems (GIS) and Geographical Information (GI) plays a key role in human activities today. Geographic Information Systems is widely applied in everyday life by many of the services we rely on. It is one of the fastest growing uses of computer technologies and is a fundamental part of modern geography.

A Geographic Information Systems (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth’s surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships.

The techniques of Geographic Information Systems can include all stages of data collection, data processing, data base management, data analysis and modelling and data presentation, to end use in the creation of maps and spatial information products, Ikhuoria and Rilwani (2002). They further argued that, Geographic Information Systems (GIS) principles involve data gathering, data
processing, database management, data modelling and visualisation in a digital computer environment. Automated data capture systems include multi-spectral remote sensing processes, Global Positioning System (GPS) data, map digitisation and scanning, and computer input and output technologies.

Geographic Information System (GIS) is a technological tool for comprehending geography and making intelligent decisions. GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. However, Geographic Information Systems can combine information from cartographic sources maps in particular, earth bound surveys, remote sensing (aerial and satellite imageries) and create overlapping layers that can be accessed, transformed and manipulated interactively in one spatial structure, Kaminska et al (2004).

Fabiyi (2004) defined Geographic Information Systems as a unique integration of computer hardware, software, peripherals, procedural techniques, organizational structure, people and institution for capturing, manipulating, storing, analyzing, modulating, modeling and displaying geographically referenced data for solving complex human related problems. This definition suggests that Geographic Information Systems is neither the software nor hardware, it neither is the procedure to solve problem, but a good integration of all these components of Geographic Information Systems.

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth’s surface. Geographic Information Systems can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships.

With Geographic Information Systems technology, people can compare the locations of different things in order to discover how they relate to each other. For example, using Geographic Information Systems the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands, such a map would help people determine which wetlands are most at risk.

**What is Remote Sensing (RS)?**

Remote Sensing involves the acquisition of spatial data of the environment without physical contact with the objects or features being sensed by using electromagnetic energy radiation, interaction and detection principles in analogue or digital formats.

Cambell (2006:6) described remote sensing as the practice of driving information about the earth’s land and water surfaces using images acquired from an overhead perspective, by employing electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from earth’s surface.

Similarly, remote sensing is the science and arts of obtaining information about an object, area, or phenomenon through the analysis of that acquired by device that is not in contact with the object area or phenomenon under investigations, Lillesand et al (2004).

It is important to note that before any process of remote sensing to occur there certain elements that comprises the process of remote sensing, thus, energy source or illumination, radiation
and the atmosphere, interaction with the target, recording of energy by the sensor, transmission, reception, and processing, interpretation and analysis and finally application. These seven elements comprise the remote sensing process from beginning to end.

**The Concept of Environmental Education**

The environment virtually encompasses everything in the world around us. This includes both natural, physical, biotic and abiotic as well as human socio-economic features. Geographers have long claimed interest not only in the unity that exists in the biosphere (ecosystem concept), but also in the intrinsic quality of individual places. Hence, geographers as resource analyst seek to understand the fundamental characteristics of natural resources and the process through which they could be and should be allocated and utilized to meet the needs of today and tomorrow. However it is clear that environmental education it is a process that is designed in order to enhance a critical way of thinking and knowledge which is expected to give a proper approach to the prevention and recovery of environmental damages.

Environmental education refers to organised efforts to teach about how natural environments function and, particularly, how human beings can manage their behaviour and ecosystems in order to live sustainable. The term is often used to imply education within the school system, from primary to post-secondary. However, it is sometimes used more broadly to include all efforts to educate the public and other audiences, including printed materials, websites, media campaigns, etc. Related disciplines include outdoor education and experiential education. Outdoor education means learning in and for the outdoors. It is a means of curriculum extension and enrichment through outdoor experiences. Experiential education is a process through which a learner constructs knowledge, skill, and value from direct experiences. Experiential education can be viewed as a process and method to deliver the ideas and skills associated with environmental education, Palmer (1998) cited in Karydas and Manakos (2008).

The Nigerian environment is saddled with many activities in which its quality is being degraded. Such environmental problems like deforestation, flooding, erosion, industrial pollution, oil pollution, rainstorm, bush burning, solid waste management to mention but a few are bedeviling the country Ajibade, (2000). These sets of problems have encouraged underutilization of resources and generated or subjected many of the populace to poverty.

Environmental or conservation education aims; to provide learners with the opportunity to gain an awareness or sensitivity to the environment, knowledge and experience of the problems surrounding the environment, to acquire a set of values and positive attitudes, to obtain the skills required to identify and solve environmental problems and, the motivation and ability to participate Jacobson et al., (2006).

Lawal (2008), defined environmental education as the learning process through which is imparted to its target groups in Schools, Homes, factories, farms, markets, etc, the environmental sensitive awareness, knowledge, attitude, skills, commitments and civic action needed for understanding, protection and improvement of the environment and the prevention or solutions of its allied problems.

In another development, Muibat et al (2008) opined that, environmental education is a problem solving techniques which is concerned with the experience, observation, monitoring and
measurement with environmental systems and problems aimed at solving environmental issues the world over, it uses both scientific and humanistic approaches of taking responsibility for the whole system. They further argued that, environmental education is conceived as a platform to explore the entire gamut of education for the purpose of ultimately changing the entire behavior of the society towards the biosphere, this is in order to achieve the objectives of conservations, thus formal environmental education, non-formal environmental education, community based environmental education and special (professional and vocational) environmental education.

The declaration of 2005 to 2014 as the Decade of Education for Sustainable Development heralds a new phase in the continuous evolution of environmental education and its subsidiary, conservation education. This initiative, for which UNESCO is the lead agency, is an international educational effort that aims to encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability and a just society for present and future generations UNESCO, (2005).

Approaches to environmental education have evolved dramatically from their natural science base of the 1960s to a social sciences orientated perspective in the 1990s and present day Palmer and Birch, (2005). Originally environmental education was considered to be simply nature studies and it was only in the 1970s that environmental studies and conservation education first emerged. In the 1980s, the promotion of environmentally responsible behaviour became the primary goal of environmental education Mappin and Johnson, (2005), so that the broad title of environmental education now included global education, politics and development studies.

In the last 15 to 20 years this has been expanded to incorporate capacity building and action research aimed at the resolution of socio-economic problems Palmer and Birch, (2005). In effect environmental education has become education for behavioural, personal and social change Mappin and Johnson, (2005).

Education, both formal and informal, is widely used as a conservation intervention in order to develop positive attitudes, and it is often assumed that effective education will automatically lead to environmentally responsible behaviour Dobson, (2007).

Environmental or conservation education aims; to provide learners with the opportunity to gain an awareness or sensitivity to the environment, knowledge and experience of the problems surrounding the environment, to acquire a set of values and positive attitudes, to obtain the skills required to identify and solve environmental problems and, the motivation and ability to participate Jacobson et al., (2006).

It should be noted that, in Nigeria nowadays there are increase in environmental degradation geometrically with industrialization and agricultural intensification as such it is paramount for the general populace to be awaken and educated by both government and all stake holders in the country on the danger of tempering the naturality of the environment, this will indeed bring about positive changes and thereby prevent any future disasters in our environment.

**The Concept of Sustainable Development**

The concept of sustainable development touches upon all aspects of the social and institutional fabric. In this sense sustainable development provides a way of articulating the overall social project
and aim of development. Since the Earth Summit in 1992 in Rio de Janeiro, there has been increasing recognition of the critical role of education in promoting sustainable consumption and production patterns in order to change attitudes and behavior of people as individuals, including as producers and consumers, and as citizens.

According to Okebukola (2007), sustainable development means the fulfillment of human needs with protection of natural environment so that these needs can be met not only in the present but in the indefinite future. He further argued that unsustainable situation occur when natural capital (the sum of nature's resources) is used faster than it can be replaced. This result in to environmental degradation the consequences of which would be local environments that is no longer able to sustain human population to any degree, hence extinction of humanity.

Wikipedia (2009), define sustainable development as a pattern of resources use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present but also future generation.

Kaufman and Cleveland (2008) defined sustainable development as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable development can be seen not so much as a technical concept but as an educational one, not so much the end goal of a government policy but a process of learning how to think in term of forever, Ogunleye (2007).

Sustainable development has been amplified to integrate issues on economic growth, social development and environmental protection during the Rio Earth Summit of 1992 and the Johannesburg summit on sustainable development of 2002. It has generally been accepted that achieving sustainable development will require balancing the environment, social and economic considerations in the pursuit of development for an improved quality of life.

Sustainable development in no small measure does not focus solely on environmental issues but virtually all aspect of human endavour, the World Health Organisation (WHO) (2005) refers to the independent and mutually reinforcing pillars of sustainable development as economic development, social development, environmental protection and the fourth being cultural.

It should be noted that, development refers to changes and is basically used to describe the process of economic and social transformation within nations. In another development Goulet (1977) cited in Thirlwall (2004), opined that, development has three basic components. These are life-sustenance, which is concerned with the provision of basic needs such as housing, clothing, food and minimal education, another components is the self-esteem which is concerned with the feeling of self-respect and independence. However, there is no country that can be regarded as fully developed if it is exploited by others and does not have the power and influence to conduct relations on equal terms and final freedom refers to freedom free from three evils of want, ignorance and squalor so that people are more able to determine their own destiny. Man is not free if he can not choose, if he is imprisoned by living on the margin of subsistence with no education and skills. All the above components of development are interrelated, and interconnected.
It is obvious to note that, sustainability is paradigm for thinking about a future in which environmental, societal and economic considerations are balanced in the pursuit of development and improved quality of life. Further more, there are number of ideas and principles underlying sustainability, thus intergenerational equity, gender equity, just and peaceful societies, social tolerance, environmental preservation and restoration, poverty alleviation and natural resources conservation.

**Environmental Education and Sustainable Development**

The critical position of environmental education for sustainable development needs no emphasis with declaration of 2005-2014 as the decade for education for sustainable development. As opined by Okebukola (2007), the United Nation (UN) recognizes that there can be few more pressing and critical goals for the future generations, in a way that respects our common heritage the planet we live on.

He further argued that, the link between environment and development was first made in 1980 when the International Union for the Conversion of nature published by the world conservation strategy and used the term sustainable development. He added that, the field of sustainable development can be broken in to four constituent parts, thus: environmental sustainability, economic sustainability, social sustainability and political sustainability. It is therefore clear that, environment, hence environmental education is a key for realization of sustainable development.

It should be noted that, countries of the world have all developed suitable strategies in the direction of environmental education. Nigeria, however developed such strategies in the same direction, for instance in Nigeria there are the establishment of both Federal and State Ministries of environment which indeed is deliberate attempt to give the issue of environment a greater concern in the country’s desire to build greater and truly sustainable development.

The awareness among the public and industrial generators has to be created and motivated by the updated techniques and incorporating the innovative and implementable solutions to reform our economy. These can be achieved through environmental education.

It is important to realise that, environmental education has two fundamental components these components help tremendously toward successful environmental knowledge; these components include alerting the public to the need to achieve global sustainable development and the likely consequences of failing to do so and secondly focusing the educational curricula for global sustainable development by incorporating the know-how and skills and also the moral imperatives.

Environmental education is a process that is designed in order to improve a critical way of thinking and knowledge which is expected to give a proper advance to the prevention and recovery of environmental damages. Dasgupta (2007), stated what necessitate the need for environmental education in a society that required sustainable development like Nigeria. He further explained that, a society cannot survive if its natural resources are rendered unfit for use by its people; therefore most of the major natural resources in the country are in grave danger of irreparable damage and the only hope of salvaging this grave situation is by making the young aware that they need to practically begin to protect the environment they inherit.
Secondly, is the moral and ethical education for changing people’s attitude to protect children living in polluted regions is only through environmental education which represents a relevant means of prevention.

**Relevance of Geographic Information System and Remote Sensing to Environmental Education for Sustainable Development**

Koinyan (1999) in Ifemuyiwa (2007) says that, development starts only when man is able to take total control of his environment to manipulate and manage progressively every thing in that environment and to increase the production of all those things he needs to live a qualitatively better life, thus development is the ultimate desire of individuals, nations and any human endeavour.

Geographic Information System (GIS) and Remote Sensing (RS) software has proven to be a useful tool in both formal and non-formal environmental education programs. Although still not widely used in schools compared with other educational technologies.

Geographic Information System (GIS) and Remote Sensing (RS) has been shown to be a beneficial tool which can be used to analyze and integrate a variety of data pertaining to environmental issues. This is an attractive feature in a field characterized by a trend toward the use multi-disciplinary methods in the study of environmental issues which will enhance knowledge for populace in the improvement of their environment as well encourage sustainability in Nigerian environment.

As Geographic Information System (GIS) and Remote Sensing (RS) software, hardware, and training continue to become more accessible to schools, teachers, students, and general public can expect to see a continued increase in the use of Geographic Information System (GIS) and Remote Sensing (RS) for environmental education in Nigeria.

With Geoinformatics technology, Geographic Information System (GIS) and Remote Sensing (RS) in particular people can compare the locations of different things in order to discover how they relate to each other. For example, using Geographic Information System (GIS), the same map could include sites that produce pollution, such as gas stations, and sites that are sensitive to pollution, such as wetlands, such a map would help people determine which wetlands are most at risk.

There is no doubt that one of the most important prerequisites for sustainable development is the availability of accurate, reliable, up-to-date and standard geoinformatics data particularly that of Geographic Information System and Remote Sensing on natural and cultural resources of the country. Such data and information is required at various levels for different purposes, for example, a tourist who needs to know the location and direction of a tourist spot; demographers need information on the total number, distribution and composition of the population; industrialists need to know the best location to establish an industry; agriculturalists, foresters, soil scientists, environmentalists, policy makers and planners all need data and other vital information to chalk out the development activities and conservation strategies to achieve sustainable development.
Geographic Information System and Remote Sensing play several different yet complementary roles in relation to sustainable development and environmental education that will enhance sustainable development in Nigeria.

Geographic Information System provides a means of converting spatial data into digital form that can then be stored, retrieved, displayed, manipulated, modified, analysed, and reproduced quickly in a new format, available for either visual display or hard copy reproduction that to educate individuals on managing their environment for future destruction.

Geographic Information System can be used for constructing models for analyzing trends and identifying factors that affect them and to simulate the effect of a specific process over time for a given scenario. Such models can also be used for environmental impact assessment or for displaying the possible consequences of planning decisions or projects that affect resource use and management.

Forestry planners can use Geographic Information System and Remote Sensing to monitor the impacts of deforestation and the wildlife manager can use technology to determine the size and location of animal populations or to determine areas having high food and habitat potential for specific species and this provide information on the issue of food security.

Geographic Information System and Remote Sensing technology can also be used as a potential media tool for creating awareness related to the country’s natural and human resources and biodiversity conservation through environmental education.

Geographic Information System and Remote Sensing as new and upcoming technology in Nigeria can provides a platform for individuals and organisations to share and upgrade data and information and facilitate real time and instant communication network on the matters of environmental management for future uses.

It is important to note that, Geographic Information System and Remote Sensing technologies help to provide information and knowledge to policy makers and environmentalist on areas with severe environmental pressure which will provide efficient knowledge on how to manage the environment.

With development of geoinformatics technology in Nigeria it can serve as a tool for spatial data collation, processing, storage, indexing, retrieval, analysis and communication of spatial information, its use in the country for natural and water resources and environmental research, monitoring, analysis and management has a positive role to play in the effective monitoring, control and management of these resources towards finding solutions to the modern day environmental problems and natural resources management.

**Conclusion**

The field of Geographic Information System and Remote Sensing had a critical role to play in the use of geospatial data and information in national developmental issues, resource management, environmental monitoring and control, regional integration and international cooperation.
With the field of Geographic Information System and Remote Sensing critical to the development of various sectors of the economy including petroleum, solid minerals, forestry, agriculture, transport and aviation, environment, security, defense, tourism, population census, monitoring and control education, health and water resources management, its use as a decision making tool in the decision making process is of paramount importance which had been recognized by the government in Nigeria and other Africa nations.

However, while the integration of the Geoinformatics technology particularly in Geographic Information System and Remote Sensing is in the development stage in the country, positive steps had been taken by government and other stakeholders involved in the development and promotion of Geoinformatics use for research, training and production of empirical data for policy formulation at the local, regional and national level towards environmental monitoring and management, resource management and developmental planning.

However, there are expectations that having professional Geographic Information System and Remote Sensing consultants and experts will go a long way in developing the field of environmental education in the country for meeting future task and demand and solving modern day environmental and natural resources management problems.

**Recommendations**

There is the need to protect children living in polluted regions; environmental education represents a relevant means of prevention because this type of education encourages learner's awareness of their environment's ambient conditions, as well as their active participation in solving local problems. It is the need of the hour to propose environmental education with the essential elements of moral philosophy.

Conventional educational methods are no longer adequate for the real needs of tomorrow. Future engineers and also other students of specialised areas must acquire knowledge and skills in their own field and keep pace with rapid advances in practically all branches of engineering as well as the other areas of specialisation.

The communication perspective opens the door to other kinds of tools that environmental educators can use in order to improve the educational practice.

To this end a generic outline syllabus, including essential elements of moral philosophy has to be proposed for environmental education in schools and also undergraduate students in college level.

There are also challenges to be met in the area of Database development in the country with the implementation of institutional framework guidelines already set in place for the full integration of the Geoinformatics technology at every facet and levels of government and organisation in the country for better decision making and policy formulation and development.
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ABSTRACT

A cross-sectional survey was conducted to determine the prevalence of intestinal parasites among students of post primary institutions in two contrasting community in Imo State between March and September 2000. Stool sample were collected from 500 students (250 Urban and 250 Rural). Of the 500 male and female students between the ages of 10 and 26 years examined, 215(43.0%) were found to be infected, using the formal ether concentration method. Four nematodes, Ascaris lumbricoides, Enterobius vermicularis, Trichuris trichura, Hookworm, two cestodes and trematode were encountered during the study. More students in the rural school were infected (46.0%) than in the urban school (40.0%). The difference in infection rates in the two schools was statistically significant (chi-square(x²) =1.000, p>0.05). The most prevalent parasitic helminthes were hookworms (16.0%) and Ascaris lumbricoides (13.4%). Generally, female were more infected 161(53.5%) than males 54(27.1%). The prevalence rates between females and the males were statistically significant at, p>0.05. The prevalence of parasitic helminthes in relation to age, toilet hygiene level and parental occupation were also assessed. Results obtained showed that more students from the rural school were infected while their parental occupation affected the level of prevalence. It was recommended that school based deworming using albendazole and metronidazole, combined with hygiene promotion and improved sanitation be carried out. Further investigations are needed to determine whether helminthes represents a public health problem.

Keywords: intestinal parasites, helminthes, infections, hygiene and prevalence

INTRODUCTION

The public health and socio-economic consequences of intestinal helminthes are of considerable global concern particularly in the rural communities of developing countries where malnutrition and other factors complicate the impact of infection. Most parasitological surveys of common parasitic infections in Nigeria have been confined to the rural villages where poor sanitation and
domestic hygiene as well as a general ignorance of the diseases, provide optimal environment for their transmission (Nwosu, 1981). Intestinal parasite or soil transmitted helminthes (STH) are the most common Neglected Tropical Diseases (NTD) world wide which continues to cause significant morbidity in Nigeria and other less developed tropical and subtropical countries. In endemic countries, gastro-intestinal infections are most prevalent in rural communities, peri-urban settings and urban storm (Brooker 2004). Soil transmitted helminthic infections are among the most common infections worldwide and affect the poorest and most deprived communities. They are transmitted by eggs present in human faeces which in turn contaminate soil in areas where sanitation is poor. The main species that infect people are the Nematodes which include the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*), and the hookworms (*Necator Americanus* and *Ancylostoma duodenale*), *Enterobius Vermicularis* and *Strongyloides* (Wikipedia 2011). These infections are most prevalent in tropical and subtropical regions of the developing world where adequate water and sanitation facilities are lacking. Other species of intestinal helminthes are not widely prevalent instead; the burden of disease is related to less mortality than to the chronic and insidious effects on health and nutritional status of the host. In addition to their health effects, intestinal helminthic infections also impair physical and mental growth of children, their educational achievement, and also hinder economic development. To this effect, the World Health Organisation (WHO) comes up with the goal to reduce morbidity from helminth infections to such levels that these infections are no longer of public health importance and improve the developmental, functional and intellectual capacity of affected children. (WHO, 1990).

Parasitic nematodes generally belong to the phylum nematoda which consists of worms of relatively simple structure. As a result of the great adaptation shown by nematodes, they have been able to parasitize man, animals including livestock’s and plants. Nematodes as a whole are very successful animals and are second to the insects with respect to adaptive radiation. They are found in all possible ecological niches. The intestinal worms do not always require any intermediate host for their transfer to their main host. Man is infected by direct contact with the egg in faeces or through contaminated food, vegetable or water (Mohammed 1980, Roberts and John 1996). The mode of infection varies from one species to another, for instance, *T. Trichiura*, infection occurs when contaminated objects or food is ingested, while in whipworm infection, human faeces are not the source of contamination, but the faeces of carnivores or flesh eating rodents. Eggs of *Capillaria hepatica* have been found in several species of earthworms which are transport hosts that may facilitate infections in normal definitive hosts.

Gastro-intestinal helmintasis constitutes a feeding cause of morbidity. The parasites do not multiply in host, therefore, the intensity and severity of infection depend on the rate and level of initial infection, re infection and super infection. Disease symptoms do not manifest unless the host is heavily infected, hence the lesser emphasis on their importance. The health and socio-economic implications associated with intestinal helminthes are considerable, especially in the rural communities of the developing countries. (Ogbe and Odudu 1988-90). Between five
hundred and one million people are estimated to be infected with parasites with direct life cycles (Peters 1978). Although present throughout the world, low standard of sanitation and poor socioeconomic conditions are obvious predisposing factors to high prevalence of helminthes infections in the developing world. (Ogbe and Odudu, 1990). Most Nigerians are suffering from *ascariasis*, while there are several thousands with hookworm, *trichuriasis*, *enterobiasis*, *strongylodiasis*, tapeworm infections and other intestinal worms.

**EPIDEMIOLOGY/ GEOGRAPHICAL DISTRIBUTION**

The world health organization (WHO) estimates that over 1.5 billion people are infected with one or more STHs. Globally, there are 700 million people infected with Hookworm (including 44 million pregnant women), 807 million people infected with ascariasis, and 604 million people infected with trichuriasis (WHO,1990). Transmission mainly occurs in tropical climates and where sanitation and hygiene are poor. There is variation in epidemiology that is, the occurrence and the method by which the worms are acquired and spread. *A. lumbricoides* has a World-wide distribution, being especially prevalent in the tropics among malnourished people residing in the developing countries being at higher risk. Areas with modern water supply and waste treatment facilities have low incidence or infection with the parasite. *A. lumbricoides* eggs are destroyed in the environment by sunlight, desiccation pathogens and predators. However, it is not unusual to find at least 100 eggs in 1g of soil from an area of endemic ascariasis (Onadeko 1989). Also prevalent in the tropics are *strongyloides* spp. which occur in the tropical regions of Africa, Asia and South America. On the other hand, *Enterobius vermicularis* and *Trichuris trichiura* are cosmopolitan in distribution. *E. vermicularis* is more common in temperate regions became of less frequent bathing and changing of underclothing, but *T. trichiura* occurs more in worm, moist regions of the World (Bethony, 2006).

Several epidemiological studies have been carried out in rural and urban areas of Nigeria on the prevalence and intensity of intestinal helminthes. According to the work by Mafiana, (1995) *Ascaris lumbricoides, Trichuris, trichiura* and hookworm are most common. The major effect of these worms is morbidity rather than mortality and the morbidity effect is particularly most severe on children because of the heavy infection they harbor and because of their vulnerability to nutritional deficiencies. Hence extensive field investigations to locate the foci and determine patterns of transmission of intestinal parasites are very necessary for primary health care system in Nigeria. However, epidemiological data are sparse for most developing countries and the incidence of parasites can vary widely even in small areas (Heinz 1968) and between the rainy season and dry seasons. Edungbola, (1988-90) estimated that about fifteen million Nigerians are suffering from *ascariasis* alone, while there are several thousand with hookworm, *trichuriasis*, *enterobiasis*, *strongylodiasis*, tapeworm infections and other helminthic infections. Apparently, the epidemiology of human intestinal parasites is vastly recorded in Nigeria. In most cases hospitals records have become an increasingly popular method of determining prevalence of these diseases (Agugua N.E.N, 1983; Reinthaler et al, 1988).in addition, reports by Brooker et al, (2004) showed that larval stages of hookworm and *strongyloides* are found under the skin and in the
lung during their migratory stages. Similarly, investigations by Crompton D.W., (2001) revealed that adult *Ascaris* normally lives in the small intestine of the host where it feeds on the semi digested food, of the host, but there is evidence that it more frequently bites the mucus membrane with its lips and sucks blood and tissue juices to some extent.

**TRANSMISSION/LIFE CYCLE**

Intestinal worms are parasitic worms that are generally contracted either through ingesting parasite eggs or larva or direct penetration while walking barefooted on contaminated soil. Adult nematodes inhabit the gastro-intestinal tract. Eggs produced by the female are passed out in faeces. The eggs embryonate and hatch into first stage larvae (L1) which in turn moult into second stage larvae (L2). The L2 larvae moult into third stage larvae (L3), but retain the cuticle from the previous moult. This double-cuticle (L3) is the infective stage. The time required for the eggs to develop into infective larvae depends on temperature. Under optimal conditions (high humidity and warm temperature), the developmental process requires about 7 to 10 days, but in cooler temperature the process may be prolonged. Ruminants are infected by ingesting the L3. Most larvae are picked up during grazing and pass to the abomasums, or intestine, ex-sheathing the extra cuticle in the process. In some groups such as *Trichostrongyle* the L3 penetrates the mucous membrane. During the next few days the L3 moults to the fourth stage (L4) and remain in the mucous membrane or in the gastric glands, for 10 to 14 days. They then emerge and moult into mature adults which start egg production about 3 weeks after infection. The period between the infection of an animal by ingestion of infective L3 larvae and the first egg production by the adult female parasite is called prepatent period. This period is different for different species of parasites (wikipedia, 2011).

**SYMPTOMS**

Though symptoms vary, they include anemia, malnutrition, and vitamin A deficiency, swelling of the abdomen, weight loss, diarrhea, and inflammation of the intestine. The most serious complications are intestinal obstruction, usually of the small intestine. Pulmonary symptoms occur in a small percentage when *ascaris* larvae pass through the lungs. *Trichuris* infection can cause blood loss as well as dysentery and rectal prolapse. However, travelers are almost never at risk of these more severe manifestations of intestinal helminthes.

**DIAGNOSIS, TREATMENT AND CONTROL**

The standard method of diagnosing STHs infection is by identifying the parasites eggs in faeces under a microscope. Adult *Ascaris* worm may occasionally be coughed out/up or found in stool or vomit. Treatment is achieved using oral drugs. The drugs available are albendazole and mebendazole which are easy to administer by non-medical personnel. They are donated by Glaxo Smith Kline and Johnson and Johnson for STH control programs. They are administered either once or twice a year depending on the prevalence of infection. The aim of WHO control strategy is to reduce morbidity caused by the disease by periodically treating all populations at risk.
including pre-school children, school age children, women of child bearing age pregnant women in their second and third trimesters, and breastfeeding women, as well as adults in certain high-risk occupations. To break the cycle of transmission, it is essential that STH treatment efforts be accompanied by health and hygiene education that encourage healthy behaviors, sanitation and simple hand washing to prevent transmission.

MATERIALS AND METHOD

The Study Area and Population

The study area comprised Owerri Municipal and Mba’itoi Council Area, both in Imo State, Eastern Nigeria. Owerri is the capital of Imo State and the seat of administration with social amenities like water, electricity, good road network, hospitals, schools and good sanitation program. On the other hand, Mba’itoi is a rural Council area where there are inadequate provision of social amenities and infrastructural development. Two secondary schools were chosen randomly and used for the study, one from each Council Area. The schools are development secondary school in Owerri municipal council and Umunaoha comprehensive secondary school in Mba’itoi local government area. In Development secondary school the students are almost living within Owerri capital, their parents and guardians are mostly civil servants, business men and women. In contrast Umunaoha Comprehensive secondary school is more than 20 kilometers from Owerri capital. The natives engage in occupations like farming, driving, clay mining and molding as well as leather works. The study population comprised all the students of the selected schools while the sample size was 500 students drawn randomly from the two schools (250 from each school).

Study Design

The study was an experimental research and the detailed methodology included questionnaire administration to students, collection and analysis of samples. One week prior to and questionnaire administration and parasitological surveys, a written informed consent for the parents/guardian of participating children was sought. Copies of the questionnaire and small plastic containers for collection of stool sample were left with the teachers for distribution to selected children. During the school based survey, the signed informed consent sheets, and stool samples were collected. A short interview was held with each child, using a questionnaire pertaining to hygiene behavior, source of drinking water and general sanitation based on the standard tool provided by joint monitoring programmed of WHO and UNICEF. The school principal with the member of staff helped to organize the students for effective sampling.

Procedure for sample analysis

The main method was the formal ether techniques in which parasites are sediment by centrifugal force. The formal ether concentration method described by King (1979) was closely followed for laboratory examination of stool specimens. 0.5gm of faecal matter taken in a test tube was dissolved in some amount of normal saline solution which acts as a clearing agent. The solution was sieved with a trainer to remove large particles. They sieved suspension was collected in a
beaker and then transferred into a centrifuging tube, centrifuged for 5mins at 3000rpm. A sterile rod was then used to loosen the layer of faecal debris from the sides of the tube which was rapidly inverted to discard the ether, faecal debris and formal water. The sediment was then mixed with the sterile rod, transferred to a slide and covered with a cover slip. The entire preparation was then examined microscopically using x10 objective with the condenser iris closed sufficiently to give good contrast. The number of each of parasite’s ova in the entire preparation was counted and then multiplied by 2 to give the approximate number of each parasite per gram faeces.

**Statistical analysis**

Simple percentages and chi-square ($\chi^2$) test were used to analyze the results obtained from sample analysis and p=0.05 was taken as the acceptable level of significance (df=1, p=0.05). the statistical methods were used in other to provide a clear deviations between observed and expected values and a test of significance which are important in decision making.

**RESULTS**

Helminth eggs were prevalence in 219 (43.8%) (Table 1). Four nematode eggs namely; Hookworm (16.0%), *Ascaris lumbricodes* (13.4%), *Trichuïs trichiura* (2.8%) and *strongloides stercoalis* (3.6%) were encountered. Two cestode ova namely *Taenia* sp (3.2%) and *Hymenolepis nana* (1.6%), and only a trematod ovum *schistosoma, mansoni* (2.4%) were encountered during the study. From the distribution patterns of helminth parasites encountered during the study, more students were infected (46.0%) in the rural school (Umunaoha Comprehensive Secondary School) than in the urban school (Development Secondary School) (40.0%). Prevalence of helminth parasites varied among various age groups with an initial increase (33.3%) in the > 10 age groups peaked in the 16-20 age groups (49.4%) before a gradual decrease as the age increased (table 1). Although prevalence varied among the various parental occupations with farmers having the highest value, (66%), followed by fishermen (53.0%) and housewives as the least 31.5% (table 2). There was no difference in prevalence rate as it relates to the parental occupation of the sampled students (p>0.05). Helminth infection was also satisfied according to type of toilet facilities used. It was observed that 16.8% of the students in the rural area defecate in the bush, 14.8% use pit latrine, while 11.4% use water closet while the bucket system was found to be no longer in existence. As expected, those who defecate in the bush harbored more parasites especially nematodes (16.8%) than any other of toilet system. On sex related prevalence, 54 of the 199 (27.1%) males had infection while (53.5%) of 161 females were infected table 4. A chi-square analysis showed that there is a significant variation in prevalence rates among sexes (p<0.05).

**Table 1:** Prevalence of helminth infection in relation to age in the two schools (Positive for helminth parasite) n= 500
<table>
<thead>
<tr>
<th>Age (years)</th>
<th>No. examined</th>
<th>(%) Hookworm</th>
<th>(%) Ascaris lumbricoides</th>
<th>(%) Trichuris trichiura</th>
<th>(%) Strongyloides Stercoalis</th>
<th>(%) Schistosoma mansoni</th>
<th>(%) Taenia sp</th>
<th>(%) Hymenolepis nana</th>
<th>Total No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>93</td>
<td>12(12.9)</td>
<td>8(8.6)</td>
<td>1(1.1)</td>
<td>4(4.3)</td>
<td>1(1.1)</td>
<td>2(2.2)</td>
<td>4(4.3)</td>
<td>32(34.4)</td>
</tr>
<tr>
<td>11 – 15</td>
<td>179</td>
<td>39(21.8)</td>
<td>20(11.2)</td>
<td>4(2.2)</td>
<td>3(1.7)</td>
<td>3(1.7)</td>
<td>4(2.2)</td>
<td>2(1.1)</td>
<td>77(41.3)</td>
</tr>
<tr>
<td>16 -20</td>
<td>172</td>
<td>26(15.1)</td>
<td>35(20.4)</td>
<td>5(2.9)</td>
<td>5(3.5)</td>
<td>4(2.3)</td>
<td>7(4.1)</td>
<td>2(0)</td>
<td>84(49.4)</td>
</tr>
<tr>
<td>21 -25</td>
<td>47</td>
<td>3(6.1)</td>
<td>3(6.4)</td>
<td>6(12.8)</td>
<td>5(10.6)</td>
<td>3(6.4)</td>
<td>1(2.1)</td>
<td>0(0)</td>
<td>21(44.7)</td>
</tr>
<tr>
<td>26 +</td>
<td>9</td>
<td>0(0)</td>
<td>1(11.1)</td>
<td>2(22.2)</td>
<td>1(11.1)</td>
<td>1(11.1)</td>
<td>2(22.2)</td>
<td>0(0)</td>
<td>5(44.4)</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>80(16.0)</td>
<td>67(13.4)</td>
<td>18(3.6)</td>
<td>18(3.6)</td>
<td>12(2.4)</td>
<td>8(1.6)</td>
<td>219(43.8)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2:** Prevalence of parasitic infection in relation to parental occupation

<table>
<thead>
<tr>
<th>Parents Occupation</th>
<th>Total No. examined</th>
<th>No. Infected</th>
<th>% Infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil servant</td>
<td>180</td>
<td>46</td>
<td>42.5</td>
</tr>
<tr>
<td>Farmers</td>
<td>94</td>
<td>62</td>
<td>66.0</td>
</tr>
<tr>
<td>Business Men</td>
<td>136</td>
<td>52</td>
<td>32.2</td>
</tr>
<tr>
<td>Fisher men</td>
<td>19</td>
<td>10</td>
<td>53.0</td>
</tr>
<tr>
<td>House wives</td>
<td>143</td>
<td>45</td>
<td>31.5</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>215</td>
<td>43.4</td>
</tr>
</tbody>
</table>

**Table 3:** Prevalence of Helminth infection in relation to type of toilet facilities used

<table>
<thead>
<tr>
<th>Toilet facilities</th>
<th>Number examined</th>
<th>Total No. infected</th>
<th>(%) of infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bush</td>
<td>100</td>
<td>84</td>
<td>(16.8)</td>
</tr>
<tr>
<td>Pit toilet</td>
<td>100</td>
<td>74</td>
<td>(14.8)</td>
</tr>
<tr>
<td>Bucket</td>
<td>0</td>
<td>0</td>
<td>(0)</td>
</tr>
<tr>
<td>Water closet</td>
<td>300</td>
<td>57</td>
<td>(11.4)</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>215</td>
<td>(43.0)</td>
</tr>
</tbody>
</table>

**Table 4:** Overall sex-related prevalence of helminth parasites encountered during the study.

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. Examined</th>
<th>No. Infected</th>
<th>% Infected</th>
</tr>
</thead>
</table>


DISCUSSION

The result of this study have demonstrated the existence of seven different helminth parasites among students of two contrasting post primary schools within Imo – States, Eastern Nigeria. It also indicates that hookworms and *lumbricoides* were more prevalent in the areas under study. The results agree with those of Nwosu (1981). Onwuliri, C.O.E and Anosike,J.C (1993), and Agugua, N.E.N (1993) who reported that these parasites, particularly hookworms and *Ascaris* are common throughout Nigeria. The relatively high prevalence of helminthes (43.0%) observed here conforms to previous findings in Eastern Nigeria (Nwosu and Anya 1980). The variation in prevalence rate of intestinal helminthiasis in different rural and urban areas could be related to several factors including people’s level of education, standard of personal/environmental hygiene as well as social habits.

. In most surveys in Nigeria, no attempt has been made to distinguish between the two types of human hookworm infections. However, recent evidence has shown that two common species of hookworm in several parts of Nigeria are *Necator americanus* and *Ancylostoma*. The habit of defecating in the bush coupled with the eating of contaminated fresh fruits and vegetables with equally contaminated and unwashed hands by these students are the principal sources of infection, since *Ascaris* is acquired by ingestion of embryonated eggs. Similarly, hookworm infection occurs mainly through percutaneous route. Most students especially those from the rural schools examined seldom put on foot – wears and this could explain the high prevalence of hookworm infection. This, assertion is corroborated by the report in Wikipedia (2011) which has it that infective larvae penetrate the skin and gain access to the host.

Students below 20 years of age are mostly affected with helminth parasites. This could be as a result of their constant exposure to contaminated areas during defaecation in the bush, use off barefoot and poor hygiene. This agrees with the report of Aguga (1993), Obiamwe (1991), who found out that student whose parents are farmers and fishermen exhibit low level of personal hygiene. Furthermore earlier investigators in Nigeria, Agugua (1983) Obinniwe (1991), found out that males were exposed to the infection stages of helminthes as their females’ counterpart, indicating that both sexes were naturally equally exposed to parasitic infection. In contrast to the present work, revealed that infection was significantly higher in females than in males. Apart from the difference in number of students, the reason for the higher prevalence in females could be attributed to their involvement in domestic work, farming activities.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>199</td>
<td>54</td>
<td>27.1</td>
</tr>
<tr>
<td>Female</td>
<td>301</td>
<td>161</td>
<td>53.5</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>215</td>
<td>43.4</td>
</tr>
</tbody>
</table>
RECOMMENDATIONS

The gastro-intestinal tract of a child living in poverty in a less developed country is likely to be parasitized with at least one, and in many cases all the three soils- transmitted helminthes, with resultant impairments in physical, intellectual, and cognitive development. Therefore the following recommendations are made.

- In view of morbidity and medical complications of helminthiasis, free medical tests and periodic de-worming of students with benzimidazole anthelmintics, mebendazole, and albendazole should be carried and sustained to remove these infections in schools.
- That environmental sanitation and personal hygiene programmes be introduced to schools and communities, and sanitation laws be enacted and enforced on all citizens to curb the transmission and spread of helminthic diseases.
- That public enlightenment and school health services be extended to primary and post-primary schools in the state to create awareness on the occurrence, mode of infection and the health impacts of helminthic parasites. This calls for a synergy between the ministries of Education and Health.
- That more emphasis be laid on developing control and preventive measures rather than treatment, to reduce the occurrence and transmission of the diseases.

CONCLUSION

Prevalence of intestinal parasitic helminthes is worldwide but more common in developing countries as a result of poor sanitation, ignorance, poverty and malnutrition. In developing countries, the rural populace is more at risk than the urban due to inadequate provision of social amenities and poor infrastructural development. Helminthic infections are among the Neglected Tropical Diseases which have resulted to morbidity and mortality, and their control and prevention are one of the major challenges facing Nigeria and other developing countries of the World. The improvement of general standard of sanitation through the installation of suitable waste management and disposal facilities, and provision of pipe-borne water supply are important pre-requisites for successful prevention and control of helminthic infections in Imo State. Thus treatment, mass chemotherapy directed at school children will be a step in the right direction. More so, with the improvement in the standard of environmental hygiene and their social habits, health problems regarding helminthes infections in the study area in particular and Imo State generally could gradually be brought under control. The school teachers have a tremendous role to play in order to change this present situation.

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WHO statistic (1992) [www.who.int/.../en/](http://www.who.int/.../en/)


TEACHERS MANAGEMENT AND CONTROL OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) FACILITIES FOR EFFECTIVE TEACHING AND LEARNING IN JUNIOR SECONDARY SCHOOLS

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Abstract

Information and communication Technology (ICT) in the 21st century, has become a globalize issue in the education sector, on the improvement and actualization of standard in instructional process in the Junior Secondary Schools. ICT is replacing the face to face teaching and learning system in Nigeria Education system, so as to meet up with the demands of the global learning system. This paper therefore examined teachers’ management and control of learning at the Junior Secondary Schools in Umuahia North of Abia-State Nigeria. Four research questions were formulated to guide the study. A modified four point Likert scale questionnaire was structured by the researcher for data collection. The results of the scores were analyzed using the mean rating of 2.50 as the cut of point for all levels of decisions. The population for the study consisted of 15 JSS and 608 JSS teachers. A simple random sampling technique was adopted for the sampling of the respondents. Analysis of data was conducted and results of findings analyzed. Discussions of findings were made. Conclusions were drawn, and recommendations made on the ways forward, for effective management and control of ICT facilities to enhance teaching and learning in schools.

Introduction

Education is the main process through which society or the nation regenerate itself and hand down not just culture, but also its discoveries and inventions, institutional memory and its entire wealth of expertise to younger generations. Education is therefore the soul of society and if we remove education, the society decays and withers away using the words of Karl Marx (1848). The teacher is an important determinant of the pace of progress of any educational system. He is like a diver who is driving a vehicle to a destination. No input is more critical in the education system than the teacher. His action can either make or destroy the system. His job is very powerful, that it can be said to be the reproduction of the society. No society can grow more than the teacher.

According to the National Policy on Education (2008) stated that “no educational system can rise above the quality of the teachers.” Also the school is an insignificant part of the society. It cannot operate in isolation of the society, it must be part of it, by reflecting the culture, norms, values and aspirations of the society. In the consideration of the importance of the teacher in the reproduction of the society, it is therefore very expedient to get such teachers well equipped for the reproduction of the society.

But the problem is that most of these teachers are not conversant with the use of ICTs for teaching in the classrooms. They cannot actually turn on the Lap/desk top, computers, let alone use it as managers of the classrooms, to teach, as it is a globalize instructional process, for effective leaning.

More so, they lack the interest, competence and ICT facilities tat can aid instructional process. To fill this gap, solutions are sought through a rigorous systematic process, to finding a lasting solution to them.

The information age is not just affecting the workplace; its influences are felt in our educational system too. New and emerging technology challenges the traditional instructional process and the way education is managed. It is vital that the teachers in the JSS keep pace with the challenges of modern teaching strategies that are used in delivering concepts to the learners. Problems of ICT facilities, which come to ones mind
include, difficulty of access, exorbitant cost, irregularity of access, above all there is unqualified and lack of manpower. Ali (2002) reported that about 90.2% of Nigerians have no satellite-based remote sensing, telescope or Global system Mobile (GSM) networking, no computer network system in offices and at schools, even the ones we have are of substandard as the standard ones are expensive to come by. School administrators should therefore ensure the availability and utilization of the ICT facilities. Research have identified that Nigeria is much backward in the use of ICT in education (Obagah 2003). Only a few schools have ICT facilities and they are in the private schools, the public schools have nothing to show. ICT facilities can contribute to the attainment of our educational goals, but if not dictated and used, properly, can frustrate the goals. Hence the focus for this paper.

The purposes for the study of this work therefore are to:

1. Investigate teachers management and control of ICT facilities for effective teaching and learning in the classroom in JSS in Umuahia north L.G.A. of Abia State.
2. Investigate that teachers are computer literate but lack ICT facilities for instruction.
3. examine whether with availability of ICT, teachers have interest to use ICT in the schools.
4. Find out school administrators implication for the use of ICT facilities in schools.

The significance of this paper will, enable all the teachers to have the knowledge, competencies interests and skills to operate the ICT facilities for instructional process. Information and communication Technology (ICT) has great potential applications in all aspects of life, especially in science. Its potentials and applications lie in the use to collect, process, store, edit, retrieve and pass information in various forms. Being the most current technology application to different fields of human endeavour, education inclusive, several studies have been conducted and used to move the nation forward through science education (Ezeliora 2003 and Okwo 2002). The use and application of ICT facilities in secondary schools is desirable, consecrating its relevance to technological advancement and national development. The Junior Secondary Schools JSS precisely, will also benefit. They will act as tools for solving the problems of health, over population, agriculture and others. ICT will substantially change the world, create new patterns of social and economic interactions and transforming life styles, work and communication. ICT will help learner become familiar with the use of ICT facilities since all jobs in the society and in future depend on it and also to use it in teaching to enhance instructional process (Smith 2002)

Research Questions:

The following research questions were formulated to guide the study.

1. To what extent are ICT facilities available in the schools for teaching?
2. To what extent do the teachers in the school use available ICT facilities, for teaching and learning?
3. What are the problems faced with the use of available ICT facilities for teaching and learning?
4. What are the implications for the administrators in the availability and utilization of ICT in the schools?

Method:

The study was carried out using a descriptive survey design method.

The population for the study consisted of the 608 JSS teachers from the 15 Junior Secondary Schools (JSS). While 102 teachers were sampled. Out of the 608 JSS teachers in the L.G.A., 102 JSS teachers were randomly sampled adopting a ballot picking technique, so, a total of 102 teachers formed the subjects for the study. The questionnaire, which was used, was developed by the researcher, for the data collection. The questionnaire
consisted of four sections. Section I, sought for the availability of ICT facilities using 4 point response scale of Very High Extent = 4, High Extent = 3, Low Extent = 2, No Extent = 1 section II focused on the extent of the use of ICT facilities, using 4 point response scale of Very High Extent = 4 High extent = 3, Low Extent = 2 and No Extent = 1. Section III was based on the factors that hinder effective use of ICT facilities, using 4 point response scale of strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1. Section IV focused on implication for administrators in the availability and utilization of ICT facilities in schools using 4 point response scale of Strongly Agree = 4 Agree = 3, Disagree = 2 and Strongly Disagree = 1. The questionnaires were validated by two lecturers from the department. A total of 102 copies of the questionnaires were distributed to the 102 respondents who formed the sample for the study. All the distributed copies were duly completed, retrieved and analyzed. The data were analyzed using mean scores. A mean rating of 2.50 was accepted as cut off point for different levels of responses.

**Results:**

Following analysis of data collection, results are presented in line with the research questions.

Table 1: the extent of ICT facilities available for teaching in schools

<table>
<thead>
<tr>
<th>S/N</th>
<th>Items</th>
<th>VHE</th>
<th>HE</th>
<th>LN</th>
<th>NE</th>
<th>X</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Computer</td>
<td>8</td>
<td>14</td>
<td>20</td>
<td>62</td>
<td>1.7</td>
<td>No Extent</td>
</tr>
<tr>
<td>2</td>
<td>Computer software programme</td>
<td>10</td>
<td>4</td>
<td>18</td>
<td>70</td>
<td>1.5</td>
<td>No Extent</td>
</tr>
<tr>
<td>3</td>
<td>Television sets and video cassettes</td>
<td>0</td>
<td>4</td>
<td>6</td>
<td>94</td>
<td>1.23</td>
<td>No Extent</td>
</tr>
<tr>
<td>4</td>
<td>Internet</td>
<td>6</td>
<td>2</td>
<td>14</td>
<td>82</td>
<td>1.4</td>
<td>No Extent</td>
</tr>
<tr>
<td>5</td>
<td>transparencies</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>88</td>
<td></td>
<td>No Extent</td>
</tr>
<tr>
<td>6</td>
<td>Over head and slide projects</td>
<td>4</td>
<td>10</td>
<td>8</td>
<td>82</td>
<td>1.4</td>
<td>No Extent</td>
</tr>
</tbody>
</table>

Table I, showed that all the items on this table, have the mean scores of 1.7, 1.5, 1.23, 1.4, 1.3, and 1.4 respectively indicating that, none of the schools in the Umuahia North have ICT facilities for teaching. They are all below 2.50 mean values which is the cut off point, indicating that the schools to no extent, use ICT facilities for their instructional process.

Table II: The extent of use of ICT facilities by teachers in the schools.

<table>
<thead>
<tr>
<th>S/ N</th>
<th>ITEMS</th>
<th>VHE</th>
<th>HE</th>
<th>LN</th>
<th>NE</th>
<th>X</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The extent you use well equipped computer laboratory to teach can be</td>
<td>6</td>
<td>8</td>
<td>18</td>
<td>70</td>
<td>1.5</td>
<td>No Extent</td>
</tr>
<tr>
<td></td>
<td>regard to be</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The extent you use these programmes, the Microsoft word, Microsoft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>excel, page maker, adobe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2, revealed that there are ill equipped/inadequate computer laboratory, non availability and use of software programmes, non accessibility of computer, on power supply as indicated by the mean scores of 1.5, 1.4, 1.4, 1.5, 1.4, and 1.4 respectively. There is no experienced manpower to use such software programmes, as the multimedia projector to reach students is indicated by mean score of 1.1

Table 3: The problems associated with the use of ICT facilities for teaching and learning.

<table>
<thead>
<tr>
<th>S/N</th>
<th>The in lack of computer literacy.</th>
<th>SA</th>
<th>A</th>
<th>D</th>
<th>SD</th>
<th>X</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>20</td>
<td>50</td>
<td>4</td>
<td>8</td>
<td>3.1</td>
<td>Agreed</td>
</tr>
<tr>
<td>2</td>
<td>There are no personal computers.</td>
<td>41</td>
<td>49</td>
<td>8</td>
<td>4</td>
<td>3.2</td>
<td>Agreed</td>
</tr>
<tr>
<td>3</td>
<td>Inadequate knowledge of ICT facilities.</td>
<td>45</td>
<td>39</td>
<td>14</td>
<td>4</td>
<td>3.2</td>
<td>Agreed</td>
</tr>
<tr>
<td>4</td>
<td>Lack competencies and interest required for the use of ICT facilities.</td>
<td>39</td>
<td>47</td>
<td>6</td>
<td>10</td>
<td>3.1</td>
<td>Agreed</td>
</tr>
<tr>
<td>5</td>
<td>No good storage facilities.</td>
<td>34</td>
<td>46</td>
<td>10</td>
<td>12</td>
<td>2.9</td>
<td>Agreed</td>
</tr>
<tr>
<td>6</td>
<td>Large class size</td>
<td>42</td>
<td>44</td>
<td>8</td>
<td>8</td>
<td>3.1</td>
<td>Agreed</td>
</tr>
<tr>
<td>7</td>
<td>Lack of standby generator.</td>
<td>44</td>
<td>44</td>
<td>0</td>
<td>14</td>
<td>3.1</td>
<td>Agreed</td>
</tr>
<tr>
<td>8</td>
<td>Poor funding for procurement and maintenance of computer.</td>
<td>40</td>
<td>52</td>
<td>8</td>
<td>2</td>
<td>3.2</td>
<td>Agreed</td>
</tr>
<tr>
<td>9</td>
<td>Lack of internet.</td>
<td>48</td>
<td>32</td>
<td>6</td>
<td>16</td>
<td>3</td>
<td>Agreed</td>
</tr>
<tr>
<td>10</td>
<td>Inadequate computer laboratory.</td>
<td>44</td>
<td>36</td>
<td>8</td>
<td>14</td>
<td>3.0</td>
<td>Agreed</td>
</tr>
</tbody>
</table>
Table 3 showed from the table analysis showed that all the items had the mean scores of 3.1, 3.2, 3.2, 3.1, 2.9, 3.1, 3.2, 3 and 3.0 respectively, indicating acceptance that, the problems listed on the table, are applicable. These by implication are that, the sampled respondent opined that no school in the L.G.A had ICT facilities let alone, facilitating teaching and learning. Many teachers do not have personal computers, lack computer literacy and others. The mean scores of all the items were above 2.50 level of significance.

Table 4: Administrators’ role to ensure quality use of ICT facilities.

Table 4 results showed that administrators have great roles to play, to ensure that, there would be the availability of ICT in our schools, and the staff/manpower will be well poised in the use of the facilities.

The mean scores for each item on the questionnaire were 3.4, 3.3, 3.4, 3.0, 3.3 and 3.2 respectively, above 2.50 cut off point for an accepted value. This therefore indicates that the respondents are in agreement that administrators have the role of ensuring quality use of ICT facilities in enhancing teaching and learning in their schools.

**Discussion of the Findings:**

The ICT facilities in the Junior Secondary Schools (JSS) in Umuahia North are nothing to write home about. This is shown in table 1, that both computer, computer software programme, television sets, internet
transparencies and overhead and slide projectors showed no extent of availability and use of the ICT for teaching in the schools. All the mean scores were below mean rating of 2.50 as accepted cut off point for different levels of responses which showed that the Government has not done her home work very well to meet up with the global demand of use of ICT in ensuring effective teaching and learning.

Table 2, the result showed that teachers do not access ICT facilities for teaching their students. The available computers are not connected to internet thereby depriving students and their teachers of the benefit derivable from the use of the facilities.

In table 3, teachers agreed that lack of computer literacy, lack of personal computer, inadequate knowledge of ICT facilities, lack of competencies required for the use of ICT facilities, large class size, lack of standby generator, poor funding and inadequate computer laboratory are most of the problems hindering the use of ICT facilities for teaching and learning. This is in line with (Chukwu, Ajere and Afolabi, 2003) who stated that only few teachers are computer literate in college of education in plateau state, Nigeria. Which means that, majority of people lack computer literacy, hence the use of ICT facilities to enhance teaching and learning process is hindered.

Table 4 showed the implication of this study for administrators. It showed that administrators have the role of recommending their teachers for going on in-service training. As administrators, the have the duty of supervision of work/instructions in the classrooms, ensuring funding for procurement of facilities and others. This is line with the basic principle of Thorndike’s (1953:244) and Skinner law of effect (1953:1969). It stated that, by providing properly scheduled rewards, it is possible to influence individual’s behaviors. For constant rewarding and reinforcement, teachers would like to learn and teach.

Conclusion

In conclusion, though ICT and ICT facilities are not available, JSS teachers in Umuahia North LGA of Abia State Nigeria do not have their own personal computers. They do not also have sufficient literacy level and skills that will enable them use the facilities for teaching and learning purposes. Also those administrators have a lot of duties for their teachers, for them to be poised, and determined to go for conferences, workshops and seminars to update their knowledge, skills, and competencies.

Recommendations

Based on the Result of eth study, the following recommendations were made.

1. The computer and internet education should be intensified at the teachers level in preparation for basic education. This is because, it will help the teachers have the skills and knowledge that will be needed for application of computer and internet for effective teaching and learning.

2. Federal Government should subsidize the provision of personal computer to teachers in JSS.

3. Teachers should knowledge of ICT facilities available in their schools as well acquire skills required for using them.

4. Serving teachers should be encourage to attend conferences, seminars and workshops to improve their competencies in the competence to use of ICT facilities for teaching

5. There must be put in place a standby generator for the use of the computer facilities since it cannot be operated without power.

6. The softwares needed for teaching should be provided.

7. The Ministry of Education and school Administrators should encourage teachers to go for in-service training on computer and internet education.
REFERENCES


CONTRAINTS IN THE APPLICATION OF BIOTECHNOLOGY TO CASSAVA PRODUCTION IN NIGERIA

Alamu, Salawu Abideen


Abstract

Biotechnology has potential to enhance the production of agricultural and industrial products for achieving food security and economic development. In agriculture, biotechnology enhances the production of high yielding and disease resistance crops necessary for achieving food security and industrial development. This paper examines the constraints in the application of biotechnology research to the production of cassava in Nigeria. The study utilized primary data collected through questionnaire administration and interview from three research institutions working on cassava biotechnology in Nigeria. Findings showed that weak infrastructural facilities, poor funding, inadequate competent personnel and absence of appropriate legislation are the constraints in the application of biotechnology to cassava production in Nigeria. In addition, one out of the three research institutions has adequate and regular electricity supply through its own captive power plant while the remaining two research institutions relied more on electricity from the national grid. Inadequate funding and shortage of competent personnel were peculiar challenges confronting all the research institutions covered by the study. The study recommends improvement in electricity supply, production of more biotechnology scientists and adequate funding to enhance biotechnology research in Nigeria.

Key Words: biotechnology, cassava production, constraints, Nigeria.

INTRODUCTION

Technology is central to the achievement of a large, strong, diversified, sustainable and competitive economy necessary for improving the quality of life of the people. Coad and Reid (2012) define technology as the utilization of equipment, software, instrument, knowledge, technique and organizational methods to design, develop and market products and services. The recognition of the vital role of technology in socio-economic emancipation led to its development by countries across the globe. The major technologies currently making waves in the global economy are nanotechnology, information and communication technology and biotechnology.

According to Acharya and Mugabe (1996), biotechnology is a cluster of techniques used to modify and / or use organism to produce goods and services. It is impacting positively on the economic development of many countries around the globe because it enhances the production of drugs, food items, crops and animals among other things. The great potential of biotechnology led to the intensification of research and development (R&D) efforts on agriculture, medicine, pharmacy and environment by the United States of America (USA), Canada and United Kingdom among others.

In the area of agriculture, biotechnology allows for the use of molecular markers to study plant genetic diversity while genetic engineering (an aspect of biotechnology) allows for the modification of plant genetic make-up in order to develop new plant varieties, which could not be achieved by other plant breeding methods (Spore, 1996). More importantly, biotechnology research provides opportunities for overcoming
natural obstacles in crop breeding processes. For example, through tissue culture, several plantlets can be made from the fragments of plant shoot. As a result, one parent plant gives rise to millions of disease-free identical plantlets which can be used to produce healthy planting materials in the future. Thus, biotechnology research has the capability to provide solution to some of the challenges facing the production of cassava (Manihot esculenta Crantz) and other crops like, cowpea, tomato, rice and potato that are vital in achieving food security in Nigeria and other countries.

Cassava is an important staple food and cash crop in Nigeria, Ghana and the Republic of Congo where it plays principal roles in achieving food security (Agwu and Anyaeche, 2007). Through simple traditional processing, cassava tubers yield several food products like fufu, garri, lafun and tapioca that are used as staple food in many parts of Africa. Among the starchy food crops, cassava gives a carbohydrate production of about 40 percent higher than rice and 25 percent higher than maize with the result that cassava is the cheapest source of calories for both human nutrition and animal feeding (Tonnkari, 2004). Nweke et. al. (2002) observed that 80 percent of Nigerians living in the rural areas eat a cassava meal at least once a week while majority eat cassava meal at least once daily. From a global point of view, cassava provides food for over 500 million people in developing countries (Roca et al 1992). The crop’s ability to provide a staple food base is a function of its flexible planting, harvesting and processing strategies as well as its relative tolerance to poor soil condition and other climatic challenges.

Cassava is one of the major crops considered for improvement in yield under the agricultural transformation agenda of the present civilian administration in Nigeria. The Federal Government of Nigeria (FGN) focus on cassava for the production of ethanol, starch, glucose, live-stock feed and so on, in addition to its principal role as major staple food. For cassava to assume these roles in the Nigerian economy, some of its production challenges such as incidence of pest (insects and diseases) must be given adequate attention. In order to address these challenges, the FGN has been investing on biotechnology research, with a view to ensure improvement in production level. Brink et al (1998) reported some of the specific government efforts with regard to the application of biotechnology in the country to include:

- Long term conservation of cassava, yam, banana and medicinal plants
- Genetic engineering of cowpea for virus and insect resistance;
- Transformation and regeneration of cowpea, yam, cassava and banana;
- Human resource development through group training, degree-related training, fellowships and networking.

Other notable effort of the FGN in the area of biotechnology was the establishment of biotechnology related institutions like National Centre for Genetic Resources and Biotechnology (NACGRAB) and National Biotechnology Development Agency (NABDA). In addition, the FGN has also put in place biotechnology policy to ensure that Nigeria benefit from the potential of the biotechnology research. Despite all these efforts, cassava production has not benefitted from biotechnology research in the country. For example, study conducted by Alamu (2010) shows that no cassava variety has been produced through biotechnology research in Nigeria. This paper examines the challenges in the application of biotechnology research for the improvement of cassava production in Nigeria.
METHODOLOGY

The study conducted a survey on constraints on the improvement of cassava through biotechnology in Nigeria. The survey was conducted on Research Institutions (RIs) in the country that are working on cassava biotechnology research.

3.1 Types of Data

This study utilised primary data collected through questionnaire and interview. The primary data collected for the study included: type of equipment and materials required for cassava biotechnology research, adequacy and competency of human capacity as well as the challenges (fund, equipment, machineries and other infrastructure) in cassava biotechnology research.

3.2 Sources of Data

Three research institutions were selected for the study based on their several years of research and development activities on agriculture and food production in Nigeria. The institutions were the International Institute of Tropical Agriculture (IITA), Ibadan, the National Root Crop Research Institute (NRCRI), Umudike, the National Centre for Biotechnology Research (NACGRAB), Ibadan and Institute for Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan.

3.3 Data Collection Instrument

The primary data used for this study were collected with the aid of questionnaire and interview guide. These two research instruments were administered on a researcher/scientist selected by the responding institutions.

3.4 Data Collection Procedure

Enquiry was made in the selected institutions select a respondent for the administration of questionnaire and conduction of interview. The administrative departments of the selected institutions were visited in order to select a Principal Scientist or Researcher working on cassava biotechnology research. The Scientists or Research Associates selected were contacted for data collection purposes.

3.5 Data Analytical Technique

Both quantitative and qualitative data collected for this study were reported based on identified similarities and differences existing among the institutions that supplied the data. Content analysis was used for analyzing data obtained from in-depth interviews while Tables were used to present the results of data obtained through questionnaire.

4.0 RESULTS AND DISCUSSIONS

4.1 Background Information of Responding Institutions

The results of analysis of data showed that three research institutions that are applying biotechnology research for improving cassava are all located in southern part of the country (Table 1). While two of them are located in Ibadan, south-west Nigeria, the other one is located in Umudike, Imo state, in the south-east of the country. The research institutions that are located in Ibadan are the National Centre for Genetic Research...
and Biotechnology (NACGRAB) and the International Institute of Tropical Agriculture (IITA). While IITA was established in 1987, NACGRAB was established in 1967. The NRCRI was also established in 1967. The ownership structure and source of fund for these institutions also varies. For example, while NACGRAB and NRCRI were established and funded by the Federal Government of Nigeria (FGN), IITA is an international research institution, controlled and funded by the Consultative Group on International Agricultural Research (CGIAR).

Table 1: Background Information of the Responding Institutions

<table>
<thead>
<tr>
<th>Name of Institution</th>
<th>Location</th>
<th>Geo-Political Zone</th>
<th>Ownership</th>
<th>Year of Establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>IITA</td>
<td>Ibadan</td>
<td>South-West</td>
<td>International</td>
<td>1967</td>
</tr>
<tr>
<td>NACGRAB</td>
<td>Ibadan</td>
<td>South-West</td>
<td>FGN</td>
<td>1987</td>
</tr>
<tr>
<td>NRCRI</td>
<td>Umudike</td>
<td>South-East</td>
<td>FGN</td>
<td>1967</td>
</tr>
</tbody>
</table>

*Source: Field Survey (2011)*

Table 2 shows the level of availability and degree of adequacy of various infrastructural facilities necessary for cassava biotechnology research in the three institutions under consideration. The Table shows that only IITA has most of the required infrastructural facilities for an effective and efficient biotechnology research. Findings also showed that IITA as an international research institute has adequate and regular power and water supply as well as availability of screen house, molecular biology and tissue culture laboratories. However the reverse is the case with the other two institutions. NACGRAB has fairly equipped laboratory, good aseptic transfer area, adequate growth room, moderate screen house and acclimatization chamber. The institute does not have regular and adequate power and water supply. The condition of infrastructural facilities in NRCRI seems to be unsatisfactory as screen house, aseptic transfer area and growth room vital for biotechnology research are not in place.

The inadequacy of infrastructural facilities in the laboratories of NACGRAB and NRCRI constitutes a clog in the wheel of progress of their biotechnology research activities. Findings revealed that some of their experiments had to be abandoned as a result of power interruption. In addition, some major experiments cannot be embarked upon as a result of inadequacy of infrastructural facilities. Similarly, inadequate infrastructure hinders these institutions collaborative efforts with other institutions.

Table 2: Level of Adequacy of Infrastructural Facilities in the Responding Institutions

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Facility</th>
<th>Level of Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IITA</td>
<td>NACGRAB</td>
</tr>
<tr>
<td>1.</td>
<td>Laboratory</td>
<td>Well Equipped</td>
</tr>
<tr>
<td>2.</td>
<td>Aseptic Transfer Area</td>
<td>Good</td>
</tr>
</tbody>
</table>
3. Growth Room | Good | Adequate | Not Exist  
4. Electricity | Regular and Adequate | Irregular and Inadequate | Irregular and 30-40% Adequate  
5. Screen House | Standard | Moderate | Not Exist  
6. Acclimatization Chamber | Good | Moderate | Not Exist  
7. Water | Adequate and Regular | Fairly Adequate | Adequate and Regular  

Source: Field Survey (2011)

4.4 Funding of Cassava Biotechnology Research

Research and Development (R&D) activities have been identified as capital intensive projects throughout the world. This is based on the fact that fund is required for the procurement of various machineries and equipment as well as payment of other logistics. As a result, adequate and regular provision of fund is a prerequisite for efficient and effective R&D activities. The same applies to biotechnology research because a lot of machineries and equipment and other infrastructural facilities required for relevant activities are capital intensive. In addition, fund is always required to pay for the services of highly skilled personnel involved in the process.

From the global viewpoint, sources of fund for research activities usually vary from public fund (government), to private donors and international organizations. At times, ownership of a particular research institution often determines its major source of funding. For example, in developing countries such as Nigeria, most of the R&D institutions are owned by the public and are solely funded by the government.

This study reveals that two of the three institutions are owned and funded by the Federal Government of Nigeria (FGN). NACGRAB for instance is solely funded by the FGN. The NRCRI however, derives 90% of its fund for biotechnology research from the FGN while the remaining 10% comes from some donor agencies (Table 3). The IITA, being an international organization derives greater part of its fund for research from international donors through the Consultative Group on International Agricultural Research (CGIAR). Specifically, the Institute obtains about 90 percent of its research fund from the CGIAR system while the remaining 10% is provided by other donor agencies. The other donor agencies are various countries across the world such as USA, UK, Canada and Nigeria among others. There are also corporate donors which include Shell Petroleum Corporation. However the contributions of both the FGN and Shell were claimed to be less than 5 percent of total grants available for research.

Funding of R&D activities majorly or solely from the public funds is a major problem in obtaining adequate fund for research activities. This is because government as an institution has a lot of responsibilities to discharge with the available public fund. As a result, the available public fund may not be enough to carry out the available developmental projects in addition to funding R&D activities. The implications of dependency of R&D institutions solely on public funds are many. In the first instance, such institutions will not have adequate funds for their R&D activities. Again, such institutions will not be able to embark on concrete research activities that have direct relevance to the economic development of the country.
Table 3: Distribution of Institutions by Sources of Fund

<table>
<thead>
<tr>
<th>Institution</th>
<th>Public Fund (FGN)</th>
<th>Other Donors</th>
<th>External Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>IITA</td>
<td>5</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>NACGRAB</td>
<td>100</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>NRCRI</td>
<td>90</td>
<td>10</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2011

With regard to availability of adequate fund for carrying out biotechnology research, the story remains the same among all the respondent institutions. This is because available funds for carrying out their biotechnology research on cassava production have been quite inadequate over the years. According to IITA Cassava Geneticist

"Funding of R&D activities in IITA has been unimpressive due to so many factors. As a result, some research programmes are folding up while some may be terminated if the situation does not improve". A NACGRAB official in his own view claimed that "R&D activities are yet to be given the required attention in terms of funding and provision of other logistics in Nigeria. Thus, the impacts of R&D activities on the nation’s economic development has been low"

4.5 Major Constraints in Cassava Biotechnology Research in Nigeria

Nigeria is a country that has been identified to be technologically poor. The situation is compounded by the fact that despite the available natural resources, Nigeria is still economically poor. The multidimensional technological problems of the nation contribute to high level of poverty and other socioeconomic problems in the country. In order to develop Nigerian economy, the technological challenges of the nation must be addressed.

This study identified some of the challenges confronting cassava biotechnology research in the country with a view to provide solution so that Nigeria can benefit from the great potential of biotechnology for food production and poverty alleviation. The responding institutions enumerated some of the problems militating against effective and efficient biotechnology research in their domains to include shortage of skilled manpower, epileptic power supply, lack of efficient and reliable Internet connectivity, bureaucratic problem and inadequate fund.

The results of data collected on IITA show that the institution is not confronted with the problem of infrastructure such as electricity, water or Internet connectivity and well equipped laboratory but with inadequate skilled manpower and lack of adequate fund. The institute has its own captive electricity and water supply plants. The case of both NRCRI and NACGRAB are quite different because they are confronted with the problems of epileptic power supply, non-availability of necessary reagent and well equipped laboratory and functional Internet connectivity in addition to inadequate funding.

In a situation where adequate fund is not available for research activities, meaningful R&D activities cannot be embarked upon. This is because most of the required R&D equipment will not be available. Inadequate funding of research activities is a major impediment in Science and Technology (S&T)
development. Under such ugly situation, there may be no fund for training of personnel and for organizing workshops and seminars. In addition, the situation may be so terrible that no fund is available for payment of staff salaries and allowances.

4.6 Recommendation

In order to ensure that biotechnology research contributes positively to cassava production in Nigeria, the following recommendations are offered, based on the findings of this study. These recommendations are discussed under the following sub-headings:

- Needs for the Provision of Adequate and Reliable Infrastructure:
  In the first instance, adequate and reliable infrastructure most especially electricity should be provided for all the Research and Development Institutions (RDIs) in the country for running various equipment and machineries.

- High Commitment to High Level Manpower Development:
  There is the need for production of adequate competent personnel for biotechnology research in Nigeria through the provision of scholarship for students in biotechnology research while biotechnology, molecular biology and genetics laboratories should be well equipped.

- Adequate and Regular Funding of Biotechnology Research:
  R&D activities have been identified as capital intensive though the return on investment is usually high. Government should provide adequate fund for biotechnology research in Nigeria. Again, private organizations should complement government efforts by contributing part of their profit for funding research activities. This becomes practicable if the matter is backed-up with appropriate legislation by the National Assembly (NAS).

REFERENCES


ACADEMIC ADVISING AND COUNSELING IN UNIVERSITIES IN SOUTH EAST NIGERIA: A NEW PERSPECTIVE

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Abstract

Academic advising and counseling is the lynchpin for students’ success in the university and integral to fulfilling the teaching and learning mission of higher education. This study utilized the survey design to explore aspects of academic advising services offered in the universities and their influence on some variables, identify the level of accessibility of academic advisers and institutional mechanisms as well as identify ways of fostering academic advising in the universities. Five hundred and forty (280 males, 260 females, mean age 23.5, SD 0.54) undergraduates purposively sampled from four universities in South East, Nigeria completed the Undergraduate Academic Advising and Counseling questionnaire. Result using percentage, mean and t test revealed that academic advising as done in the universities surveyed focused mainly on academic matters neglecting other important areas. It was also found that most of the academic advisers were not always accessible and institutional mechanisms were weak. Ways of fostering academic advising like slotting time in the time table for academic advising were identified. Training academic staff on academic advising issues, university showing more commitment on academic advising and getting feedback from students were some of the recommendations made. Limitations, further research and implications were highlighted.

Keywords: Academic advising, counseling, universities, South East Nigeria,

Introduction

Several sectors of the society have been undergoing changes in response to the forces of globalization and internationalization. The higher education system is already in the web of twenty – first century explosions. The core missions and values of higher education still remain to contribute to the sustainable development and improvement of society as a whole. The universal mandate of our universities is to produce highly qualified graduates and responsible citizens able to meet the needs of all sectors of human activity among others (World Conference on Higher Education, 1998)

The current influx into tertiary institutions poses a great challenge to the realization of that mandate. With the increase in student population, institutions are faced with increasing diversity of student population both in academic preparation, socio economic background and other factors. It can no longer
be assumed that students are sufficiently motivated to learn for themselves in the face of indifferent teaching. There is, therefore, the need for tertiary institutions to reposition themselves to adequately cater for such diversity.

Academic advising and counseling have been seen as crucial to the higher education learning experience (Simpson, 2013). Through academic advising, students learn how to become actively engaged in the higher education system by thinking critically about their roles as students at the university and as adults in the larger society (Simpson, 2013). Academic advising and counseling have been seen as integral to fulfilling the teaching and learning mission of higher education (NACADA, 2006). It is the core element in all institutions that is formally structured into the students’ academic life that forms the connection between the student’s individual goals and institutional mission. It is an important avenue for discussing connections between advisee goals and the mission of the University (Hemwall & Trachte, 2005). Though students are expected to be responsible for constructing their knowledge, learning is also seen to depend on institutions and staff generating conditions that stimulate and encourage their involvement (Australian Council of Educational Research, 2010).

Academic advising and counseling services offer academic advising, career and special services and support to students. Academic advising is designed to assist students in achieving academic and personal success through informed decision making and academic planning. Students are assisted to take full advantage of their experience at the university to maximize their potential and realize their personal as well as institutional goals. Oriano (2013) sees academic advising and counseling as critical lynchpin for student success. According to Oriano (2013) academic advising in its most comprehensive and effective form can no longer be characterized as merely assisting students to register for courses. Academic counseling is a service concerned with creating opportunities and awareness for personal/social, educational and vocational growth of the individual that can enhance national and international development (Nwokolo, Anyamene, Oraegbunam, Anyachebelu, Okoye, & Obineli, 2010). Universities must begin to find ways to holistically engage students from first year in planning their academic and vocational futures if we are to make needed improvements in university education. Academic advising is primarily a developmental process in which, over time, students clarify their life and career goals and make educational choices that will assist them to realize their goals. During academic advising, faculty members work one-on-one with the students to relay important cultural beliefs and values about the University. Habley (1994) saw it as the only structured service in the University in which all students have the opportunity for ongoing one-on-one contact with a concerned university staff outside the formal classroom.

The mission of academic advising and counseling is to facilitate students’ success by offering a comprehensive range of quality services that promote educational, career and personal/social development. It plays vital roles by providing services to enhance the learning environment and address the diverse needs of all students. Faber and Avadikian (2002) see academic advising as an important academic service that has not yet been fully institutionalized in many campuses. According to them, academic advising gets each student close to faculty members who rub off their experience of the university on the students and thereby foster and propagate university culture.
Academic advising is uniquely positioned to make an enduring impact on the academic and personal success of the students by empowering, challenging and supporting them. Effective and proactive academic advising can assist students to better understand their academic disciplines and enable them to participate actively as members of the academic community. Campbell and Nutt (2008) state that academic advising when done well plays a critical role in connecting students with learning opportunities to foster and support their engagement, success and the attainment of key learning outcomes. Academic advisers are key drivers of that achievement.

The role of academic advisers is to perform specific functions designed to assist students maximize their potential in the university. Advisers can help students understand their roles at various points in life such as the role of a student or a citizen in the larger community by helping students develop autonomy, integrity and responsibility; characteristics, Chickening (1994) says are the most important skills acquired in the university in order to be successful in life. Advisers can also help students through a wide variety of situations. Effective advisers achieve their goal of advising when they are accessible and do more than provide information (Hunter, McCalla-Wriggens & White, 2007).

Academic advisers must first change their mindset about academic advising and its purposes. Since academic advising extends learning opportunities beyond the traditional classroom (Chemers, Hu & Garcia, 2001), then advisers must create environments that encourage learning by demonstrating respect and fostering positive and trusting interpersonal relationship with their students. They should possess adequate knowledge of institutional vision and mission statements (Donnelly, 2009).

Simpson (2013) notes that effective advisers must assess each particular student in terms of his needs, goals, interests, skills, and abilities and adapt their approach to address them appropriately. To streamline the activities of academic advisers, Hemwall and Trachte (2005) proposed ten vital principles academic advisers should adhere to. They include consideration of university mission and vision; encouragement of critical thinking in students; alignment of advisee personal goals with institutional goals; awareness of advisee’s strengths and weaknesses, dissecting advisee mindset and sensitizing them as well as understanding advisees’ individual backgrounds. Others are creating conducive atmosphere for academic excellence; leading the dialogue between adviser and advisee as an advanced learner with more useful information; guiding advisees in ways that make the students think critically about their role in college as well as to face contradictions and difficult issues as they arise. Lowenstein (2005) also outlined basic functions of academic advisers cutting across their academic, personal/social and career aspects as well as full integration into the university culture.

Emphasis on academic advising stems from its obvious importance in actualizing individual and institutional goals. Quality advising fosters student development and at the same time enriches the academic community, the adviser, and the society at large. It contributes to students’ perceptions of the University as they teach their students the cultural robes of their institutions. Good academic advising generally has a positive impact on students’ academic performance as well as personal satisfaction with their college experience (Habley and McClanahan, 2004). Universities should leverage on academic advising to enhance learning outcomes and other benefits. Simpson (2013) identifies the benefits of effective academic advising as creating relationships between gown and town (college and real world),
increasing retention, fostering alumni relationships, fostering development of life-long learning and
decision-making abilities as well as adjustment to college life. Drake (2011) highlights that academic
advising assists student to understand their strengths and weaknesses. Oriano (2013) concludes that
recurrent and meaningful academic advising increases student’s engagement and learning outcomes.
Smith (2005) identifies proper academic advising as increasing overall satisfaction with college,
promoting effective use of campus support services and encouraging contact with staff outside the
classroom. Good academic advising might be the single most under-estimated factor of a successful
college experience (Light, 2001).

However, Pizzolato (2008) shows that advising is more effective in eliciting learning outcomes when
advisers alter their communications with advisees in ways that encourage an interpersonal relationship
between adviser and advisee, stress personal connectedness, genuine concern and accommodation
based on the specific needs of the advisee. Pang (2012) proposed a learner (advisee) - centered, holistic
and flexible academic advising in our Universities for it to be impactful. Pietras (2010) suggests a
restructuring of the provisions of academic advising in an effective and efficient manner that meets the
needs of both the advisee, college and the society.

As currently structured, academic advising in most Nigerian Universities is limited in its ability to assist
students in identifying academic and career pathways that will help them achieve their goals. As pointed
out by Faber and Avadikian (2002) academic advising is not a priority in many universities including
those in South East Nigeria. There are no institutional mechanisms put in place to ensure that students
receive quality advising. Many of the advisers are not grounded in institutional policies and culture. The
purpose of this study is to survey academic advising and counseling in some Universities in South East
Nigeria across some disciplines. The objectives of the study are specifically to:

1. Determine aspects of academic advising offered by advisers as perceived by students.
2. Identify the perceived influence of academic advising on some variables.
3. Identify the accessibility of academic advisers to students.
4. Identify the institutional mechanisms for monitoring academic advising
5. Identify ways academic advising could be fostered in the universities.
6. Ascertaining if there are gender differences in the aspects of academic advising provided to
   students.

Four research questions were raised to address the issues. Thus,

1. What are the aspects of academic advising offered by advisers in Nigeria universities?
2. To what extent do students perceive the influence of academic advising?
3. To what extent are academic advisers accessible to students?
4. To what extent are institutions monitoring academic advising in the universities?
5. In what ways can academic advising be fostered in Nigerian Universities?

Hypothesis

There is no significant gender difference on the aspects of academic advising offered to students in
Nigerian Universities.
This study is significant as it has the potential to change the way academic advising is rendered in Nigeria and point to the direction of a more robust, elaborate and comprehensive advising model. The goal of academic advising is to improve the overall learning experience of the University students. This will not be achieved if academic advising is done in a haphazard manner or is merely assisting students to register courses. A sound academic advising properly articulated and implemented will assist students to carve out niches for themselves in the global marketplace where there are no “jobs” but with boundless opportunities for those prepared for them.

**Method**

Participants: participants were 540 (280 male, 260 female, age range 19 – 36, mean age 23.5) undergraduates in their 400 level who had been assigned academic adviser for at least two previous academic sessions. They were purposively sampled from four Federal Universities in South East Nigeria. The Federal University in the fifth state was new and so did not meet the selection criteria. Those sampled completed the consent form before completing the questionnaire.

**Instrument**: The Undergraduate Academic Advising and Counseling (UAAC) questionnaire was used for the study. The instrument was validated by three experts in Guidance and Counselling, Psychology and Measurement and Evaluation. The reliability was established using Cronbach alpha after a two – week interval which yielded coefficient of 0.88. The questionnaire was divided into sections. Section A elicited demographic variables like Institution, course and level of study, age and gender and whether they have academic advisers. Section B contained aspects of academic advising and counseling with 25 items subdivided into academic matters (1 – 10), adjustment to University life and culture, (11 – 16); Personal life (17 – 23); and Career focus (24 – 25). The respondents were expected to rate the overall influence of academic advising under those subheadings in section C. Section D dealt on the perception of the respondents on the accessibility of the academic advisers. Section E was on institutional mechanisms for monitoring of academic advising while Section F captured how academic advising could be fostered in the Nigerian Universities.

**Procedure**: Research assistants were trained and used to administer the questionnaire. A total of 600 questionnaires were distributed. Forty (6.67%) were incomplete, twenty (3.33%) did not meet the criteria. Five hundred and forty (90%) was thus used for the study. Section B adopted Yes or No response pattern with 1.5 as acceptable mean. Percentage was used to ascertain the overall rating of influence of academic advising on the four subdivisions and in the accessibility of the academic advisers. Section E which was on institutional mechanisms for academic advising also adopted Yes or No pattern. Section F adopted the four-point rating scale of Strongly Agree, Agree, Disagree and Strongly Disagree with 4, 3, 2 and 1 respectively. The acceptable mean was 2.50.

**Results**

<table>
<thead>
<tr>
<th>S/N</th>
<th>My academic adviser</th>
<th>Mean</th>
<th>SD</th>
<th>Decision</th>
</tr>
</thead>
</table>

Table 1

Mean ratings for aspects of academic advising and counseling
Table one shows the aspects of academic advising and counseling. Only items 1, 3, 4, 5, 9, 10 and 20 were accepted. The rest were rejected because their means were below the acceptable mean.

Table 2
Percentage Influence of Academic Advising and Counseling on Some Variables

<table>
<thead>
<tr>
<th>s/n</th>
<th>Significant influence</th>
<th>Good influence</th>
<th>No influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic matters</td>
<td>73.3%</td>
<td>20.4%</td>
</tr>
<tr>
<td>2</td>
<td>Adjustment to university life and culture</td>
<td>37.6%</td>
<td>32.9%</td>
</tr>
<tr>
<td>3</td>
<td>Personal/social life</td>
<td>30.4%</td>
<td>34.4%</td>
</tr>
<tr>
<td>4</td>
<td>Career focus</td>
<td>28.8%</td>
<td>30.7%</td>
</tr>
</tbody>
</table>
Table 2 shows the influence of academic advising and counseling on academic matters, adjustment to university life and culture, personal/social life and career focus. Influence on academic was rated very high with 73.3%. The rest were low.

The result for the third research question on accessibility of academic advisers showed that 225 (41.6%), 254 (47.1) and 61 (11.32) reported that their academic advisers were very accessible, not always accessible and rarely accessible, respectively.

Table 3

Percentage Ratings on Institutional Mechanisms for Monitoring Academic Advising

<table>
<thead>
<tr>
<th>S/N</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87%</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>3</td>
<td>87.6%</td>
<td>12.4%</td>
</tr>
<tr>
<td>4</td>
<td>7.2%</td>
<td>92.8%</td>
</tr>
</tbody>
</table>

From table 3 above the low percentage ratings on items 2 (18%) and 4 (7.2%) are instructive. Institutional mechanisms for monitoring academic advising are very weak.

Table 5

Mean Scores on How to Foster Academic Advising and Counseling in Nigerian Universities

<table>
<thead>
<tr>
<th>S/N</th>
<th>Mean</th>
<th>SD</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.36</td>
<td>0.99</td>
<td>Accept</td>
</tr>
<tr>
<td>2</td>
<td>2.87</td>
<td>0.62</td>
<td>Accept</td>
</tr>
<tr>
<td>3</td>
<td>3.22</td>
<td>0.82</td>
<td>Accept</td>
</tr>
<tr>
<td>4</td>
<td>3.34</td>
<td>0.91</td>
<td>Accept</td>
</tr>
<tr>
<td>5</td>
<td>3.28</td>
<td>0.87</td>
<td>Accept</td>
</tr>
<tr>
<td>6</td>
<td>2.11</td>
<td>0.18</td>
<td>Reject</td>
</tr>
<tr>
<td>7</td>
<td>2.57</td>
<td>0.41</td>
<td>Accept</td>
</tr>
<tr>
<td>8</td>
<td>3.07</td>
<td>0.68</td>
<td>Accept</td>
</tr>
<tr>
<td>9</td>
<td>3.02</td>
<td>0.72</td>
<td>Accept</td>
</tr>
<tr>
<td>10</td>
<td>2.93</td>
<td>0.61</td>
<td>Accept</td>
</tr>
</tbody>
</table>
Table 5 above shows that respondents surveyed favored most of the possible ways of fostering academic advising in the universities identified in the questionnaire. However item 6 which is ‘appointing professional academic advisers responsible only for academic advising’ was not accepted.

Table 5

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>SEM</th>
<th>DF</th>
<th>t-cal.</th>
<th>Crit. value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>280</td>
<td>1.41</td>
<td>0.200</td>
<td>0.012</td>
<td>538</td>
<td>1.1335</td>
<td>1.96</td>
<td>NS</td>
</tr>
<tr>
<td>Female</td>
<td>260</td>
<td>1.43</td>
<td>0.21</td>
<td>0.013</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P=0.05 level of significance

The result of the unpaired t test for the hypothesis at 0.05 level of significance showed that there was no statistically significant difference between genders in their perception of the aspects of academic advising and counseling in the institutions sampled. The t.value of 1.1335 is less than the table value of 1.96.

**Discussion**

In order to provide quality academic advising and counseling that will foster learning, research is needed to identify the flaws in extant practice and generate specific factors that contribute to quality experiences in the university. In this study we surveyed the aspects of academic advising and counseling, the perceived influence of academic advising and counselling on academic performance, adjustment to university life and culture, personal/social life and career focus. Perceived accessibility of academic advisers were also isolated while ways of fostering academic advising in the Nigerian Universities were surveyed. We also tested the hypothesized gender difference in the perceived aspects of academic advising and counseling.

The result of the first research question revealed that academic advising focused mainly on academic aspects neglecting important aspects like personal/social, career focus and adjustment to university life and culture. The result of the second research question also shows that academic advising had significant influence only on academic matters. This supports Chiemeke and Nwelih’s (2008) work that concluded that students and lecturers are unsatisfied with the current process of academic advising in Nigerian Universities.

The result of this study negates the very essence of academic advising and counseling which according to Oriano (2013) should be comprehensive and holistic and should no longer centre mainly on assisting students register their courses. This is why Pang (2012) proposed a learner (adviser)-centered, holistic and flexible academic advising in our university for it to be impactful. In line with this, Pietras (2010) suggests a restructuring of the provisions of academic advising in an effective and efficient manner that meets the needs of both the advisee, college and the society.
Result of the third research question reveals that 41.6% reported that their academic adviser were always accessible while 47.1% and 11.3% reported that their academic advisers were not always accessible and rarely accessible, respectively. According to Hunter et al (2007), effective advising is attained only when academic advisers are accessible and do more than provide information.

Result of the fourth research question indicates that institutional mechanisms for streamlining and monitoring academic advising in Nigerian Universities are very weak. This is an indication of their level of commitment to academic advising. The respondents surveyed also indicated that training of academic staff on effective advising, getting feedback from students, and sensitizing students on the importance of academic advising and what it entails could enhance the practice of academic advising. Providing decent offices for academic advisers, employing more lecturers, giving opportunities for students to choose their academic advisers and university showing more commitment for academic advising in Nigerian Universities were also favored. They did not however support appointment of professional academic advisers. This supports Tinto’s (2002) proposal for a paradigm shift in academic advising that promotes students success by setting high expectations, providing support services offering feedback and facilitating involvement in learning through frequent contacts between faculty and students.

Conclusion

Universities are noted for academic excellence and integrity. This cannot be achieved only in the formal classroom environment. Periodic one-on-one contact with faculty staff grounded in university’s vision, mission and culture will rub off their experience on the students. Drawing from the result of this study, we conclude that a lot needs to be done in the area of academic advising and counseling. Robust, comprehensive, effective, efficient and flexible academic advising system should be instituted, implemented and monitored. This will foster and propagate university culture of excellence and integrity in teaching, research and extension of knowledge.

Recommendations

Based on the findings of this study, we recommend the following:

1. A more robust, effective and functional academic advising system be by university authorities
2. All academic staff be empowered through seminars, conferences and workshops on academic advising.
3. Allotting time in the time table for academic advising activities like it is for sports.
4. Strengthening institutional mechanisms for monitoring academic advising.

Limitations and suggestions for further research

This study is limited in certain ways. Our sample was small and from one zone in the country. Our findings are not generalizable to other zones and in other State and private owned universities whose activities in academic counseling may be different. Further research can look in these other directions.
We also relied on self-report which are not easily verifiable. This study also focused on advisee perspectives. Future research can explore adviser viewpoints to get a balanced perspective.

Implications for Practice

Conclusions drawn from this study have implications for the university system and other stakeholders. It calls attention to the need for a paradigm shift in the way academic advising and counseling is structured and implemented in Nigerian universities. A new perspective of academic advising should be holistic and functional. To successfully transform the current practice of academic advising, training programs on academic advising ought to be developed and implemented. Emphasis should be on interpersonal communication skills, sound knowledge of university vision, mission, culture, and knowledge of students’ needs. This will lead to proper alignment of institutional goals to individual students’ goals. Drawing from the result of this study, universities should create advisee-centered, holistic and flexible advising systems for it to be impactful.

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SUSTAINABLE TEACHER EDUCATION IN NIGERIA THROUGH INFORMATION LITERACY IN THE 21ST CENTURY

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&

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ABSTRACT

The 21st century characterized by information revolution has been responsible for what is today known as globalization which has to do with global interaction between humans on issues of common interest irrespective of space or time, the emergence of these slogan Countless number of information is produced almost every second, in countless formats; just as different technologies are invented or upgraded which facilitate easy and fastest access to this information, leaving information consumers with a multiple source and types of information to choose from. It is in the light of this that, this paper examines the challenges of the 21st century to the teacher education institutions which are expected to train teachers that will in turn, train others preparing them for the places of work in the information age. It is recommended in this paper that, a paradigm shift is necessary from the traditional “use of libraries course” that is taught in educational institutions to Information Literacy which by its concept and content, is more encompassing and will be able to prepare the students better for lifelong learning. An outline course was recommended in this paper for examination by experts and possible review and implementation in tertiary institutions especially teacher education institutions for the effective teaching of information literacy skills in teacher education institutions in Nigeria in line with the Association of College Research Libraries-ACRL’s guideline

INTRODUCTION

Like many other centuries, the 21st century came with its own revolution, this time, the Information Revolution. This revolution according to the United States Department of Labour-USDL, (1999) is powered by technology, fueled by information and driven by knowledge. As a result of this revolution, our societies are now becoming more divers, complex, media saturated and borderless once. There is no mixing word; this revolution is having a greater impact on our society than the transition from oral to print society (US Department of Labor, 1999). The revolution is responsible for the paradigm shifts in every aspect of human endeavor, the education sector inclusive. The century has been characterized by increase in the need and the demand for information resulting in the increase in its production, and the resultant explosion in the scramble
for its access. Consequently upon this, there is a strong challenge for schools to shift from their traditional methods of being mere venues for the transmission of a prescribed knowledge/information from a teacher to students in a given time and place to what Thornburg (2000) called the principles of “learning to learn” (the knowledge and skills of possible continuous learning), this new paradigm is known as constructivist theory. The shift is necessary because, illiteracy in the 21st century according to Tuffler, (2002) will not be inability to read and write, but the inability to learn, unlearn, and relearn.

Our 21st century students are facing many emerging issues such as: Global warming, Famine, Poverty, Health Issues, Global population explosion, Economic down tone and other environmental and social issues and most ultimately, Information explosion or overload.

These issues require constant investigations into cause effects, and most importantly, solutions for them. Because the problems are global in nature, they require both individual and collective approach with partners beyond the shores of once immediate environment. This has prompted the need for students of the 21st century to be proactive in terms of ability to communicate effectively beyond their immediate environment. This will equally enable them to participate in global matters that affect their society, and be able to impact changes either individually, or in collaboration with others around the world in solving any challenge they may face.

Given the new emerging technologies and the resulting globalization, there is no limit to the chances for igniting new discoveries and developments in areas such as new forms of energy, advances in medicines, restoration of environmentally ravaged areas, and exploration of the space and beneath the sea.

Age is of no significance in this strive; anybody can make an impact with effective education that addresses the “person as a whole”, without limit to professional development and curriculum designed for a particular workplace. Our students need the 21st century skills which could be learned through our curriculum that should be interdisciplinary, integrated, project-based, and are learned within a project-based curriculum. However, more information is produced on a daily bases, in every fraction of a second. Everybody today is more or less a “publisher” since anybody can host a website, or go into desk top publishing.

According to Humes, (2000) “We are outfitting our schools, libraries, and homes with electronic technologies--but are we preparing our students and teachers for the onslaught of information that is provided by these technologies? What happens when the student can get more information from the Internet than previously conveyed by a teacher or a textbook? What should a student do when faced with so many informational possibilities? Which of the information is credible and which is not?

With the increase in the production of so much information, and the exponential growth in their access, there is therefore, every chance of misinformation, hence, everyone whether in the education system or not--must have not only reading skills and computer skills but information skills, too.

**Education according to World Bank (2008) is the premise of progress in every individual, family, or society; hence, it is a treasure that must be cherished by all. This is because, education makes man a right thinker, it tells him how to think and make decisions. It is only education that makes it possible for man to receive information from outside his world, acquaint himself with the past and collect all necessary information regarding the present (khan 2006). Hence, the place of education in the development of human mind and that of any nation can never be over emphasized.**
Education is one of the most required powerful instruments, which is central to development, and a key to the realization of any development goal. At global level, it has been realized that, the fight for reduction in poverty, inequality and sustainable economic growth etc which form parts of the Millennium Development Goals, (MDG) can never be realized without Education (World Bank, 2008). Hence, one can safely say that, Education is globally acknowledged as one of the crucial allies in the development process.

Education can be either formal or informal however; this paper is more concerned with the formal education which according to Brickman (2008) is that intentional and more or less systematic effort to affect the behavior of others, while the informal education has to do with the way people learn to adapt their behavior to that of their environment. Formal education is usually acquired in three stages of Primary, Secondary, and Tertiary Institutions (Colleges and Universities).

For the purpose of precision, this paper is focused on the tertiary institutions especially, the colleges and faculties of education and other teacher education institutions. Tertiary institutions according to Ojedokun (2007) are institutions that are responsible for the advancement of learning and knowledge as well as the roles of transmitting and transferring knowledge in such a way that it would assist in the achievement of both economic and social objectives of a nation. This he observed they can do through their graduates who should provide “leadership roles in education as researchers, teachers, consultants, and managers”. These graduates are challenged to create and apply new knowledge and innovations and also provide analytical perspectives on development problems and services to both public and private sector.

Within many organizations the ability to initiate and process change and the capacity to turn new ideas quickly into marketable products or services is what determines your worth, (Ashton and Sung, 1994). Staff are increasingly required who are multi skilled, have problem solving skills, can deal with less routine tasks, are IT literate and capable of independent continuous learning. These demands have significant implications for education at all levels. In reality therefore, we are in the 21st century, but in practice our students especially teacher education students in Nigeria are not yet there. This is particularly so because, most of our teacher education institutions (Colleges and Faculties of Education in Nigeria within the knowledge of the author) don’t have any information literacy programme in place that could equip these students with all the attitudes, and knowledge they require to function effectively as global citizens.

The only similar programme is the age long “use of libraries” course which is ironically taught by almost anybody willing to teach as long as he or she is a library staff or in the alternative, in some institutions such courses of study don’t even exist as a unit but as topics under another course “English and Communication Skills” (Jimoh, 2009).

Skills required in the 21st century workplace

The work place of the 21st century is characterized with certain skills which must be possessed by anyone who wants to be relevant in the society. Such skills according to EnGauge; North Central Regional Educational Laboratory in Tinio, (2002) include amongst others;

**Adaptability:** Ability to adapt and manage in this new complex, interdependent world,

**Curiosity:** Desire to know, and to know more than is already known.

**Creativity:** Ability to use imagination to create new things.
**Risk-taking**: Ability to take risks,

**Teaming**: Ability to work in a team,

**Collaboration and interpersonal skills**: Ability to interact smoothly and work effectively with others.

**Personal and social responsibility**: Be accountable for the way one uses ICT’s and to learn to use ICT’s for the public good.

**Interactive communication**: this has to do with Competence in conveying, transmitting, accessing, understanding and using information.

**High Productivity**: Ability to prioritize, plan, and manage programs and projects to achieve a desired result, ability to apply what is learnt in the classroom to real-life contexts to create relevant, high-quality products (application of knowledge).

To this effect therefore, our students who are potential teachers, leaders, and managers of different institutions and organisations after school must be equipped with what has been described as the 21st century skills. These skills amongst others are: ability to collaborate with others in team, ability to think critically by being able to take on complex problems, ability to communicate fairly in presenting issues orally, they also need to have good skills of writing, knowing how to utilize technologies independently is also a necessity. Other skills required include; citizenship education; this involves the ability to take on civic and global issues; they are equally required to learn about careers through internships, and be able to conduct research and do all of the above. All of these skills are best acquired through an effective and well developed Information literacy curriculum.

**Information Literacy**

Information literacy, otherwise known as information competency, is the ability to access, evaluate, organize, and use information from a variety of sources. Being information literate requires knowing how to clearly define a subject or area of investigation; select the appropriate terminology that expresses the concept or subject under investigation; formulate a search strategy that takes into consideration different sources of information and the variable ways that information is organized; analyze the data collected for value, relevancy, quality, and suitability; and subsequently turn information into knowledge (ALA 1989). This involves a deeper understanding of how and where to find information, the ability to judge whether that information is meaningful, and ultimately, how best that information can be incorporated to address the problem or issue at hand.

Information literacy according to Darch et al. (1997) requires an awareness of the way in which information systems work, of the dynamic link between a particular information need and the sources and channels required to satisfy that need.

**Importance of Information Literacy**

The need to evaluate the credibility of information cannot be over emphasized, this is especially bearing in mind the continuous proliferation of different types of information, the need for them, and diverse medium through which they are disseminated, especially the contemporary electronic medium (internet etc).

To this effect, since anyone can make a Web page, the question is how one can tell how reliable such information is. A critical point about using the Internet is that individuals posting
An information literate person is according to ALA, (1999) ...is one who has learned how to learn. He knows how to learn because they know how knowledge is organized, how to find information and how to use information so that others can learn from them. They are people prepared for lifelong learning because they can always find the information needed for any task or decision at hand."

Conclusion

The Information Age which is characterized with information explosion in which even information professionals have lost count of what information is produced when, where, and at what time is no longer a mirage nor is it any longer a figment of imagination, it is now a reality and this revolution is rather exploding beyond what is known of it. Each day when one wakes up, some newer and more sophisticated information and Communication Technologies are either invented, re-invented, or improved upon, consequent upon this, something new information or knowledge is created and disseminated world over at the speed of light. Most of this information is disseminated electronically via the internet where everybody log-on to in order to post anything of his wish and its access is open to everybody as well. The fundamental issue therefore, is since this is now undermining the traditional pair-review of intellectual output, resulting in what some information specialist describe as “information overload,” the only and easiest way to manage the crises of information explosion is by being information literate.

Recommendations

In the light of the need for everybody to be information literate in order to equip themselves with adequate tools and attitude required to navigate the information superhighway, especially our teacher education students whom after school are expected to train others on how to continue learning in the spirit of lifelong learning, the following course programme is hereby proposed for discussion and consideration in line with the Association of College and Research Libraries ACRL, (2005) also endorsed by the American Association for Higher Education (October 1999) and the Council of Independent Colleges (February 2004) and equally recommended for Nigerian Teacher Education Institutions by Ojedokun, (2007). These course if effectively covered in a semester or two will sufficiently take care of the numerous problems our students face in knowing when information is needed, what type of information is needed, what source (reliable) to get the desired information, how to use information and most ultimately, how to cite and reference information source in these information saturated 21st century of ours.

**Suggested Course of Study on Information Literacy for Teacher Education and other Higher Education Institutions**

Course Title: Introduction to Information Literacy

Credits: 3 contact hours per week
Goal: This course is aimed at providing the students with the essential skills and attitudes required to function successfully in this Information Age.

GENERAL OBJECTIVE

At the end of this course, students should be able to:

1.0 Know the concept of Information
2.0 Know the various Sources of Information
3.0 Know Information Access tools
4.0 Know information search strategies
5.0 Know how to evaluate Information Sources
6.0 Know how to cite Information sources.
7.0 Know the legal issues in the use of Information

1.0 Know the concept of Information
1.1 Define Information
1.2 Explain the characteristics and types of information i.e. oral, textual, graphic, and numeric.
1.3 Explain the formats of information
   1.3.1 Print
   1.3.2 Audio-visual
   1.3.3 Micro-format
   1.3.4 Electronic etc.
1.4 Explain the importance of information
   1.4.1 To feed anticipation
   1.4.2 To reduce uncertainty
1.5 Understand the concept of “use of Information”

2.0 Know the various Sources of Information
2.1 Define information sources
2.2 Explain the different types of information sources with examples.
   2.2.1 Primary
   2.2.2 Secondary
   2.2.3 Tertiary

3.0 Know Information Access tools
3.1 Define information access
3.2 Identify and explain information access tools i.e. indexes, abstracts, bibliography, catalogues, OPAC, e.t.c.
3.3 Know the web search tools (web directories, search engines, library gate-ways etc).

4.0 Know information search strategy
4.1 Define information search strategy
4.2 Explain information search strategies
   4.2.1 Explain search preparation
   4.2.2 Query formulation
   4.2.3 Structuring of search query
   4.2.4 Application of Search strategy
   4.2.5 Explain web-search techniques/strategies

5.0 Know how to evaluate Information Sources
5.1 Define information evaluation
5.2 Identify and explain evaluation criteria
5.3 Explain how to evaluate on-line resources

6.0 Know how to cite Information sources.
   6.1 Introduction/definition of citation and plagiarism.
6.2 Explain the reasons for citation.
6.3 Identify and explain citation elements i.e. Author, Title, Date of Publication, Publisher, Place of Publication etc and their arrangements according to APA, AMA, MLA, Turabia, Chicago, etc.
6.4 Differentiate between reference citation and reference list (stating the location of each).

7.0 Know the legal issues in the use of Information
7.1 Define and explain “intellectual property” and “intellectual property right”
7.2 Explain what copyright is
   7.2.1 Ownership
   7.2.2 Coverage
   7.2.3 Statement
   7.2.4 Period of validity of copyright
   7.2.5 Fair use of copyright work

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EFFECT OF MUNICIPAL SOLID WASTE ON THE GROWTH OF MAIZE (Zea Mays L.)

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ABSTRACT

A pot experiment was conducted in the greenhouse to determine the effect of municipal solid waste on the growth of maize (Zea mays). Growth parameters of percentage emergence, plant height, leaf area and number of leaves per plant were collected and subjected into statistical analysis, using ANOVA and Fisher’s L.S.D. at 5% probability level. Plant growth parameters decreased with increase in cropping cycle. Similarly, maize grown on dumpsite soils did better than the control soil samples. It showed increase in plant height, leaf area and number of leaves per plant at a range of 16.82 cm to 12.87 cm, 5 to 4 and 64.69 cm to 59.88 cm for the dumpsite and control samples respectively. Soil pH, organic matter (OM), total Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sodium (Na) and Effective Cat-ion Exchange Capacity (ECEC) decreased with increase in cropping cycle respectively. The dumpsite soil sample recorded higher mean values than the control (P<0.05). There is every indication that municipal solid waste is beneficial to plant if only proper and careful sorting and separation of hazardous waste is done.

Key Words: Growth, Dumpsites, Municipal, Solid and Waste.

INTRODUCTION

Maize (Zea mays L.) is the most important cereal crop after rice in Sub-Saharan African and one of the three most important cereal crops in the world. Maize is high yielding, easy to process, readily digested, and cost less than other cereals. This annual plant of the gramineae family is descended from a common ancestor which is unknown or disappeared (Irvine 1970). Every part of the maize plant has economic value: the grain, leaves, stalk, tassel, and cob all are used to produce a large variety of food and non food products.

In industrialized countries, maize is largely used as livestock feed and as raw material for industrial products, while in low income countries, it is mainly used for consumption. In sub-Saharan Africa, maize is a staple food for an estimated 50% of the population (IITA, 2006). It is an important source of carbohydrate, Iron, Vitamin B, and minerals. Africans consume maize as Starch based Porridges, paste, grits and beer. Green maize (fresh on the cob) is eaten parched,
baked, roasted or boiled and plays an important role in filling the hunger gap after the dry season (IITA, 2006).

Municipal Solid Waste (MSW) are unwanted Bi-products of modern life, generated by people living in Urban areas. These are inclusive of all waste under the control of local authorities or agents acting on their behalf. Municipal Solid Waste has a compostable potential of 60-90%. It’s typical composition include paper, glass, wood, plastics, soils chemicals, food waste, plant debris, metal textiles and rock with the organic materials making up 50-70% of all Municipal Solid Waste (MSW). Ideally, the compost feedstock should only contain compostable materials such as food scraps, papers, cardboard, wood, non-compostable solid waste (glass, metals, and plastics).

In general, the fewer non compostable material in the feed stock, the better finished compost will be for agricultural used (Amusan et al, 2005).

Nutrient availability to plant is strongly influenced by organic and inorganic amendments that usually increase the amount of carbon and other nutrients, especially nitrogen. Organic matter is added to soil by the incorporating plant materials, animal residue manure, sewage sludge or municipal waste. Amendments not only influence soil fertility directly, but can also affect the composition and activity of soil organisms (Carmine et al, 2004). Peter (2005) also reported that municipal solid waste has the ability of improving soils that have been cropped for many years, but which may be deficient in nutrients such as Boron, Zinc, Copper, and municipal solid waste compost mitigate such deficiencies. Stengel 1995; Aghoola 1990 also added that crop residues contain considerable quantities of major crop nutrients as well as being source of organic matter.

Other benefit include improved soil physical characteristics such as nutrient retention capacity and stimulation of microbial activities that can improved plant growth and decrease the leaching of pollutants into waste supplies. Municipal Solid Waste (MSW) compost has been used to maintain the long term productivity of agro-ecosystem and to protect the soil environment form over cropping (Carmine et al, 2004). Nutrient availability to plant is strongly influenced by organic carbon and other nutrients, especially nitrogen.

Haven looked at the apparent problems of municipal solid waste, management and provable importance to plant growth. This study was carried out to see how municipal waste can affect maize growth.

METHODS AND PROCEDURES.

The research work was conducted in the green house of the Teaching and Research Farm of Bayelsa State College of Arts and Science (BYCAS), Agudama-Epie, Yenagoa. Yenagoa lies between latitude 04 15” North, 05 22” South and Longitude 05 22” West and 06 45” East.
Yenagoa is one of the rapidly growing cities in Nigeria with a population over 700,000 people covering an area of about 622.80km (62280.00 hectares). Yenagoa lies in the heaviest rainfall area in Nigeria, with heavy rain and short dry season (From November to March). The area has a humid tropical climate with a mean temperature of 30°C and mean annual rainfall range of 3000-4500mm BSCAC (2006).

Five (5) sampling locations were established. Municipal Solid Waste was collected from the different dump sites within Yenagoa metropolis as follows:

Location 1   -   Agudama-Epie
Location 2   -   Tombia Road
Location 3   -   Swali
Location 4   -   Igbogene
Location 5   -   Biogbolo

Location 2 is used by the Bayelsa State environmental Sanitation Authority for solid waste disposal. Others are used by the residence living in those areas. All the dumpsites are still active and have been used for the past ten (10) years. Apart from Location 2 that covers a large expanse of land, others are between 300-700sq meters. The waste at each dumpsite is generally unsorted and consists of all forms of agricultural, domestic, industrial and hospital waste, with a high percentage constituting mainly of domestic and house hold products.

**Sampling Procedure**

At each location municipal solid waste were randomly collected at a depth of (0-30cm) with the aid of an auger, and were placed into a well labeled polythene bags and pulverized differently. Control samples were also collected from fallow plots, at each location from a distance of 100m away from each dumpsite.

**Planting**

The Municipal Solid Waste and soil sample from the fallow plots were sent to the laboratory for analysis. The samples were air dried and sieved to pass through 2mm sieve. 50g of the Municipal Solid Waste was weighed into 2kg soil pulverized properly and the control sample were also weighed into 3 replicates all totaling 30 plastic buckets in the green house. The samples were kept wet daily for 20days before planting was done. This experiment was repeated the second time, after ten (10) days of fallow with constant watering to keep the soil samples at field capacity. The test crop (maize) was sourced from the International Institute of Tropical Agriculture (IITA), Yenagoa office, Bayelsa State. Four (4) seed were planted and later thinned down to two (2) stands with regular watering.

**Experimental Design/Tools for Data Analysis**
The complete Randomized Block Design was used, and ANOVA (fisher’s L.S.D.) was used to compare mean (Wahua, 1999). And the following plant parameters were collected for data analysis.

1. **Percentages Emergence**
   Crop emergence was analyzed as a percentage of seedlings of 4 and 5 days after planting (DAP) to the actual number of seeds planted. Plants that survived were counted.

2. **Number of leaves**
   The numbers of leaves per plant were counted starting from 2 to 4 weeks after the date of planting (WAP).

3. **Plant Height and Leaf Area**
   Plant height per plant were measured from the base of the plant to it tip. Leaf areas per plant were determined non-destructively by length x width method described by Savena and Singh (1965) using Linear equation. Leaf Area = 0.75 (LXW) from 2 to 4 weeks after planting (WAP).

**Soil Sampling and Analysis after planting**

The control and municipal solid waste mixed samples in the buckets were sampled at 0-7cm depth 6 weeks after planting (6 WAP). The respective soil samples were transferred for Laboratory analysis from the green house. Samples were air-dried and ground to pass a 2mm sieve prior to chemical analysis. Soil pH was determined on a 1:1 soil: H2O solution with a glass electrode pH meter according to the procedure of Tel and Rao (1982). Organic matter was determined using a modification of the method of Walkley and Black (1934). Total nitrogen was determined using a Techno icon auto analyzer (Technicon AAll) after digesting the sample with a mixture of concentrated Orthophoric and sulfuric acid in a tecato digester. Available phosphorus in the soil was determined by the Bray’ method using the Technico auto analyzer (Tel and Rao 1982). Exchangeable Cations were extracted with NH4 O4C + 0.00lm EDTA at 20:15 fresh soil: extractant ratio. The concentration of Calcium and magnesium in the extracts were determined with Atomic Absorption Spectrophotometer (AAS) were measured with a flame photometer. The Effective Cation Exchange Capacity (ECEC) was calculated by the sum of exchangeable cat ions and exchangeable acidity, expressed in an cmol kg-1 soil.

**RESULT**

**Plant Growth Parameters.**

The inclusion of municipal waste in the growth of maize was aimed at improving a source of nitrogen (N) to soil. The study reveals that there was significant effect of cropping cycle and the municipal solid waste from the various dumpsites on the emergence of maize see fig 1 and plate 1 to 10.
Plate 1 to 5 below are photographs taken at 4 weeks after planting in the first cropping cycle. It is obvious that the dumpsites did better than the controls.

Plate 1: Tombia Dump and Control (TOMD & TOMC)

Plate 2: Biogbo Dump and Control (BIOD & BIOC)

Plate 3: Igbogene Dump and Control (IGD & IGC)

Plate 4: Swali Dump and Control (SWD & SWC)

Plate 5: Agudama Dump and Control (AGD & AGC)
Plates 6 to 10 below are photographs taken at 4 weeks after planting in the second cropping cycle.

Leaf Number, Area and Plant Height.
The effect of cropping cycle has a significant difference on leaf number, area and plant height.

The leaf area, number and plant height decreased with increase in the cropping cycle see fig 2-4. There is also a significant difference between the various maize growth parameters. Maize grown on municipal solid waste mixed sample did better than the control samples. See table 1 and plate 1 to 10. This is in consonant with earlier work carried out by (Carmine et al, 2004). Nutrient availability to plant is strongly influenced by organic and inorganic amendments that usually increase the amount of carbon and other nutrients; especially nitrogen.
Table 1: Effect of Municipal Solid Waste on Maize Growth

<table>
<thead>
<tr>
<th>Dumpsite</th>
<th>% Emergence</th>
<th>Plant Height (cm)</th>
<th>Leaf No.</th>
<th>Leaf Area (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGD</td>
<td>84.42</td>
<td>13.98</td>
<td>5</td>
<td>32.27</td>
</tr>
<tr>
<td>AGC</td>
<td>89.58</td>
<td>8.26</td>
<td>4</td>
<td>39.72</td>
</tr>
<tr>
<td>TOMD</td>
<td>100</td>
<td>12.40</td>
<td>4</td>
<td>44.36</td>
</tr>
<tr>
<td>TOMC</td>
<td>91.67</td>
<td>9.15</td>
<td>4</td>
<td>34.94</td>
</tr>
<tr>
<td>SWD</td>
<td>99.09</td>
<td>13.47</td>
<td>5</td>
<td>48.41</td>
</tr>
<tr>
<td>SWC</td>
<td>68.18</td>
<td>12.87</td>
<td>4</td>
<td>59.88</td>
</tr>
<tr>
<td>IGD</td>
<td>70.83</td>
<td>16.82</td>
<td>4</td>
<td>64.69</td>
</tr>
<tr>
<td>IGC</td>
<td>66.67</td>
<td>13.09</td>
<td>5</td>
<td>30.32</td>
</tr>
<tr>
<td>BIOD</td>
<td>77.08</td>
<td>16.28</td>
<td>4</td>
<td>57.62</td>
</tr>
<tr>
<td>BIOC</td>
<td>93.75</td>
<td>12.16</td>
<td>4</td>
<td>53.72</td>
</tr>
<tr>
<td>LSD</td>
<td>15.0</td>
<td>1.74</td>
<td>0.4</td>
<td>10.32</td>
</tr>
</tbody>
</table>

P (<0.05) Agudama dumpsite and control (AGD & AGC), Tombia dumpsite and control (TOMD & TOMC), Swali dumpsite and control (SWD & SWC), Igbogene dumpsite and control (IGD & IGC) and Biogbolo dumpsite and control (BIOD & BIOC).

Table 2: Effect of Municipal Solid Waste on Soil Physiochemical

<table>
<thead>
<tr>
<th>DUMPSITE</th>
<th>pH</th>
<th>N (%)</th>
<th>P (ppm)</th>
<th>O.M. (%)</th>
<th>Ca (mol/kg)</th>
<th>Mg (mol/kg)</th>
<th>K (mol/kg)</th>
<th>Na (mol/kg)</th>
<th>ECEC (cmol/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGD</td>
<td>5.68</td>
<td>0.10</td>
<td>15.00</td>
<td>3.94</td>
<td>17.92</td>
<td>5.53</td>
<td>0.16</td>
<td>0.13</td>
<td>25.16</td>
</tr>
<tr>
<td>AGC</td>
<td>5.40</td>
<td>0.09</td>
<td>5.00</td>
<td>3.67</td>
<td>6.60</td>
<td>1.70</td>
<td>0.08</td>
<td>0.07</td>
<td>8.61</td>
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<tr>
<td>TOMD</td>
<td>6.25</td>
<td>0.08</td>
<td>12.00</td>
<td>3.31</td>
<td>10.83</td>
<td>3.33</td>
<td>0.17</td>
<td>0.71</td>
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<tr>
<td>TOMC</td>
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<td>0.07</td>
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<td>6.91</td>
<td>1.93</td>
<td>0.11</td>
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<tr>
<td>SWD</td>
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<td>7.00</td>
<td>4.45</td>
<td>14.93</td>
<td>3.49</td>
<td>0.14</td>
<td>0.09</td>
<td>20.19</td>
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<tr>
<td>SWC</td>
<td>5.87</td>
<td>0.05</td>
<td>5.33</td>
<td>2.09</td>
<td>6.16</td>
<td>1.42</td>
<td>0.09</td>
<td>0.05</td>
<td>9.48</td>
</tr>
<tr>
<td>IGD</td>
<td>5.81</td>
<td>0.21</td>
<td>17.67</td>
<td>6.98</td>
<td>12.88</td>
<td>4.14</td>
<td>0.13</td>
<td>0.13</td>
<td>19.21</td>
</tr>
<tr>
<td>IGC</td>
<td>5.89</td>
<td>0.13</td>
<td>10.67</td>
<td>3.00</td>
<td>13.25</td>
<td>3.42</td>
<td>0.09</td>
<td>0.05</td>
<td>18.47</td>
</tr>
<tr>
<td>BIOD</td>
<td>6.55</td>
<td>0.14</td>
<td>19.00</td>
<td>6.41</td>
<td>8.59</td>
<td>3.06</td>
<td>0.09</td>
<td>0.07</td>
<td>13.30</td>
</tr>
<tr>
<td>BIOC</td>
<td>5.86</td>
<td>0.07</td>
<td>11.22</td>
<td>3.04</td>
<td>7.28</td>
<td>2.69</td>
<td>0.09</td>
<td>0.07</td>
<td>11.67</td>
</tr>
<tr>
<td>LSD</td>
<td>0.02</td>
<td>0.02</td>
<td>0.74</td>
<td>0.03</td>
<td>0.89</td>
<td>0.17</td>
<td>0.01</td>
<td>0.01</td>
<td>0.02</td>
</tr>
</tbody>
</table>

P(<0.05) Agudama dumpsite and control (AGD & AGC), Tombia dumpsite and control (TOMD & TOMC), Swali dumpsite and control (SWD & SWC), Igbogene dumpsite and control (IGD & IGC) and Biogbolo dumpsite and control (BIOD & BIOC).
Municipal Solid Waste Effect on Soil Properties.

Earlier studies have shown that organic matter is added to soil by incorporating plant materials, animal residue manure, sewage sludge or municipal waste (carmine et al, 2004). Stengel 1995; Aghoola 1990 also added that crop residues contain considerable quantities of major crop nutrients as well as being source of organic matter. Some changes were observed of some available plant nutrients in the soil between before planting, first and second cropping cycle soil samples see. Fig 5-11 and Table 2. The effect of various cropping cycles on soil properties differs significantly. Soil pH reduced with increase in the cropping cycle that is the soil samples analyzed become increasingly acidic from before planting to the second cycle of cropping ECEC and phosphorus level also reduces from before planting to the second cropping cycle. For the organic matter, Nitrogen, Potassium and Sodium level in the various soil samples analyzed before planting commenced record higher levels and gradually reduced from first cropping cycle to the application of municipal waste had been used up by the maize grown in the first cycle. This is also in line with an earlier study carried out by (Ikpe et al, 1999) soil nutrients increased proportionally with increase in soil amendment application.

The various cropping cycles had significant effect on the level of calcium and magnesium levels in the soil samples analyzed. The level of both Ca and Mg levels decreased with increase in the cropping cycles.

CONCLUSION

The result of this study shows the importance of municipal solid waste in the growth of maize. The application of municipal solid waste had a significant effect on the performance of the growth parameters (plant height leaf area and number of leaves per plant measured with virtually all dumpsites doing better than their control. Also soil chemical properties (PH, N.P.K, OM, Ca, Mg, Na and (ECEC) measured decreased with increase in the cropping cycle. So there is every need to add municipal solid waste to soil to improve it fertility status, provided the materials are free from poisonous substances.

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GLOBALIZING VOCATIONAL AND TECHNICAL EDUCATION CURRICULUM FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

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Abstract

The paper is on globalizing vocational and technical education for sustainable development in Nigeria. The paper examines globalizing vocational technical education curriculum to enhance national growth and productivity in Nigeria. The paper also discussed sustainable scientific and technological development in Nigeria through revamping vocational and technical education and training for sustainable development. Finally, the paper has drawn conclusion with suggestions/recommendations on the need for government to take concrete measures to globalize and upgrade our vocational and technical education skills, techniques, knowledge and attitudes through the teaching/learning of vocational and technical education in our institutions of learning for sustainable development.

Keywords: Globalizing, Vocational Technical Education, Curriculum, Sustainable Development

Introduction

Globally, vocational and technical education is accepted as the acquisition of practical skills, attitudes, knowledge that is applicable to various trades or occupations for the advancement of social and sound economic life of the citizens. The best legacy to beneath to citizens is sound technical education skills, techniques and knowledge. In this 21st century it is quite obvious that, skills techniques and knowledge is the greatest asset to possess. Durosoro (2006) opined that, the traditional sources of wealth like gold, oil and other merchandises have already given way to thoughts and ideas. Mr. Bill gate, the richest man on the surface the earth today, did not by
knowledge, skills techniques and ideas of information communication technology (ICT). Durosaro maintained that, Japan, Malaysia and India are making billions of United States Dollars by exporting computer software rather than oil, cassava or gold. Indeed, this is a century of skills, techniques and knowledge and no one should be under the illusion that without knowledge he or she can hope to survive talk less of thrive.

Vocational and Technical Education in Nigeria should adequately provide the desired sound technical education to the citizens in Nigeria because the entire education system appears to be in crisis. There is the crisis of technical education funds and finances management, and crisis in teaching technical education institutions of learning. The problems of technical education are problems of every individual or household either directly or indirectly. The teachers, students, parents, Government at all levels should know the future developments, challenges and prospects.

Vocational Technical Education

According to Olaitan, Nwanchukwu, Igbo, Onyemachi and Ekong (1999) affirmed that, vocational technical education is education for work. It can be made available only for those who need it, because they are interested in it and also hope to progressively continue to participate in it. It is meant for those who can profit by it because they hope to sell the skills acquired through occupations and make a living. In vocational technical education technical teachers expose learners to learning in job related situations using functional teaching models in an environment that depicts real work situations.

National Policy on Education NPE (2004) stated that, vocational technical education is used as a comprehensive term referring to those aspects of the education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life.

Ogwu and oranu (2006) confirmed that, vocational technical education enables all types of learner to have lifelong education and to develop maximum self-potentials. Vocational technical education impart relevant skills for employment, to these groups of Nigerians, they will be enabled to play their roles in the development of the nation.

Also the thrust of vocational technical education is to prepare students or Nigerians with occupational skills that lead to employment in their chosen careers or depending upon their
individual goals. Furthermore, vocational technical education purpose is to provide students or citizens with skills they will need to obtain entry-level employment or to pursue further education after graduation.

**Sustainable Scientific and Technological Development in Nigeria through Revamping Technical and Vocational Education and Training (TVET) for Sustainable Development**

Sustainable Scientific and Technological Development in Nigeria through technical vocation and training (TVET) is significant and timely when we compare Nigeria (TVET) of developed or advanced or industrialized countries like Japan, United States of America, Germany and China we are really infants in technical and vocational sub sector. Technical and vocational education teacher’s minds should begin to revolve up to the point of suggesting new ways of beefing up our technical and vocational education programmes to conform to global standard so as to actualize vision 20:2020 and other transformation programmes.

Siegel (2008) noted thus;

"technical education and vocational education teachers should be involved in the following equality of instruction such as local exhibition, cooperating with various industries improvement of reading through technical and vocational education, field trips, updated technical and vocational education curriculum, recruitment of technical and vocational teachers and students clubs."

Revamping technical and vocational education in Nigeria would bring about many ideas, techniques, skills and professional suggestions to revitalize much of what technical and vocational education teachers and stakeholders are doing in technical and vocational education to create a climate or renitence that would surpass all that we or they accomplished in the past 52 years of independence. The Nigerian youths need to be encourage and motivated to attend institutions of learning and read technical and vocational courses and see tangible evidence of the need to listen, learn skills, techniques and aspire to make or produce or construct things of items selves. They need more direct activity for sheer motivation. They learn by as John Dewey said many years ago which is still valid.

Similarly, Olaitan, Nwachukwu, Igbo, Onyemachi and Ekong (1999) stated that;

"The present state of effectiveness of vocational and technical education is education for work and therefore, all human and materials resources required for the successful execution of this education should be given adequate attention by the government and policy makers. Since this attention has not been provided for the needed improvement of the available human and material resources the state of effectiveness of technical and"
Vocational education has remained very low, and remain so until adequate attention is given to it.

It is worthy to note that, until vocational and technical is revamped by means of manpower development, adequate funding, changes of technical and vocational education teachers attitudes towards their jobs, students attitudes towards technical and vocational education courses, trainee interest, retention and achievement, motivation of technical and vocational education teachers to mention but a few. This would be achieved by adopting good measures at various levels of government begin to bear fruits. If technical and vocational education is not revamped we would continued to observed sharp rise in business failures, unemployment and fall in the Nigeria industries, companies and factories declaring record losses.

Also, Ogwo and Oranu (2006) revealed that;

> Technical and vocational education when effectively handled will help in conserving and developing the vast natural resources available in the country. Given adequate technical and vocational training, Nigeria will be able to look inward and exploit the local materials resources as well as traditional inequality of ours. By the skillful adoption and creative invention of technology artifacts, one can genuinely describe a technology as Nigeria. These are some of the things the effectively organized technical and vocational education can help the country to achieve.

Revamping technical and vocational education would open the door to investors; it would lift a burden from the neck of Nigerians and would stabilize the economy. Nigeria government need to found or invest in considerable amount of money to achieve our independence in all sectors of the economy, such as importation of vehicles spare parts, fuel, food (rice) and other consumable goods. If technical and vocational education is not revamped, Nigerian’s could not avoid all the hazards consequences of using sub-standard products or items that are been produced by China and other developed and underdeveloped nations.

Nigeria, the giant of Africa may ran into a major glitch or problems, the consequences of which may still be suffering in years ahead because of non-revamping of technical and vocational education since 1960. The result is moderate decline in the production of qualified technical and vocational teachers, lack of machines, workshops or laboratories, lack of infrastructures etc. revamping technical and vocational education would urgently make Nigeria to be debt free, significantly saving Nigeria from heavy interest and penalty payments and it had to go through in the past, at present and future if technical and vocational education is revamped it would enhance national growth sustainable development and productivity in all sectors of the Nigerian economy.
Globalizing Vocational Technical Education Curriculum to Enhance National Growth and productivity in Nigeria

It is necessary for Nigeria to advance through globalizing vocational technical education curriculum to make her vocational and technical education curriculum very relevant through training and retraining of vocational technical education teachers in all the course or trades in vocational technical education and the acquisition of teaching and learning facilities for rapid growth and productivity.

This could be confirmed by Lall and Teubal (2001) when they argue that;

*Globalizing vocational and technical education curriculum for growth and productivity would enhance scientific and technological development which would be based on learning and stimulating. This process requires the setting of priorities, identification of linkages and selection of technological promotion. This requires an overall vision of where the economy should or could be heading. A failure of coordination amongst skills and techniques, policy can prevent an economy from achieving a higher development path. This is because moving into new activities and adopting new technology requires sufficient good quality and appropriately skilled workers with new technologies involves learning and acquiring practical experience as well as informal skills.*

Similarly, Dirk (2001) maintained that:

*Globalizing vocational technical curriculum has meant an increase in the development of technology, technology flows across countries and increased fragmentation of production processes worldwide. This has required an ever greater need for information flows to manage and take part in the process of globalization. Lack of information is precisely at the heart of market and coordination failures. So in times when technology moves faster and faster around the world, there is an increased need to be up to date with the latest needs for human resources development in order to solve market failures which would prevent a match between demand and supply of skills.*

Globalizing vocational technical curriculum is very important in the competitiveness in the global labour market. Appropriate training of Nigeria in skills acquisition will enable Nigeria and other developing countries to achieve the transformation of our workforce skills to match our economic, political, social, scientific and technological transformation. Globalizing vocational technical education curriculum would complement by a sophisticated and modern skills training system and lifelong learning.

Globalizing vocational technical education curriculum for national growth and productivity can only be effective in Nigeria if vocational technical education is practice as it is practice in developed nations like United States of America (USA), Japan, and Germany. But in Nigeria,
vocational and technical education is totally dependent on the expertise and facilities of other developed nations. Non-globalizing of vocational technical education curriculum would create a threat to the achievement of the Seven point Agenda of the Federal Government and Vision 20:2020

Similarly, Johansen and Adams (2004) said that:

Globalizing vocational technical education curriculum and reviewed skills development in Sub-Saharan Africa, which is on the whole very different from skills development in other regions. Management and finance provide powerful instruments for promoting reforms in vocational and technical education.

Nigeria at 52 years should crave for vocational technical education that could lead us to growth, productivity and development so as to reduce poverty and accomplish government strategic plans in all sectors of the economy for sustainable development strategic plans in all sectors of the economy for sustainable development. Nigeria, the Giant of Africa has not achieve any meaningful development in the vocational and technical education sector because of the neglect of vocational and technical education. This has greatly affected growth and productivity in all the sectors of our economy. Therefore, Nigeria would continue to lag behind in all the aspects of human endeavour and the eight Millennium Development Goals (MDGs), Seven point Agenda and vision 20:2020 all these would be a mirage or difficult to achieve if vocational and technical education is not given the desired attention.

But vocational technical education is the base or stratum which all the sectors of the economic hinge on for development in developed and developing countries. Getting vocational technical education curriculum globalized like developed Nations for efficient and rapid growth and productivity is an important first step in revamping vocational technical education for national growth and productivity.

We need to globalize our vocational technical education curriculum in all Nigerian vocational and technical education institutions in tune with highly industrialized countries curriculum so as to produce better quantity and quality vocational technical education graduates in Nigeria.

Conclusion
Globalizing vocational technical education for national growth and productivity in Nigeria require urgent government, stakeholders in vocational and technical education and the private sector intervention. Based on the above, discussion the following conclusions has been drawn:

- It is important and necessary to restructure and globalize vocational technical education curriculum in various educational programmes or courses in institutions of learning that link in with the demand of the citizenry.
- Vocational technical education curriculum globalizing should be undertaken urgently for the purpose of relevance and participate effectively at the global labour market and Nigeria would not be depending on other developing and developed countries for assistance on all the sectors of the economy for national growth and productivity.

**Recommendations/Suggestions**

Government should motivate vocational and technical education teachers by giving them incentives so as to improve the standard of training to remain competitive in the global labour market.

- Vocational and technical education should be given more attention, funds should be allocated to vocational and technical education hence globally, emphasis is on skill acquisition, education for scientific and technological self reliant because vocational and technical education affects social status of Nigeria.
- Hence vocational technical education is hinged on skills, knowledge and attitudes upgrading for national growth and productivity, vocational technical education institutions should be equipped, staffed with qualified vocational technical education teachers and new vocational technical education institutions should be establish in Nigeria to upgrade fresh graduates, old workers so that they may be highly productive and this would enhance national growth also.

**References**


QUALITY ASSESSMENT OF PEPPER PASTE USING DIFFERENT MILLING METHODS

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ABSTRACT

This paper focused on milling methods for pepper. Four milling methods were considered; Attrition, Stone, Mortar & pestle, and Blender. Investigation on the quality; the microbial analysis, the physiochemical analysis, and the sensory evaluation were carried out on pepper milled using these milling methods mention above. The output temperature of the pepper for stone, mortar & pestle, blender and attrition were 38.47°C, 38.47°C, 48.37°C and 48.47°C respectively. The yield efficiency of the pepper for Attrition, mortar & pestle and Blender were 87.1%, 90.47%, 94.4% and 96.17% respectively. Total plate count, coliform count and fungal count for Attrition, Stone, mortar & pestle and Blender were 1.6 x 10⁻⁶, 2.3 x 10² & 8 x 10⁻⁵; 1.65 x 10⁻⁵, 1.29 x 10² & 2.08 x 10⁻³; 7.4 x 10⁻⁶, 4.9 x 10⁻³ & 1 x 10⁻⁴; and 2.28 x 10⁻⁹, 1.33 x 10⁻² & 2.16 x 10⁻³ respectively. Showing that Attrition had the highest level of microbiological contamination. Physiochemical analysis of the product for Attrition had reduction in protein, ester extract, (fat), ash and crude fibre. It also has high level of iron, zinc, and magnesium compared to the other methods of milling, these show that the nutrient contents of the product was adversely affected. Sensory evaluation shows that the colour and texture of the pepper milled with Attrition and stone were preferred above mortar & pestle and blender. In terms of quality, stone and Mortar & pestle have advantage over Attrition and blender, with the nutrients having little or no significant damage with less microbial contamination.

Keywords: Quality, Pepper, Milling, Methods, Assessments

INTRODUCTION

Pepper is often described as the king of spices and it shares a place on most dinner tables with salt. The word pepper originated from the Sanskrit word “pippali”, meaning berry. It is grown almost every part of the world today. It also comes in different sizes, colors and shapes. The colors can either be white, black, red or green (Azghar Ali Farooqi et al., 2005).

Pepper as other vegetables serves as a good source of antioxidant substances such as carotenoids (provitamin A) and vitamin C which confer protection against carcinogenic components and delay aging process. It is also rich in ascorbic acid and other phytochemicals. Red pepper is
sensitive to aflatoxin contaminations depending on the atmospheric temperature, humidity, drying and processing conditions.

Traditionally, pepper is processed either in its fresh form or dry state. In the ancient times pepper is mostly milled using stone mill or mortar with pestle. With the introduction of technology, other forms of milling methods are now being introduced. Despite the introduction of new, easy and contamination - free milling methods, many people still prefer the ancient and local ways of milling pepper claiming that it is more nutritional than the ones milled using the new technology.

The major components of the soluble neutral sugars found in pepper fruit are sucrose, glucose and fructose which is responsible for its sweetness (Luning et al. 1994). Fructose and glucose constituted the known fermentable sugars in beans, cucumbers and pepper (both in green and red pepper) (Nielson et al., 1991).

The most apparent changes in term of composition and size occur in the pectic fraction of the cell wall, which include increased solubility, depolymerization, de esterification and a significant net loss of neutral sugar-containing side chains (Fisher and Bennett, 1991; Seymour and Gross, 1996). Arancibia (2003) suggested that disruption side chains of the cell wall structure and separation of cellular components by grinding with 100% alcohol facilitated the released of soluble pectin. He concluded that pectin content remained the same throughout the ripening process which ranged between 78µg/mg to 104µg/mg with an average of 88µg/mg.

Pungency in pepper is due to the amount of capsaicinoids, including capsaicin and four structurally related compounds namely nordihydrocapsaicin, dihydrocapsaicin, homocapsaïn and homodihydrocapsaicin (Hoffman et al., 1983). These are alkaloid compounds that produce the hot flavor or pungency associated with eating chili (Collins et al. 1995). Pungency is the most outstanding property of capsicums, resulting from the direct effect of capsaicin. Capsaicin content, as determined by the method outlined by Bajaj (1980).

Deshpande et al. (1982) reported that phosphate in plant is stored in seeds as phytate and is present in the outer aleurone layer of the cotyledons of the endosperm. Phytate affects the nutrient availability and reduces protein quality. Phytate also interact with protein and reduces protein solubility and availability (Sathe and Salunkhe, 1984).

Polyphenolic compounds adversely affect protein digestibility and may inhibit hydrolytic enzymes such as α-amylase. Polyphenols also impart intense colour and off flavours. (Deshpande and Damodaran, 1990; Sathe and Salunkhe, 1984).

Many food processes frequently require the reduction in size of solid materials for different purposes. eg. Size reduction may aid other process such as expression and extraction or may shorten heat treatment, as in blanching and cooking. Comminution is the generic term used for size reduction and includes different operation such as crushing, grinding and milling, mincing and dicing. Most of these terms are related to a particular application. The reduction mechanism deforms the pieces of food until it breaks or tears. Breaking of hard material along cracks or deflects in their structure is achieved by applying diverse forces. The types of forces commonly used in food processes are compressive, impact, attrition or shear and cutting (Brennau et al., 1981).
It is also accepted that only a small percentage of energy supplied to the grinding equipment is actually used in the breakdown operations. Much of the input energy is lost in deforming the particles within their elastic limits and through inter-particle friction. A large amount of this wasted energy is released as heat, which in turn may be responsible for heat damages of biological material.

Milling is a unit operation designed to break a solid material into smaller pieces (Mc Gee 2004). It is also used to create a free-flowing material. Milling usually involves constraints with regard to particle size. Particles size is controlled by using different screens and clearances. The type of mill used also has a major impact on quality yield of the output. Milling is divided into wet and dry milling. Wet milling is used to produce to produce fiber starch and protein extracts. Kethireddipalli et al. (2002) reported that freshly wet milled paste produces dishes of superior quality. Overall wet milling produced a superior taste and end product.

Milling involves the application of external force; the amount of particles reduction caused by the external forces depends on the amount of energy applied to the particle, the rate at which it is applied (Wennerstrum et al., 2002).

**MATERIALS AND METHODOLOGY**

Sixty grammes of pepper were milled, using Attrition, Stone, Mortar & pestle, and Blender. The following parameters were measured during the milling process: time taken to mill and temperature. Sensory evaluations, such as texture and colour were carried out by setting up panelists. Microbial analysis (total plate count and coliform count) was carried out on each of the output. Nutritional analyses were also carried out. The output/yield percentage was calculated using the expression below

\[
\text{yield} \% = \frac{\text{output}}{\text{input}} \times 100
\]  

(1)

The throughput value was also determined using the expression below according to Kethireddipalli et al., (2002.)

\[
\text{Throughput} = \frac{\text{mass of input}}{\text{time}} \text{ (kg/min)}
\]  

(2)

Measured parameters of the chemical analyses of the milled samples from the different milling methods include alkalinity, acidity, chloride and hardness using standard methods. The amount of iron and magnesium present were measured using the method described by Olutiola et al. (1991).

Proximate analysis was also carried out. The following parameters were measured: moisture content, ash content, crude fat, protein, crude fibre, carbohydrate and vitamin C using standard methods. Sensory evaluation was also carried out using the 9 - point Hedonic scale.
RESULTS AND DISCUSSION

The mean values of the milling parameters is presented in Table 1.

Table 1 Mean parameters of milling methods

<table>
<thead>
<tr>
<th>S/N</th>
<th>Attrition milling</th>
<th>Stone milling</th>
<th>Mortar and pestle</th>
<th>Blender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milling time (min)</td>
<td>6.87 (±0.25)</td>
<td>13.17 (±0.37)</td>
<td>14.77 (±0.38)</td>
<td>6.27 (±0.15)</td>
</tr>
<tr>
<td>Temperature(°C)</td>
<td>48.47 (±0.25)</td>
<td>38.47 (±0.06)</td>
<td>38.47 (±0.06)</td>
<td>42.37 (±0.06)</td>
</tr>
<tr>
<td>Yield %</td>
<td>87.1 (±0.3)</td>
<td>90.47 (±0.21)</td>
<td>94.4 (±0.3)</td>
<td>96.17 (±0.15)</td>
</tr>
<tr>
<td>Throughput (kg/min)</td>
<td>8.76 (±0.33)</td>
<td>4.6 (±0.12)</td>
<td>4.07 (±0.11)</td>
<td>9.59 (±0.24)</td>
</tr>
</tbody>
</table>

The standard deviations are in parenthesis.

The results on the microbial analysis of the different milling methods are as shown in Table 2.

Table 2 Mean value of Microbial analysis

<table>
<thead>
<tr>
<th>Organism isolated</th>
<th>Attrition milling</th>
<th>Stone milling</th>
<th>Mortar and pestle</th>
<th>Blender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total viable count (cfus/g)</td>
<td>5333</td>
<td>5600</td>
<td>2467</td>
<td>7600</td>
</tr>
<tr>
<td>Organism isolated</td>
<td>Bacillus spp; Pseudomonas sp; Flavobacterium sp</td>
<td>Bacillus spp; Pseudomonas sp; Flavobacterium sp</td>
<td>Bacillus spp; Pseudomonas sp;</td>
<td>Bacillus spp; Pseudomonas sp;</td>
</tr>
<tr>
<td>Total coliform count (cfus/g)</td>
<td>7667</td>
<td>4300</td>
<td>1633</td>
<td>4433</td>
</tr>
<tr>
<td>Organism isolated</td>
<td>Aeromonas sp; Enterobacterium sp</td>
<td>Aeromonas sp;</td>
<td>Aeromonas sp;</td>
<td>Aeromonas sp;</td>
</tr>
<tr>
<td>Total plate count (cfus/g)</td>
<td>2667</td>
<td>6933</td>
<td>3333</td>
<td>7200</td>
</tr>
<tr>
<td>Organism isolated</td>
<td>Aspergillus spp; Rhizopus sp</td>
<td>Aspergillus spp; Rhizopus</td>
<td>Aspergillus spp;</td>
<td>Aspergillus spp; Rhizopus sp</td>
</tr>
</tbody>
</table>

The physiochemical properties of the milled pepper using the four different milling methods are presented in Table 3.
Table 3  Mean values of physiochemical parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Attrition milling</th>
<th>Stone milling</th>
<th>Mortar and pestle</th>
<th>Blender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content (%)</td>
<td>87.23 (±0.12)</td>
<td>86.73 (±0.15)</td>
<td>84.37 (±0.15)</td>
<td>85.73 (±0.15)</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>1.3 (±0.1)</td>
<td>1.47 (±0.06)</td>
<td>1.63 (±0.06)</td>
<td>1.57 (±1.14)</td>
</tr>
<tr>
<td>Ether extract (fat) %</td>
<td>0.47 (±0.06)</td>
<td>0.53 (±0.06)</td>
<td>0.57 (±0.06)</td>
<td>0.53 (±0.06)</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>2.83 (±0.12)</td>
<td>3.1 (0)</td>
<td>3.1 (±0.51)</td>
<td>3.07 (±0.06)</td>
</tr>
<tr>
<td>Crude fibre</td>
<td>2.17 (±0.15)</td>
<td>2.4 (0)</td>
<td>2.4 (±0.1)</td>
<td>2.33 (±0.06)</td>
</tr>
<tr>
<td>Carbohydrates (by difference) %</td>
<td>6 (±0.17)</td>
<td>5.73 (±0.15)</td>
<td>7.93 (±0.06)</td>
<td>6.77 (±0.06)</td>
</tr>
<tr>
<td>Ca ++ (mg/100g)</td>
<td>65 (0)</td>
<td>66.33 (±0.57)</td>
<td>66.67 (±0.58)</td>
<td>65.33 (±0.58)</td>
</tr>
<tr>
<td>Fe ++ (mg/100g)</td>
<td>4.87 (±0.12)</td>
<td>2.97 (±0.06)</td>
<td>2.13 (±0.06)</td>
<td>2.4 (±0.1)</td>
</tr>
<tr>
<td>Zn ++ (mg/100g)</td>
<td>0.67 (±0.06)</td>
<td>0.4 (0)</td>
<td>0.3 (0)</td>
<td>0.43 (±0.06)</td>
</tr>
<tr>
<td>Mg ++ (mg/100g)</td>
<td>1.53 (±0.06)</td>
<td>1.2 (0)</td>
<td>1.3 (0)</td>
<td>1.3 (±0.1)</td>
</tr>
<tr>
<td>PO4- (mg/100g)</td>
<td>85 (0)</td>
<td>86.67 (±5.77)</td>
<td>90 (±5)</td>
<td>90 (0)</td>
</tr>
<tr>
<td>Ascorbic acid (mg/100g)</td>
<td>35.23 (±0.25)</td>
<td>45.23 (±0.25)</td>
<td>35.23 (±0.2)</td>
<td>45.13 (±0.12)</td>
</tr>
<tr>
<td>Foaming capacity (%)</td>
<td>13.03 (±0.21)</td>
<td>13.83 (±0.80)</td>
<td>13.83 (±0.15)</td>
<td>13.3 (±0.17)</td>
</tr>
<tr>
<td>Foam stability (%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total titratable acidity</td>
<td>0.89 (±0.01)</td>
<td>0.86 (±0.01)</td>
<td>0.83 (0)</td>
<td>0.86 (±0.01)</td>
</tr>
</tbody>
</table>

The standard deviations are in parenthesis.

Table 4 shows mean values of sensory evaluation carried out for the different milling methods

Table 4  Mean value for sensory evaluation

<table>
<thead>
<tr>
<th>Milling methods</th>
<th>Colour</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attrition milling</td>
<td>Very much dislike</td>
<td>Moderately like</td>
</tr>
<tr>
<td>Stone milling</td>
<td>Very much dislike</td>
<td>Moderately like</td>
</tr>
<tr>
<td>Mortar and pestle</td>
<td>Moderately dislike</td>
<td>Very much dislike</td>
</tr>
<tr>
<td>Blender</td>
<td>Slightly like</td>
<td>Neither like or dislike</td>
</tr>
</tbody>
</table>

Discussions

During the milling processes, it was observed that it took a longer time using stone, and the mortar and pestle but the output’s temperature was low. Attrition milling and blender took a shorter period but the temperature of the output was high. It was noted that the milling time for mortar and pestle also depends on human factor; this is because it requires high energy. The miller stops milling as soon as he gets tired. But it’s less stressful when compared to stone milling. Table 1 shows the difference in the milling time of the four milling methods used. The milling time for mortar was found to be highest and despite the time being used, its output remains coarse unlike that of attrition milling and blender which takes a shorter time to mill but still has a smooth texture when compared to mortar and pestle.
High temperature is said to reduce some nutrients like protein and dietary fibre in foods. After milling, it was observed that the temperature of the product from the different milling methods varies. The exit temperature of the product from Attrition milling and Blender was observed to be higher while that of Stone mill and Mortar were low (Table 1).

There was a decrease in the output of pepper when using attrition mill; this was because most of the pepper got stuck in the mill discs of the machine. There was a greater yield percentage in the product milled from Blender when compared to the other three methods. The yield percentage from stone is also high but there were some losses and this was as a result of the surface of the stone used in milling.

In terms of texture, attrition milling is the smoothest and that of stone milling is also smooth but this was obtained after repeated milling. The texture of output from blender and, mortar and pestle is coarse. A panelist was set up and it was observed that most of them preferred the texture from attrition mill. In terms of colour, the product from attrition mill was found to be different when compared to others. When the products were observed, it was noted that the product from Attrition milling had a dark red colour, this was as a result of the material used for constructing the machine, and the grease used for lubricating the moving parts.

The outputs, when subjected to physiochemical analysis, it was observed that there was a significant decrease in the protein, fat and fibre contents of the product from attrition mill. This was as a result of the high temperature recorded from the use of the machine. It was also observed that there was an increase in the iron and zinc content; this was as a result of the material used for constructing the machine. During the milling process, the movement of the rotating parts causes tiny chips of metal to get into the food. When this happens, there is a chemical reaction between the food and the chips that falls in them. This can be harmful to the human health. It was also observed that the milled food from Attrition mill was very acidic when compared to the other milling methods. Acidity of the food is said to be as a result of the chemical reactions that took place in the food. It was observed that Mortar and pestle had the highest amount of carbohydrates.

Microbial analysis carried out as presented in Tables 2 shows that, there was a large amount of fungi found in the product from Attrition milling. The microbial load or contamination was found to be lowest in the product from Mortar and pestle. The contamination load in the product from Attrition mill was as a result of hide outs found in the machine.

Contamination from mortar and stone depends on the hygiene of the user. It was observed that when a hole appears on the surface of the stone where food is milled, the continuous rubbing of the grinding stone against the stone’s surface automatically smoothen the surface. It was also observed that the position of the person milling with stone matters a lot. The miller should be in a squatting position and must not bend over the stone, thereby preventing sweat from getting in contact with the food. It was also observed that the wood for the construction of Mortar affects the quality of the product.
CONCLUSION

Every consumer of food has preference on what type of processing technique to use. From the analysis done, it was discovered that stone and Mortar had minimal disadvantages. Most or if not all the nutrients in pepper are kept intact, with little or no significant damage. The use of these milling method; stone and Mortar is the best because the product can still retain its quality in order to provide the body with the necessary requirement. Most people use Attrition mill every day without knowing the implication it has on their health.

It can be concluded that the quality of pepper can still be kept undestroyed when the right milling method is used. The pepper milled on stone and mortar is of a better quality than that of blender and attrition mill, but it is time consuming and requires a great deal of labour. Commercially, the use of stone mill or mortar to mill a large quantity of pepper can be discouraging. But attrition mill can mill a larger quantity of pepper at a shorter time.

Recommendations

From the results, it was discovered that the pepper paste from stone mill was of a high quality when compared to the other methods used. But the use of stone is an ancient and outdated way of milling pepper. It is time consuming and strenuous. Therefore, the following were recommended;

1. That attrition mill should be constructed using stainless steel material.
2. The amount of water to be used during the milling process should be specified. This will help to reduce the amount of soluble protein that will be washed away.
3. Because of the rapid growth in technology, the limestone used in stone milling can be used in constructing the grinding part of the attrition mill. This can be achieved by cutting the stone into disc and then attached to attrition mill or a plate mill. Its operations are essentially the same in that mechanical shearing and compression on the material are the main grinding forces.

REFERENCES


